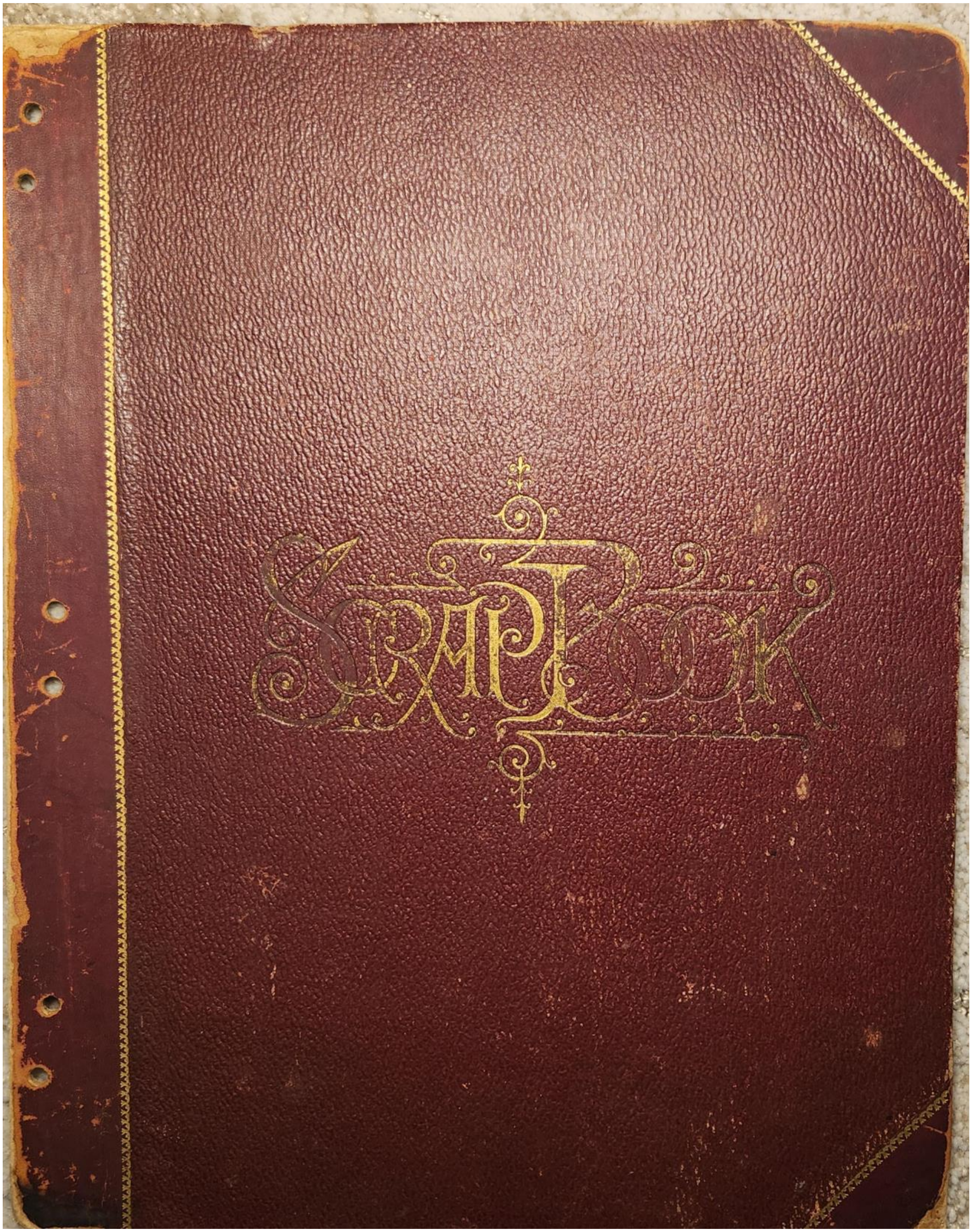
Scrap Book

(7148) S. W. B. writes: I have a lot of rubber garden hose that is cracking on the outside from exposure to the sun and rain. Can you tell me what to apply to stop it? Also tell me how to make a waterproof paint or coating for the inside of an iron tank to keep from rusting. A. Rubber Hose, etc., to Soften.—1. Dip in petroleum, expose to the air, and repeat the operation if necessary. 2. Ammonia, 2 parts; water, 4 parts. Expose for a few minutes. 3. If very hard, soften with vapor of carbon bisulphide, with the further application of vapor of kerosene. Coat your iron tank with asphaltum varnish to prevent it from rusting.

(7471) C. [illegible] B. says: Can you furnish, through your Notes and Queries in the SCIENTIFIC AMERICAN, a receipt for making a salad dressing of the mayonnaise variety, but having keeping qualities that will render it suitable to be put up in bottles, and kept as a stock article?

A.

Powdered turmeric	1	oz.
Powdered tragacanth	1	"
Olive oil	8	"
Eggs	8	"
Water	5¾	pts.
Ground mustard	1½	oz.
Salt	8	"
Acetic acid (glacial)	2	"
Tincture of capsicum (Or according to taste.)	½	"
Sugar	1	lb.

Mix the first three ingredients in a mortar capable of holding one gallon, then add the eggs, which have been whipped previously, and incorporate thoroughly until an emulsion is formed; next mix separately the mustard and water, allow to stand ten or fifteen minutes, or until the flavor is fully developed, then add the last four ingredients, mix and add the liquid gradually to the contents of the mortar. It should make a smooth, uniform emulsion; finally, strain through cheese cloth. This is a seasonable preparation, and may serve not only for the delectation of the pharmacist himself, but would furnish an article of sale as well.

(7406) A. E. writes: The following experiments are interesting, if not important; they may not be new, but I have never seen them or read of them. If you think them worthy a place in the SCIENTIFIC AMERICAN or SUPPLEMENT they are at your service. Cut a piece of paper or card about two inches square, and stick it against the glass of a window. Look at this card through a prism, and you will see blue at the top of the card and violet beneath the blue. At the bottom of the card you will see red, and yellow beneath it. So we get the most refrangible colors at top, and the least refrangible at bottom. Now place a second card same as the first just below, about half inch from the first, so that the blue at the top of the second card falls on or mixes with the yellow of the upper one, and the result of the union of the two, Y and B, is a beautiful green. I think this is not in accord with modern views, but the fact

counted for. [A. This is a very pretty experiment, which we do not remember to have seen put in this form before. The principle is not new. The edges of all objects seen through a prism or unachromatic lens are fringed with colored bands by the decomposition of the light into its various wave lengths. The production of green light by passing white light through yellow and blue light is not difficult of explanation by "modern views" and accords with them, as may be easily proved by a spectroscope. The yellow seen in this case is opaque to and cuts off blue, indigo and violet; similarly the blue is opaque to and cuts off red, orange and yellow. The only color which can pass through both the yellow and the blue is green. It is therefore seen whenever yellow and blue are s[illegible] placed that we look through or at them together. It is easy of proof that the yellow and blue lights when mixed form, not green, but white, that is, they are complementary colors. In a darkened room project upon the wall the yellow and then over it the blue, by some arrangement of mirrors or two lanterns, and where both lights fall on the same space, the wall is white.—EDS.]

(7409) E. A. B. asks for a receipt for making a kind of resin which is of a more sticky nature than the common resin used for violins, a kind of resin which is sticky enough so that, if applied to a violin bow and drawn across a steel string (touching very lightly), it will take effect. A. 1. For violin resin boil down Venice turpentine with a little water until a drop cooled on a piece of glass is of proper consistency. During the boiling cold water must be added from time to time. When sufficiently thick pour into cold water, knead well, and when cold break into pieces. Expose to sun until dry and transparent. 2. Select the best clear brown resin, melt it in a clean basin to nearly a boil, which will clear it of turpentine or other volatile oils. Pour in paper molds.

Hardened and Washable Articles of Plaster of Paris.—For the hardening of gypsum a firm in Heidelberg has taken out a German patent on a process which apparently surpasses all those in existence and furnishes very satisfactory results. Either burnt gypsum is prepared and mixed with the liquid named below or else the finished articles of hot gypsum or of mixtures of gypsum and other bodies are impregnated by painting with the fluid. The same consists of a solution of ammonium triborate in water. For this purpose boracic acid is dissolved in warm water and a certain amount of ammonia is added, whereby a substance readily soluble in water and deviating much in its properties from known compounds results. The saturation of the gypsum or painting of the plaster of Paris articles is carried out in the cold. The objects are subsequently rinsed off and dried. The surface becomes very hard after two days and insoluble in water, while the induration in the interior advances more slowly. By means of the fluid described gypsum floors can be hardened and rendered more durable and impervious to the influence of the weather. Saturating with ammonium borate is said to be especially useful on exterior walls of buildings, barracks, etc.; on the latter, because experiments have proved an antiseptic action of the liquid.

Transferring Pictures, Prints, Etc.—In order to transfer prints of various kinds to glass, wood, etc., soak them for a short time in a solution of 10 parts of potassium hydrate in 90 parts of alcohol (more or less). This procedure is to soften the varnish in the printer's ink. After rinsing in pure water the print is placed face down on the plate which is receive the picture or print, covered with a dry sheet and then pressed with squeegee or in a letter press.

Colored prints are painted over with a colorless, sticky varnish, pressed against the object intended to receive them, and, when dry, the paper is removed by rubbing cautiously with an aqueous solution of potash.

Some years ago a French typographical journal gave the following curious process for the reproduction of any printed design whatever—pictures, printed pages, etc. The paper to receive the reproduction is treated with the following, which is applied with a sponge, or, preferably, with a soft, flat brush:

Gelatine	10 parts
Ferric chloride	22 "
Tartaric acid	10 "
Zinc sulphate	10 "
Distilled water	400 "

Mix in the dark, and keep in a deep, orange colored glass bottle (an ordinary bottle, tightly covered with a heavy, yellow colored paper, and kept in a close pasteboard box, will answer). The coating should be applied in a dark place, and the paper dried in the dark. When dry, place the design on the coated surface, and bring into close contact. Place on a sheet of glass, cover with another, clamp together, and expose to the direct rays of the sun until the yellow cover of the surface of the sensitive paper is bleached to a white. Remove from light, and develop by leaving for three or four minutes in the following:

Gallic acid	2 parts
Alcohol	7 "
Distilled water	100 "

If left exposed exactly the right length of time, the lines will appear on a white ground of an intensely black color. If exposed too long, they will become more or less gray.—Pharmaceutical Era.

To Blacken Wood.

M. Koninck suggests the following method of blackening wood, which has the advantage of resisting acids and alkalies:

A.

Cupric chloride	75 parts.
Sodium chlorate	67 "
Water	1000 "

B.

Aniline hydrochlorate	150 parts.
Water	1000 "

Paint the wood with A and a short time after with B, and remove with a damp cloth the yellow powder that forms. Repeat this operation every day till the desired color is obtained, and then rub the wood with vaselin or linseed oil. By using potassium bichromate instead of the soda salt, a good black color is obtained at once.—The British Journal of Photography.

(8645) A. B. D. [illegible]ks: In applying gold leaf to sign work, what would be the sizing used? A. In wood signs use gold size. For glass signs use a thin solution of gelatin.

SELECTED FORMULÆ.

A simple fire extinguisher may be made by any one at small cost, by dissolving two pounds of common salt and ten pounds of ammonium chloride in three quarts of water and filling the solution into quart bottles of thin glass. This mixture has been found very suitable for extinguishing small fires. The bottles must be tightly corked and sealed, to prevent evaporation. At the breaking out of a fire, the bottles are thrown into the flames or their vicinity, and the extinction is effected by the contents of the breaking bottles. —Südd. Ap. Ztg.

Miscellaneous Notes and Receipts.

The Uses of Chrome Glue Especially as Glass Cement.—Chrome glue is known to consist of a moderately strong gelatine solution (containing 5 to 10 per cent of gelatine) to which about one part of acid chromate of potassium in solution is added to every five parts of gelatine. This mixture possesses the property of becoming insoluble by water through the action of sunlight under partial reduction of the chromic acid, a property which is advantageously utilized in photography. The author coated both fractures of a glass as uniformly as possible with the freshly prepared solution, pressed them together, and fixed them in this position with a cord. The cylinder glass was exposed to the sun light and was found to be firmly united after a few hours. Even hot water did not dissolve the oxidized chrome glue, and the fracture was scarcely noticeable. Valuable articles of glass, which would be disfigured by a thick cement joint, can be very nicely repaired in this manner.

In the production of waterproof textures chrome glue is likewise of use; at least, where a certain tightness is no drawback. The fabric, after having been put in a frame, only needs to be painted one to three times with the hot chrome glue and then to be exposed to the sun light or day light.—Prof. Schweizer, in Textil Zeitung.

Mode of Preserving Flowers and Grasses.—In drying flowers and grasses, which are to retain their fresh colors and natural shades, proceed as follows: Take a box with a sliding cover, remove the bottom and immediately below the lid (inside the box) attach a medium fine wire sieve. Procure fine, clean sand, sift off the dust, wash out the sand and dry it at moderate heat. Then warm the sand again in a copper kettle and after it has become hot enough add one-half part (weight) finely scraped stearine to one hundred parts (weight) sand: this is mixed and intimately incorporated with the sand, so that each grain receives a coating of stearine. Cut well developed specimens of flowers or ornamental grasses, place the box with the sliding cover and sieve downward, put in a layer of sand about two inches high, stick the flowers, etc., into this and cover them gradually with sand, but in such a manner that the stems and leaves retain their natural position. Thus continue with alternating layers until the box is filled, then put on the bottom carefully and set the box in a warm place, which must not be too hot. After about forty-eight hours drying is finished the box is taken down and the sliding cover pulled off carefully; the sand will fall through the sieve [illegible] flowers, grasses, etc., remain dr[illegible] shapes and colors.

—K[illegible] Licht.

To Render Fine Fissures in Tools, etc., Vis[illegible] [illegible] order to make the extent of fine cracks in to[illegible] visible, it is recommended to moisten the su[illegible] the cracked article with petroleum, to rub off and to wipe off the surface with chalk. The pet[illegible] which has entered the fine cracks sw[illegible] ent is visible in its whole extent.—Oe[illegible] uer Berg- und Huettenwesen.

Miscellaneous Notes and Receipts.

Autographic Ink.—Autographic ink is made by melting together the following substances: 10 parts soap (white grain soap), 10 parts wax, 3 parts tallow, 5 parts shellac, 5 parts mastic, 3 parts lampblack.

(7138) A. H. C. says: Can you inform me where I can get a cement which is not soluble in alcohol and that will hold glass? A cement, for example, that would mend a glass whisky or brandy flask so that it would hold liquor. A. Take the best kind of glue; pour on an equal quantity of water; let it soak overnight; next morning melt it over a gentle heat, and add fine Paris white or white lead; mix well, and add a little acetic acid, carbolic acid, oil of cloves, or any other ethereal oil, to prevent putrefaction. This cement is also adapted for flexible objects like leather. It will not withstand boiling water well, as this softens the glue.

(7139) E. G. B. asks for a recipe for making grafting wax. A. Grafting wax:

1. Pitch. .... 4 oz.
   Resin .... 4 "
   Lard .... 2 "
   Beeswax .... 2 "

Melt over a slow fire, or

2. Melt together equal quantities resin and beeswax, and add enough tallow to produce the proper consistency. Grafting wax:

3. Pine resin .... 50 parts.
   Tallow .... 10 "
   Turpentine .... 5 "
   Alcohol, 90 per cent .... 5 "

The resin is melted in an iron vessel. The turpentine is added, next the tallow, and finally the 90 per cent alcohol. Stir the ingredients thoroughly and cool.

(7140) H. I. F. ...

(7135) M. P. S. writes: In your issue of January 16, under the head of Science Notes, you state the coldest region on earth is the country around Werchojansk, in Siberia, where the thermometer sometimes falls below 68° Centigrade below zero (90° F. below zero). Are you not in error when you say 68° = 90° Fah.? Does not 68° C. = 154⅖° Fah.? ... formula is ... taught. A. The article you refer to is correct ... degrees below 0° C. are minus quantities, so that ... dition, being algebraic, involves an arithmetical ... tion. Those not conversant with algebra, ... below 0° C. may proceed as follows: If the ... the multiplication of degrees below zero Centigrade ... 5. (a) less than 32, subtract it from 32; if (b) ... than 32, subtract 32 from it. The result of a is to ... pressed as degrees above zero Fah.; the result of b ... be expressed in degrees below zero Fah. But treated algebraically the formula is correct. Thus −68 × ... −122⅖; adding 32 we have −122⅖ + 32 = −90⅖. The process gives a fraction more than 90° Fah. below zero as the equivalent of the Centigrade degrees, which corresponds with the article, except that the fraction is omitted, as of inconsiderable amount.

(7136) G. F. H. writes: 1. Is there ... compound, not poisonous, which, when paper is moistened with a solution of it and a current of electricity passed through the paper, will give the same ... result as is obtained by like treatment of paper moistened with a solution of ferro-cyanide of potassium? That is, will there be traced on the paper a permanent blue line or a distinct line of any color? A. A solution of potassium iodide acts thus. A very dilute starch solution may be added to the iodide solution to intensify the color. 2. Can paper be so treated as to become a conductor when dry, the current being of the strength of one gravity cell? If so, what is the treatment required? A. No; except by brazing or coating with black lead or some such treatment. The conducting powers of paper charged with chemicals, as used in chemical telegraphic recorders, is due to the presence of moisture.

(7571) J. H. C. asks for the best receipts and manner of tempering springs, such as gun springs, for main spring and such like. Also receipt for tempering mill picks. A. To Temper Steel Springs. Heat to an even red heat, rather low, to prevent cracking; quench in lukewarm water. Place in ladle with enough tallow to cover it; heat until tallow burns with a large flame, extending beyond ladle, then set the ladle aside and allow it to cool.—To Temper a Revolver Spring. Heat the spring to a cherry red, and plunge in linseed oil. ... draw the temper to the desired degree, hold the spring over the fire and allow the oil to burn away; take away from the fire, put on more oil, and let it burn away. Burn the oil off three times and plunge in the oil again. The spring is then ready for use. Do not overheat the steel. Test the temper frequently with a file.—To Temper a Small Spring. Heat the spring to a light red, plunge in cold water; hold the spring over the flame of a small fire of shavings until it becomes black, then hold in the fire until the black disappears. Cool the spring by swinging it in the air.—There is nothing peculiar in hardening mill picks, only that they should be as hard as possible and moderately tough. The greatest care should be taken to avoid burning the steel. Where there is much of this work to be done, the picks can be heated in a pot of cherry red hot lead, then dipped plumb into clear water at about 60 degrees. Do not draw the temper. The hardening by the ordinary smith's fire can be well done if charcoal is used and not hurried through the fire. Hurry burns the corners. Much also depends upon the shape of the pick, as to whether it is a sectional or leaf pick, or a thick, solid pick, the last being the most difficult to manage on account of the sharp edge and thick back. They should be laid across the fire so as to heat the eyes as fast as the edge.

SELECTED FORMULÆ.

Gasoline Cream.—Solidified gasoline or benzine jelly for removing grease spots may be made after any one of the following:

Tincture soap bark	12 fluid drachms.
Benzine to make	8 fluid ounces.

Mix and shake for one-half hour, then allow to stand twelve hours to solidify.

Infusion soap bark (20 per cent.)	4 fluid drachms.
Benzine	2 fluid ounces.

Proceed as above.

One hundred and twenty grammes white soap are dissolved in 180 grammes hot water in a liter bottle, 30 grammes of ammonia added. The solution is then made up to three-fourths of the bottle by water and shaken up. A teaspoonful of this mixture is placed in a bottle holding 250 grammes and mixed therein with some benzine and afterward the bottle is filled with benzine under protracted shaking.—Pharmaceutical Era.

Window Pane Barometer.—By painting the window pane or wall paper with any one of the following solutions, different colors are exhibited upon atmospheric changes, owing to the well known properties of nickel and cobalt salts, which color in accordance with the variation or amount of moisture in the air.

No. 1.—Chloride of cobalt, 1 part; gelatine, 1 part; water, 100 parts.

No. 2.—Chloride of copper, 1 part; gelatine, 10 parts; water, 100 parts.

No. 3.—Chloride of cobalt, 1 part; gelatine, 20 parts; water, 200 parts; nickel oxide, 0·75 part; chloride copper, 0·25 part.

In damp weather all will be colorless; in clear weather No. 1 will be blue, No. 2 yellow, and No. 3 green.—Meyer Bros. Drug.

Green Carnations.

Mr. S. W. Williams, of East Orange, N. J., having seen a quotation from The Gardener's Chronicle, regarding the staining of carnations, undertook some experiments to determine its correctness and kindly sends The Druggist's Circular the following report:

"Acid wool green B will answer the purpose. If the stalks of white carnations are allowed to stand for a few hours in a solution of this dye, the color is readily taken into the circulation, following the veining of the petals and producing a beautiful effect. Any depth of color from the faintest tint to a brilliant green may be obtained by varying the strength of the solution. A comparatively strong solution usually has the effect of giving a rich green border to the petals, with a more delicate tracing of the veining toward the center of the flower. Dilute solutions give a more natural effect. Naphthol green B acts slowly, but gives a very pretty tint.

"There are very likely many other green dyes which will answer the purpose, and perhaps better; but the writer tried malachite green, direct green, and a number of others with negative results. An 'acid' yellow worked with indigo carmine may be made to produce colors ranging through apple to the more yellow greens, while the same blue used in combination with the wool green should give bluish greens.

"The Circular certainly did its part fully in securing the statement of an expert in this line. It is easy to understand how his actual experiments were misleading. Of the many dyes tried by the writer, but about one in five was taken into the circulation of the plant. One theory to account for this is that 'basic' dyes may be intercepted by tannins or other incompatible principles in the stalk, whereas 'acid' colors may be allowed to pass on to the flower. As a number of 'acid' dyes failed, however, to enter the circulation, the writer would seek to offer no explanation without further study. It is strange also that, of several flowers of the same kind placed in the same solution, some appropriated the color much better than others. One theory for this is that a flower not fully opened would naturally draw up the solution more readily than another which had more completely matured. The writer's experiments, however, have not proved this to be necessarily so, nearly full blown flowers seeming to act about as well as any.

Miscellaneous Notes and Receipts.

Blue Color for Copper.—A steel-blue color on copper is produced by a solution of 20 grammes of potassium sulphide and 20 grammes of kitchen salt in 10 liters of water. Old copper plates of engravings or etchings can be colored with this in an extremely fine tone, since by diluting the solution all the shadings of the design on the plate can be obtained.—Technische Mittheilungen f. M.

SELECTED FORMULÆ

Wood Staining.—The following recipes for imitating various woods are given by C... Drysalteries:

1. Lemon Wood.—This can be imitated ... ing sycamore wood in a hot solution of gamboge ... pentine.

2. Coub... Wood.—Maple, sycamore, ... a hot decoction of logwood or Brazil ... dye; washed over with sulphuric acid.

3. Black Ebony.—(a) After saturating the wood with a solution of sulphate of iron and then apply a hot decoction of logwood ... galls till the required tint is obtained. When the surface has dried, wipe off all superfluous dye ... polish with linseed oil.

(b) ... beech, plum, pear, alder, lime, or plane ... wood in a hot infusion of logwood ... dry, mordant the wood with a cold solution ... of copper.

(c) Immerse the wood into a cold solution ... phates of copper and iron acidulated with oil ... When the wood is sufficiently impregnated ... mordant, place it in a bath containing py... (crude acetate) of iron, logwood, and gall ... heat to 60-100° C.

4. Red Ebony.—Sycamore previously mordanted ... alum is steeped in a hot decoction of Brazil ... When the surface is dry, apply a cold solution of copper acetate.

5. Jacaranda or Violet Wood.—(a) Immerse walnut, alder, cherry, or beech in a hot decoction of Brazil wood and potash. Put in the black veins afterward by means of a brush charged with solution of sulphate of iron.

(b) Soak pear, beech, ash, elm, alder, poplar, or birch for twenty-four hours in a hot solution consisting of ... nut shells 5 parts, acetic acid 1 part, water 80 to ... parts. Finally dry in the air.

6. Lignum Vitae.—Having steeped plane, sycamore, or beech in a hot decoction of madder, apply oil of vitriol, and wash as soon as the desired effect is obtained.

7. Mahogany (Light).—(a) Prepare a tincture with dragon's blood 4 parts, washing soda 1 part, methylated spirits 60 parts. This may have to be strained. ... ly it to the wood, previously wetted with dilute ... us acid and allowed to dry. One or more applica... must be made, according to the particular shade ... d.

(b) Immerse sycamore or maple in a hot decoction of Brazil wood.

(c) Treat cherry wood with lime water for twenty-four hours, and then steep it in a hot infusion of mahogany sawdust.

(d) Immerse sycamore or lime in a hot decoction of madder.

(e) Walnut previously passed through nitric acid, or which has stayed some time in strong lime water, is dried and polished with oil colored with orchil, and then varnished with red varnish. This recipe is said to give specially good results. Walnut is a wood closely resembling mahogany in the grain, so that it lends itself to the purpose with particular readiness.

8. Mahogany (Fawn).—Steep maple or sycamore in hot infusion of logwood.

9. Mahogany (Red).—Immerse white walnut in a hot decoction of Brazil wood, or sycamore in a hot infusion of annatto and potash.

10. Mahogany (Dark).—(a) Boil 1 pound of madder and ¼ pound of logwood chips in 2 gallons of water, and apply the hot liquid thoroughly with a brush. Then allow the surface to dry, and go over it with a solution of 1 ounce of pearlash in a gallon of water.

(b) Put poplar, acacia, alder, poplar, or lime into a hot decoction of Brazil wood and madder.

(c) Make a tincture by dissolving 4 parts of dragon's blood, 2 parts of alkanet and 1 part of aloes in 120 parts of spirits of wine. Apply this to the wood with a brush.

(d) Steep chestnut in a hot solution of gamboge.

(e) Steep sycamore, beech, or cherry in a hot decoction of logwood. The last two woods should be first mordanted with lime water.

11.—Oak.—(a) Boil 10 ounces of Vandyke brown, 2 ounces of bichromate of potash, 2 ounces of washing soda, and 4 ounces of carbonate of ammonia in a gallon of water for seven or eight minutes. Apply the solution obtained to the wood.

(b) The appearance of age can be given to new oak wood by exposing it to ammonia gas. To imitate old oak on ash, elm, box, alder, chestnut, maple, yew, or sycamore, acetate of iron or nitrate of copper, or both, can be made use of. The tints can be varied at pleasure by using the metallic salts separately or mixed, and by giving them various degrees of dilution. They should be used cold. Weak solutions of acetate of iron give green shades, and stronger ones various hues of brown, darkening as the concentration of the iron salt increases.

12. Rosewood.—Boil 1½ pounds of logwood chips in a gallon of water until the volume of the infusion is reduced to 2 quarts. Apply this boiling hot. If more than one application is necessary, the wood should be allowed to dry before a fresh brushing over is done. The finished surface must be grained with a camel-hair pencil dipped in logwood infusion containing the sulphates of iron and copper.

13. Walnut (Black).—Infusion of walnut shells was formerly used to color white walnut, alder, poplar, or beech, but the process at present in vogue is to boil a mixture of 2 parts of Cologne earth and 1 part of potash in 12 parts of water until the volume is reduced to rather less than half, and to apply the resulting liquid to the wood cold with a pad or brush. Potassium permanganate can also be used.

Please give recipe for good aquarium cement. C. F.

Take equal parts of litharge, of fine dry sand, and of plaster of Paris, add only one-third of a similar part of pulverized resin. Mix thoroughly, and make into paste with boiled linseed oil and Japan (driers). Let it stand four or five hours before using. It loses strength if it stands a day. Give plenty of time for drying.

(8669) H. M. W. writes: We understand there is an easily prepared paper which may be used for the finding of the negative and positive poles of an electric wire. Will you kindly inform us how to make this paper and whether it will keep? We only wish for a small quantity. A. We give below two methods for this purpose, both of which are easy. First method: Dissolve sodium sulphate, a teaspoonful, in a half pint of water, in which also dissolve about the same quantity of potassium iodide and of starch. To dissolve the starch the water must be heated. Soak white blotting paper in this solution and dry it. Cut it into strips of any convenient size, a half inch by two inches is suitable. Keep the paper in a dry place such as a tin box or a glass bottle. To use, moisten a strip and place the two poles upon it, nearer together or farther apart, according to the voltage of the current. A dark spot will appear at the *positive* pole. Second method: Dissolve 15 grains of phenol-phtalein in a half ounce of common alcohol. Dissolve also 20 grains of sodium sulphate in 4 ounces of water. Soak blotting paper in the first solution and drain off the superfluous liquid. Then soak it in the second solution and dry it. Afterward treat it in the same manner as in the first method. A red spot appears [illegible] *negative* pole.

Blue Drawing Paper.—The blue drawing paper of commerce, which is frequently employed for technical drawings, is usually little durable. For the production of a very serviceable and strong drawing paper, the following process is recommended. Mix a solution of—

Gum arabic	2 c. cm.
Ammonia iron citrate	3 "
Tartaric acid	2 "
Distilled water	20 "

After still adding 4 c. cm. of solution of ammonia with a solution of—

Potassium ferricyanide	2·5 c. cm.
Distilled water	10·0 "

and allow the mixture to stand in the dark half an hour. Apply the preparation on the paper by means of a soft brush, in artificial light, and dry in the dark. Next, expose the paper to light until it appears dark violet, place in water for ten seconds, air a short time, wash with water, and finally dip in a solution of—

Eau de javelle	50 c. cm.
Distilled water	1000 "

until it turns dark blue.—Apotheker Zeitung.

Salt Water for Burns.—Any one who has to work near a fire is liable to contract, despite the best of caution, not only a small burn, but even larger wounds of that kind. A very efficacious remedy, according to Dampf, a German class paper, has been found to be a solution of cooking salt in water, which is at hand everywhere. It is best to immerse fingers, hands and arms in the solution, which must be tolerably strong. For burns in the face and other parts of the body, salt water poultices are applied.

According to the D. Tapezierer Zeitung, rust spots are removable from linoleum by rubbing with st el chips. Any other stains on linoleum can be removed by the same simple medium.

Rubbing Wax for Linoleum Floors.—Melt yellow beeswax, 5 kilos.; carnauba wax, 10 kilos.; add, while lukewarm, oil of turpentine, 4·5 kilos., and benzine, 40 kilos., stirring diligently, and fill in tin cans.—Seifensieder Zeitung.

Repairing Rubber Pads and Covers.—Rubber goods, wherever cracks are appearing, may be successfully mended in the following manner:

Before the pa[illegible]hing, the cracked surfaces to unite well must be dried, entirely freed from all dirt and dust and greased well, otherwise the surfaces will not combine.

In case [illegible] water-proof coat, or rubber boots, etc., [illegible] tely thick piece of India rubber, [illegible] object, cut off the edges obliquely with a sharp k[illegible] ioistened in water, coat the defective places as well as the cut pieces of rubber with oil of turpentine, lay the coated parts together and subject them for 24 hours to a moderate pressure.

The mended portions will be just as water-proof as the whole one.

Rubber cushions or articles containing air are repaired [illegible] after being cleaned as afore- [illegible] it in alcohol (90°) [illegible] the holes, allow [illegible] er article, pillow, [illegible] again.—Neueste

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HEKTOGRAPH PAD

Soak one ounce of gelatine over night in enough water to cover it well, take care that all the gelatine is swelled. Over a salt-water bath (2 oz. salt in pint water) heat 6 or 7 ounces of pure glycerine to 200 degrees F. Pour off surplus water (on gelatine) and add the gelatine to the hot glycerine. Continue the heating for an hour, carefully stirring occasionally, avoiding bubbles and froth. Finally, add 20 drops of oil of cloves to prevent decomposition. Then pour mixture into shallow pans. Before using (after cooling) wash gently with water the surface of the pad, to prevent sticking.

Receipts.

[illegible] ssolve (1) 10 parts [illegible] l; (2) 20 parts isin- [illegible] grain brandy; (3) [illegible] rts grain brandy; [illegible] ld be thoroughly [illegible] boiled down to 180 [illegible] rfindungen.

[illegible] be rendered tight [illegible] oistening the cane [illegible] er by means of a [illegible] cane-work becomes [illegible] chair in the open [illegible] t and allow to dry [illegible] ying.—Die Mappe.

[illegible] sists in mixing to- [illegible] ate, 20 grammes of [illegible] odium bromide, 10 [illegible] grammes of water, [illegible] ces to be silvered [illegible] in the kiln. Then [illegible] ath and precipitate the metallic silver on the [illegible] places. In a similar manner gilding may be done. The effects produced in this manner may be called handsome in every respect. —Offerten Blatt für Bijouterie, etc.

Tinning Brass.—Small articles of brass like hooks and eyes may be covered with a thin coating of tin by any of the following methods:

1. Make a saturated solution of cream of tartar in boiling water; place the articles to be coated between sheets of tin, immerse in the liquid, and boil until a sufficient deposit has been obtained. The brass should be freshly cleansed by immersion in dilute acid and subsequent washing or otherwise, just before being submitted to the tinning operation. The articles after being coated are washed in water and brightened by being shaken with bran.

2. Boil peroxide of tin with a strong, aqueous caustic potash solution, until the liquid is saturated with tin, and immerse the articles in this solution.

3. Roseleur recommends the following method: Prepare a solution of—

	Parts.
Chloride of tin in crystals	6
Pyrophosphate of sodium	60
Distilled water	3,000

Place the articles on perforated zinc trays, immerse in the solution, and boil, stirring the contents occasionally to change the points of contact.

The zinc trays are to be scraped clean after each operation to insure perfect contact in the next.—Druggists' Circular.

Kid Glove Cleaner.—The following will probably answer the purpose as well as anything else:

White castile soap, old and dry	15 parts.
Water (rain or distilled)	15 "
Solution of chlorinated soda	16 "
Ammonia water	1 "

Cut or shave up the soap, add the water, and heat on the water bath to a smooth paste. Remove, let cool, and add the other ingredients and mix thoroughly. To use, apply a little to the glove on a piece of clean flannel. It is said that stains may be removed even from the most delicately colored kid gloves by suspending them for a day in an atmosphere of ammonia. Provide a tall glass cylinder, in the bottom of which place strong aqua ammonia. Be careful to remove from the sides of the jars any ammonia which may be spattered upon them. Suspend the gloves to the stopper in the jar. They must not come in contact with the liquid.—National Druggist.

Paper for Wrapping Silverware.—Make a solution of six parts of sodium hydrate in sufficient water to make it show about 20° B. (s. g. 1·60). To it add four parts zinc oxide, and boil together until the latter is dissolved. Now add sufficient water to reduce the specific gravity of the solution to 1·075 (10° B.) The bath is now ready for use. Dip each sheet in separately, and hang on threads stretched across the room, to dry. Be on your guard against dust, as particles of sand adhering to the paper will scratch the ware wrapped in it. Ware, either plated or silver, wrapped in this paper, will not blacken even in a St. Louis atmosphere, where we have a good deal more hydrogen sulphide in the air than our share.—National Druggist.

Gloss Starch.—

Boracic acid	15 kilos.
Borax	9 "
Stearine	3 "
White beeswax	3 "

Boil with the adequate quantity of soda lye of 20° Bé. until a liquid mass of unform consistency is obtained, and dry.

The product thus obtained is now mixed with the finest rice starch, in the ratio of 1 to 10, whereby gloss starch is produced, which imparts to the linen, etc., a very fine luster and great stiffness.—Neueste Erfindungen und Erfahrungen.

Baking Powder.—A formula for this powder proposed by Crampton, of the United States Department of Agriculture, as the result of an investigation of the leading baking powders of the market, is:

Potassium bitartrate	2 parts
Sodium bicarbonate	1 part
Corn starch	1 part

The addition of the starch answers the double purpose of a "filler" to increase the weight of the powder and as a preservative. A mixture of the chemicals alone does not keep well.

The stability of the preparation is increased by drying each ingredient separately by exposure to a gentle heat, mixing at once, and immediately placing in bottles or cans and excluding excess of air and consequently of moisture.

This is not a cheap powder; but we cannot recommend any substitute. It is the best powder that can be made, as to healthfulness; there are others which while cheaper are strongly, and we are convinced, justly, opposed by sanitarians.

(7169) F. L. C. says: Please give me, through Notes and Queries, a recipe for a hard cement for bicycle tires. A. For bicycle tire cement, mix together two parts pitch and one part of gutta percha. Melt over a water bath and use hot.

A method of replacing the ordinary anæsthetics used in dental surgery by the action of high-frequency currents has been brought out by Messrs. Regnier & Didsbury, of Paris. M. d'Arsonval has already shown that high-tension and high-frequency currents have a local anæsthetic effect, and the experimenters wished to see whether this could not be used to advantage for dental operations, and so do away with the inhalations of gas, which are not without danger to the patient. In the case of extraction they found it to work quite successfully. A d'Arsonval-Gaiffe apparatus was used, having a coil which gave a 1.2-inch spark, with a rotary interrupter and an oil condenser. The apparatus is connected to an Oudin resonator, one of whose terminals is joined by a flexible cord to an electrode fixed upon the jaw. The electrode is molded in plastic material and covered inside by metallic powder and a layer of tinfoil. Under these conditions the current gave the patient no sensation other than a slight heating in the region covered by the electrodes. It was found that a tooth with one root was made completely insensible by the application of a current of 150 milliamperes for 3 to 5 minutes, while the larger teeth needed 200 to 250 milliamperes for 6 to 8 minutes. As to the use of the method for more prolonged operations, the experiments are not as yet conclusive, although they are favorable on the whole.

To "Oxidize" Silver.—Silver may be colored a brownish-black by the following solution:

Ammonium chloride	2 parts
Copper sulphate	2 parts
Potassium nitrate	1 part
Acetic acid	5 parts

If only a part of an article is to be colored, apply the solution with a camel's hair brush, to the parts. If the entire article is to be colored, immerse it in the solution. In both instances the article and the solution should be previously warmed.—Drug Circ.

To Remove Rust from Nickel.—Smear the rusted parts well with grease (ordinary animal fat will do) and allow the article to stand several days. If the rust is not thick the grease and rust may be rubbed off with a cloth dipped in ammonia. If the rust is very deep, apply a diluted solution of hydrochloric acid, taking care that the acid does not touch the metal, and the rust may be easily rubbed off. Then wash the article and polish in the usual way.—Drug. Circ.

Remedy for Warts.—

Salicylic acid	2 parts
Alcohol	2 parts
Ether	5 parts
Collodion	10 parts

Paint the warts every morning with the solution.—Drug. Circ.

Hektograph Inks.—

Black.

Methyl violet	10 parts
Nigrosin	20 parts
Glycerin	30 parts
Gum arabic	5 parts
Alcohol	60 parts

Blue.

Resorcin blue M	10 parts
Dilute acetic acid	1 part
Water	85 parts
Glycerin	4 parts
Alcohol	10 parts

Dissolve by the aid of heat.

Red.

Fuchsin	10 parts
Alcohol	10 parts
Glycerin	10 parts
Water	50 parts

Green.

Anilin green, water soluble	15 parts
Glycerin	10 parts
Water	50 parts
Alcohol	10 parts

—Drug. Circ.

To Cement Tortoise Shell.—Fit the broken pieces carefully and wrap in a piece of paper to hold them firmly in place. Heat two pieces of iron and place the article with the paper around it, between them. The iron must not be so hot as to burn. Squeeze the article between the iron pieces for a few minutes, and allow it to cool. The shell melts and forms a cement which firmly joins the broken parts.—Drug. Circ.

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Depilatory (original)
Mix Monosulphide of Stronium with any good shaving soap, and shaving can be done with "any old razor."
Or mix with two or three times as much chalk (no soap this time), and with water, or the lke, make a paste of it.

Depilatory (Scientific American)
A strong solution of sulphuret of barium made into a paste, as wanted, with powdered starch, and applied at once.
(Barium compounds are poisenous if taken into the stomach.)

Another

Sulphuret of Potassium	1 part
Pearl Ash (dry)	1 part
Quicklime	8 parts

POLISHING CLOTHS.

We will complete this article with a word upon polishing cloths, which are undyed velveteen in the stage of manufacture known as "dressed-off." They may be improved by soaking in a solution of ammonia, or a saturated solution of hyposulphite of soda, then dried. Polishing tissue was thin paper saturated with ammonia solution and dried; it is now obsolete.—Oils, Colours and Drysalteries.

SELECTED FORMULÆ.

Camphor Ice.—

(1)

White wax	16 parts
Benzoated suet	48 parts
Camphor, powdered	8 parts
Essential oil, to perfume.	

Melt the wax and suet together. When nearly cold, add the camphor and perfume, mix well and pour into molds.

(2)

Oil of almond	16 parts
White wax	4 parts
Spermaceti	4 parts
Paraffin	8 parts
Camphor, powdered	1 part
Perfume, q. s.	

Dissolve the camphor in the oil by the aid of a gentle heat. Melt the solids together, remove and let cool, but before the mixture begins to set add the camphorated oil and the perfume, mix and pour into molds.
The Era Formulary gives the following for camphor ice with glycerin:

Stearin (stearic acid)	8 pounds
Lard	10 pounds
White wax	5 pounds
Spermaceti	5 pounds

Melt on a water bath in an earthen or porcelain dish; strain into a similar vessel; add a solution of 2 ounces powdered borax in 1 pound of glycerin, previously warmed, to the melted substance when at the point of cooling; stir well; add camphor 2 pounds, powdered by means of alcohol 3 ounces; stir well and pour into molds.

Ink-Erasing Powder. —The Pratkischer Wegweiser gives the following:

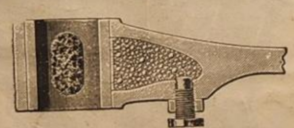
Alum	1 part
Sulphur	1 part
Amber	1 part
Potassium nitrate	1 part

Powder and mix. Keep in well-closed vials. A little of this powder dropped on a fresh ink spot or fresh writing, and rubbed with a bit of cloth or blotting paper removes the mark completely.

502 CURRENT TOPICS. [J. F. I.

A Simple Electrolytic Method of Measuring Current Frequency. A. P. ROLLET. (*Comptes Rendus*, Dec. 26, 1924.)—Two wires of silver one millimetre in diameter placed in an alkaline solution are the electrodes for an alternating current. While a wire is the anode, it is oxidized and a dark layer of oxide of silver is deposited upon it. This is reduced during the time in which the wire is the cathode. While the current is passing, let the electrolyte flow out through the bottom of the containing vessel, thus exposing the wires gradually. The liquid will leave some portion of the wire while it is blackened with oxide. When the opposite phase of the current comes it cannot reduce the exposed oxide because the latter, being above the liquid, is not traversed by the current. As the electrolyte travels down it leaves behind it alternate dark and bright bands on the silver wires. A dark and a bright band together represent one cycle. The apparatus is calibrated by an alternating current of known frequency. It can be used up to 75 cycles per sec. The construction is quite simple. G. F. S.

A mass of balls of various sizes, under pressure, does act like a liquid, as we have ascertained by testing



in various ways. (On the table, at the reading of the paper, was shown a connecting rod of full size fitted up to be adjusted in this manner, just as it is used in practice, and also a model with a glass front and a spring piston, which permits the individual motion of the steel balls to be seen when the adjusting screw is turned. The mass is kept mobile by putting sufficient pressure on the movable piston.)

PHASE-REVERSAL ZONE-PLATE.

A copy of this figure, in the form of a transparency on glass, can be used instead of a lens.

IMPROVED PROCESS OF DUPLICATING PHONOGRAPH RECORDS.

The commercial demand for phonograph records for amusement purposes amounts to several thousand records a day. It would not be practicable to supply such a demand if each record had to be made separately by singing or playing before a phonograph. For several years the practice has been to record each performance on from four to a dozen machines at once, the machines being arranged on racks or shelves with the horns converging toward the band or singer. The records thus made are called masters, and are copied in duplicating machines, which work somewhat on the principle of a pattern lathe. Two mandrels rotate side by side, one bearing the master record and the other a blank on which it is to be copied. A reproducer stylus rubbing over the master guides a recording stylus which cuts the duplicate record in the blank. By this method a number of duplicates are made from each master, but after a while the master shows signs of wear, and the duplicates produced are not of good quality. Ordinarily about twenty good duplicates can be made from one master before the latter is condemned.

As many of these masters require a whole band of music to make them, they are expensive, and it is very desirable to have a method of producing a larger number of duplicates from a single master. Two successful solutions of this problem have recently been perfected.

By the first method an electrotype mold is made by first depositing over the master an exceedingly thin coating of metal by Edison's process of vacuous deposit, electroplating, and backing up the copper plate with a stout backing of metal. Records are cast by introducing melted wax into the mold about a core. The mold is used cold, so as to chill the surface of the wax.

To remove the record from the mold advantage is taken of the facts that wax has a high coefficient of expansion, and that the record groove is very shallow, so that when the record is cooled it contracts more than the mold and is readily slipped out endways. The molds may be preserved indefinitely, and any number of duplicate records produced from them.

The other process referred to is quite different from this, and is very ingenious. The master is dipped into a solution of gelatine and bichromate of potash, which when dried and exposed for a time to the light remains as a thin, tough skin adhering closely to the record. This is coated with shellac, and afterward with a substantial backing of wax, which is turned true and pushed into a brass tube. When the master record is broken out, there remains on the interior of the composite cylinder thus produced a very faithful gelatine mold of the record. A one per cent solution of celluloid is flowed over the interior of this mold and permitted to dry, leaving a very thin skin of celluloid which is then coated with chromatized gelatine. Several alternate layers of celluloid and gelatine may be laid on in this mold until a skin of sufficient thickness is obtained, which is then strengthened by a suitable backing having in its center a hole properly tapered to fit the mandrel of the duplicating machine. The brass tube and the wax part of the mold are then removed and the gelatine matrix stripped from the celluloid, leaving a very perfect copy of the original record with a surface of celluloid.

This record is used as a master in the duplicating machine, and it shows no signs of wear even after many hundreds of wax duplicates have been made from it.

Flue cleaner — } Zinc compound Burn old zinc on
Spark plug cleaner — }

Crude oil etc { Floor dressing
Harness dressing
Furniture polish
Boiler compound

Fire Extinguisher { Whiting or asbestos meal.

House cooling by compressed air using ribbed motor.

VACUUM ILLUMINATION AT THE ELECTRICAL EXHIBITION.

Modern electric lighting by means of arc and incandescent lamps is the outgrowth of discoveries made over a half century ago; and while the progress in electrical matters made since the business began to assume a commercial character is little short of wonderful, it seems almost unaccountable, in the light of what is known, that the grand electrical awakening was so long delayed.

Vacuum tube electrical lighting is almost a parallel case. The vacuum tube itself is not a new thing; it has long been known that it could give considerable light, but it is only very recently that anyone has had courage enough to undertake to reduce vacuum tube lighting to a practical form and render it available for everyday uses.

Fig. 2.—VACUUM TUBE OF RAPID CIRCUIT BREAKER.

At the Electrical Exhibition in this city was shown a Gothic chapel of fair size furnished with pews, a pulpit and full-sized organ. It was carpeted and furnished with stained glass windows and illuminated in a novel and attractive manner by a new and successful system of vacuum tube lighting invented by Mr. D. McFarlan Moore. Mr. Moore has been perfecting this system for some years, as will be seen by an examination of the files of the SCIENTIFIC AMERICAN. The exhibit embodies his improvements and gives an excellent idea of the practical value of this system. The windows are screened so as to exclude external light, thereby giving the observer the exact value of vacuum tube illumination. The vacuum tubes are about two inches in diameter and of sufficient length to reach from the pilasters to the apex of the ceiling. They are bent to conform to the curvature of the Gothic arches and their upper ends abutted against straight tubes extending along the highest part of the ceiling, all being mounted in neat, specially designed fixtures. Over the arched front door of the chapel were arranged vacuum tubes, in the form of letters, which spelled out the legend Moore's Vacuum Tube Chapel. The light within was soft and diffusive, having the color of daylight. The tubes were connected up in parallel, and the current used was the "kick" or extra current derived from simple coils without magnetic cores, and not from the secondary wires of an induction coil, as is generally supposed.

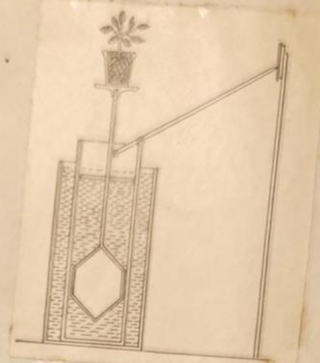
The secret of success lies in the use of a circuit breaker which completes and breaks the circuit 60,000 times a minute; but great rapidity in the breaks is not the only feature of the circuit breaker. Mr. Moore has placed the entire circuit-breaking mechanism in a vacuum tube, as shown in Fig. 2, in which a high vacuum is maintained. By this construction sparks are avoided and the instantaneous break depended upon for efficiency is secured.

The rapid circuit breaker is operated by a Gramme ring surrounding the tube, as shown in Fig. 3, and forming the field magnet of the motor which breaks the circuit, the armature being attached to the commutator of the circuit breaker. The breaker is connected with the Edison three-wire system, a simple coil being inserted in each of the leads.

No perceptible heat is given out by the tubes, and it is believed that this is the nearest approach to the production of light without heat that has been made.

From what has been said it will be seen that this system of lighting is adapted to the present commercial circuits—a great point in its favor. This system in its present stage of development has an efficiency about equal to incandescent lamp lighting, but it is believed experiments now in progress will show an efficiency far in advance of that already secured.

By changing the gases in the tubes, and by varying the degree of exhaustion, the color of the light may be varied for decorative purposes. Instantaneous photographic portraits have been made by this light, and it is believed photographers will find vacuum tube lighting of great utility in the absence of sunlight.



Medicated Vegetables.

From American Gardening.

Will the doctor of the future, instead of prescribing some unpleasant drug, order a course of medicated vegetables? This may be the result of the present attempts to cultivate plants containing abnormal quantities of certain medicinal substances. It is well known that the amount of any characteristic element in a plant varies with its richness in the soil, and it is also known that the assimilation of mineral elements of the body is much more readily accomplished when these are partaken in the form of food. In the past, if the body needed an excess of iron, it has been supplied by tinctures taken through glass tubes. The modern idea is to supply this want by such vegetables as medicated spinach. Experiments with plants grown in soil enriched by hydrate of iron proved that they contained a much larger percentage of iron than those grown in natural soil. This opens a whole vista of interesting possibilities. The iron, the potash, the manganese, the nitrogen needed by the system can be supplied more effectively and more palatably through vegetables than through medicines. Already many vegetables are known to have curative properties. Celery is generally held to be good for rheumatism and nervous disorders; lettuce for insomnia; peanuts for indigestion; onions for liver complaints; carrots for scurvy; tomatoes for the liver; blackberries for diarrhoea, and apples for nervous dyspepsia and rheumatism. Certified milk, with its stated proportion of fat, sugar and solids, would have seemed improbable some years [illegible] the future see certified vegetabl[illegible]

The Photoluminescence of Flames. E. L. NICHOLS and H. L. HOWES. (*Phys. Rev.*, Nov., 1923.)—"The brightness of the flame plus the light transmitted by the flame from a nitrogen-filled tungsten lamp placed behind it, should normally be slightly less than the sum of the two intensities taken separately, whereas instead of showing a loss by absorption the combined brightness was persistently greater." After failure of other explanations that suggested themselves the authors were driven to conclude "that the flame was actually somewhat brighter when exposed to the light of the neighboring source." They proceeded to test this hypothesis and found that the facts agreed with it. An air-hydrogen blast lamp was used with Li, Na, Sr and Ca salts. Light from a tungsten lamp, a carbon arc, a mercury arc and an iron spark fell in turn upon the flames. "The iron spark was most effective, the increases being over 10 per cent. for Ca and Sr. Not only the ultra-violet beyond $.3\mu$ is effective but also light above $.43\mu$." On the other hand, red or yellow light of such wave-length that it was absorbed by the flame reduced the emission of the flame by a few per cent. No matter whether the effect of the incident light was to enhance or to reduce the emission, it seemed to produce the same effect upon all the lines derived from the flame. When a calcium band was observed while its parent flame was illuminated both by light through ruby glass and by light from an iron spark its brightness was greater than that of the flame alone but less than that of the same flame exposed to the spark light alone. The flame of the Bunsen burner showed scarcely any change due to illumination, and the different parts of the hydrogen flame were sensitive in different degrees. G. F. S.

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POULSEN TELEGRAPHONE.

BY SPECIAL PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

One of the most interesting devices exhibited at the Paris Exposition is the telegraphone invented by the Danish engineer, Valdemar Poulsen. The principle of the apparatus will be understood from the diagram, Fig. 1, in which *E* is an electro-magnet of small dimensions, placed in a telephone circuit including the battery, *B*, microphone transmitter, *M*, and receiver, *T*. The poles of the electro-magnet are very near together, with just sufficient space to allow the steel wire, *a b*, to pass; the wire may be drawn forward so as to bring its successive portions between the poles. The wire used is steel piano-wire of about 1/25 inch diameter, and it advances at the rate of seven or eight feet per second. The arrangement resembles that of an ordinary phonograph in which the wire, *a b*, replaces the wax cylinder, and the magnetic flux between the poles, the stylus. The sound is recorded in the following manner: when the microphone is spoken into or otherwise receives a series of impulses, the electric impulses set up in the circuit cause variations of current in the coils surrounding the electro-magnet, and in consequence the magnetic flux between the poles undergoes a series of variations corresponding to the original sound waves. These magnetic pulsations act in turn upon the steel wire as it passes along in front of the poles, and magnetize it transversely; each part of the steel wire thus preserves its part of the magnetization, which depends upon the strength of the flux at that instant. The magnetic trace upon the wire thus corresponds exactly to the original sound waves. It remains only to reproduce the record; this is done by connecting the receiver to the terminals of the electro-magnet and passing the wire again between the magnet poles, in the same direction as befor and at about the same speed. As its magnetization varies from point to point its movement between the poles causes a variation in the magnetic flux and sets up a series of pulsating currents in the circuit, corresponding in form of wave with the preceding, and thus a sound may be heard in the telephone receiver which corresponds to the original.

M. Poulsen had constructed several different types of the telegraphone before reaching the form now shown at the Exposition. With this instrument, the sound as heard in the receiver is very distinct and is entirely free from the disagreeable scratching noises generally heard in the phonograph. The illustration and diagrams, Figs. 2a, 2b, and 3, show the general appearance of the instrument and the disposition of the various parts. A drum about 15 inches long and 5 inches in diameter revolves between two supports fixed to a metal base; at one end of the cylinder is a pulley which receives a cord passing below to the motor. In this case an electric motor is used, connected with the main lighting circuit. The drum is of brass and has a spiral groove in its surface in which is wound a continuous layer of steel piano wire about 1/25 inch in diameter; the wire makes about 380 turns. The carriage containing the electro-magnet slides upon a rod which extends across between the brackets. The electro-magnet, shown in section in the diagram, has its cores formed of soft iron wire about 1/25 inch in diameter, surrounded by electro-magnets about ⅜ inch long, wound with fine wire. The poles are brought near together and the ends are sharpened and slightly curved on the inner surfaces so as to partly embrace the wire. The coils are surrounded by insulating material, which consolidates the whole. The magnet, *M*, is held above the wire upon a support, *S*, and into it is fitted a contact-piece, *C*, carrying a flexible cord for the current. To guide the magnet along the wire by the points alone might injure these, as they are somewhat delicate, and accordingly a guiding arrangement has been provided which consists of a steel knife edge, *K*, fixed to an arm in the rear; the arm is fixed to a brass sleeve, *B*, which slides upon the main rod. In this way, the carriage, which rests also upon the sleeve, is guided by the knife-edge. The arrangement devised by Poulsen to bring back the carriage to the starting point is simple and ingenious. As the cylinder turns the carriage is thus guided to the end of its course; at this point is fixed an inclined plate, *S*, carried on an arm, seen also to the left of the illustration. The projecting piece, *T*, of the lever, *H*, strikes the plate and the magnet carriage is tilted back in the direction of the arrow; the lever then engages with a catch, *E*. It will be seen that if the carriage is now moved to the right, the rear arm, *A*, will be lifted by the weight of the carriage around *R* as a center. This causes the button, *R*, to engage with a wire, *P*, which is wound spirally around the rod, *O*, and as this rod is revolved by a pulley the carriage is brought back to its starting point. The chain, shown at *L*, serves to hold the magnet off the wire when not in use.

In order to reproduce conversations with the utmost distinctness, the wire-wound drum must be rather

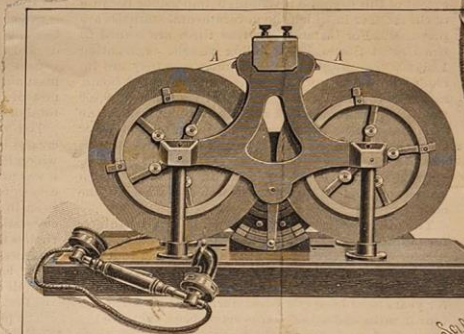


Fig. 4.—POULSEN'S RIBBON TELEGRAPHONE.

rapidly rotated. Experience has shown that a velocity of 1·64 feet (0·5 m.) per second gives the best results. A conversation of one minute in duration could, therefore,

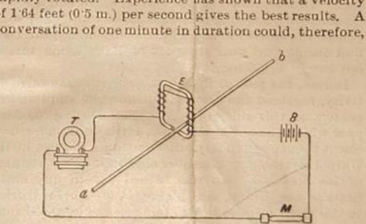


Fig. 1.—DIAGRAM SHOWING PRINCIPLE OF POULSEN'S INVENTION.

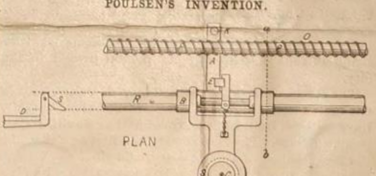


Fig. 2a.—TOP PLAN VIEW OF THE WIRE WOUND DRUM AND RECORDING MAGNET.

The malarial fevers depend upon a parasite which is introduced into the blood by the mosquito's bill. Being sensitive to light these microbes bury themselves in the red blood corpuscles. It is suggested that the efficacy of quinin in malarial poisoning depends upon its fluorescence by which it makes white light bluish; a color that is inimical to the growth of the microbes. The other alkaloids which are valuable in the cure of malarial diseases are esculin and fraxin, which are to the horse-chestnut and ash what quinin is to Peruvian bark, and which show the same fluorescence as quinin. Iodin by union with starch in the body produces a deep blue color.

Nov 1923

Colors Shown by Rotating Discs When Illuminated by Two Sources of Light. A. STEICHEN. (*Physikal. Zeit.*, March 1, 1923.)—A disc with adjacent white and black portions is rotated. Let it be illuminated intermittently by light from an arc lamp that passes through holes in the periphery of another rotating disc so timed in speed that the first disc shall appear to be at rest. Then the black parts of the chief disc appear black while the white parts assume the color of the light from the arc. Now let a dim incandescent lamp shine upon the disc, so that it is lighted by a steady as well as by an intermittent source. The white parts of the disc take on a color similar to that of the arc light and the black portions appear to be of the complementary color, no matter what color be given to the light from the arc. This effect is connected with the formation of colored shadows.

G. F. S.

Oxidized Silver—Imitation Precious Stones—Mountings.

Another important product is oxidized silver, obtained by dipping the article into a solution of sulphuret of potash, by means of which the article is covered with a thin layer of silver sulphide. Beautiful shades are obtained by wiping off the silver sulphide in spots. The scale of different colors is thus produced.

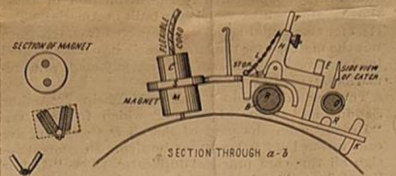


Fig. 2b. SECTION OF WIRE-WOUND APPARATUS.

be recorded on 98·4 feet (30 m.) of wire, which is ap- proximately the capacity of the instrument illustra- in Fig. 3. But, for the ordinary requirements of lit-

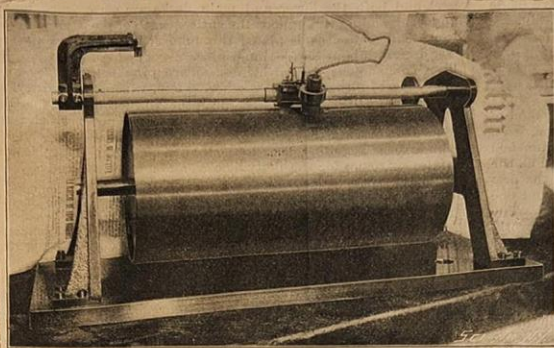


Fig 3.—POULSEN'S WIRE TELEGRAPHONE.

this time is far too short. Longer conversations are recorded and reproduced by means of the apparatus shown in Fig. 4, in which a very thin, flat steel ribbon, resembling a telegraph tape, takes the place of the wire. The ribbon, *A*, passes from one roll over a standard mounted in the middle of the apparatus to a second receiving roll. Upon the standard the electro-magnet—not shown in the illustration—is mounted, the two poles of which are arranged transversely to the ribbon. The principle is the same as that of the instrument previously described. Although the layers of the ribbon are tightly rolled in a coil, the magnetism of one layer exerts no influence whatever upon the magnetism of the adjacent layers.

A conversation once magnetically recorded can be repeated indefinitely. Experiments which have been made show that a conversation can be reproduced from one to two thousand times without any perceptible diminution in clearness.

To efface the record, it is necessary only to pass a current from a few cells of battery in the circuit of the electro-magnet, when the magnetization of the wire is equalized and it is ready to receive another record. Poulsen recently presented an account of the telegraphone to the Académie des Sciences, in which he explained its principles. He also noted an interesting experiment which has been made by his assistant, M. Pederson, who has charge of the instrument at the Exposition; this is the registering and reproducing of two separate conversations on the same wire. Two electro-magnets are used, whose windings are combined so that each is insensible to the record produced by the other. The first electro-magnet has its windings connected in series, and the second in opposition; under these conditions the records produced by the two magnets may be superposed and separated at will. The superposition of the two magnetic curves has the effect of a resultant in each point of the steel wire, but as one of these components is always neutralized by one or the other of the receiving magnets, it is seen that by using one or the other set of magnets, the first or second series of components may be received, that is to say, the first or second conversation.

The telegraphone is already in practical operation in several telephone stations in Denmark, and by its use telephone messages may be received and kept indefinitely. A subscriber may thus receive messages which have been sent in his absence.

Double or tripple messages may be recorded & reproduced on the same ribbon by using double magnets for each message & changing the combinations. Patent by Pedersen

RADIO-TELEGRAPHY BY INVISIBLE INFRA-RED RADIATION.

J. Herbert Stevens and A. Larigaldie have perfected a detector apparatus, particulars of which have recently been communicated to the Paris Academy of Sciences. With their device they have been able to obtain records of infra-red radiations over distances of more than 20 km., the best results being obtained with a thermocouple.

In the tests as carried out the source of emission was an arc or electric lamp projector, the luminous flux of which was absorbed by a filter screen, a black glass coated with manganese dioxide or gelatine. These screens absorb 50 per cent of the total energy, but do not allow any rays which may affect the eye to pass.

The receiver is a parabolic mirror arranged to trap the maximum of radiant energy; the thermophile being placed at the focus of this mirror.

A metal plate 1/100 mm. thick is autogenously welded to the point of a crystal of high thermo-electric power. The thickness of the plate and the diameter of the point of contact were kept as low as possible so as to form a whole of very low thermal capacity. The best results were obtained with a platinum plate and a crystal of tellurium tempered and welded in the direction of crystallization. The junction is enclosed in a glass bulb having a fluorine window.

The thermocouple is mounted at the terminals of a lamp amplifier, the current being broken by a ticker of musical frequency. A potentiometer is connected up in the circuit in order to obviate all eddy currents due to the surrounding conditions which might cause a difference of constant temperature between the two junctions.

The diminuntion in the radiant energy captured at the receiver is generally proportional to the distance covered from the transmitter, but regard must be had to the absorptive power of the atmosphere, which is sometimes low and sometimes considerable according to the proportions of water-vapor, fog, dust, and CO_2.

Where the thermophile is not used in telegraphy but in pyrometry, in tele-mechanics, or for revealing the presence of bodies whose temperature differs from that of the surroundings (*e. g.*, icebergs at sea), its current is passed into a fairly sensitive galvonometer to give a deflection of 3 to 4 mm. per micro-ampere (2 to 3 ohm coil).

For ships the authors have designed a special double pivot galvanometer of the same sensitivity as the previous one, which is capable of working in any position and is unaffected by pitching or rolling.

The following tests made are worthy of mention:

(1) In September, 1918, signals were exchanged between two stations 14 km. apart. The transmitting station was provided with an arc projector of 1.50 m.

(2) In May of this year signalling experiments were made between two stations 7,500 meters apart. At the transmitting station there was a 0.40 m. mirror and an 800 watt nitrogen-filled electric lamp; while at the receiving station a gilt mirror of 0.24 m. was used. (Genie Civil, Aug. 2, 1919.)

-advertising-

The Farmer's Plight

THE following table has been prepared by a Nebraska farmer of a statistical turn of mind, and shows the amount of taxes, in terms of corn, his farm has paid for 10 years, the market price taken for a basis being that quoted by the Department of Agriculture for December 1 of each year. The figures speak eloquently of the real trouble with agriculture.

Year	State Taxes	Price Corn	Bushels Corn
1912	$ 8.11	$ .37	22
1913	12.16	.65	19
1914	12.16	.53	23
1915	10.60	.47	23
1916	14.14	.78	18
1917	19.67	1.20	16
1918	17.81	1.28	14
1919	30.55	1.23	25
1920	26.82	.41	65
1921	42.90	.30	143

It took more corn to pay taxes in 1921 than for all the five preceding years. The table also shows the increase of the tax levy in dollars.

Perhaps the foregoing reveals why the farmer hearkens to the call of organization.

...ome of ...e adm... ...nd de...

a fraction of a second. Phosphorescence in this restricted meaning is most strikingly exhibited by the artificial sulphides of calcium, strontium and barium. If any of these are exposed either to daylight or to the ultra violet rays, they will shine for hours in the dark with a soft colored light, the color being dependent however upon not only the nature of the substance itself, but upon its physical condition and on the temperature. Thus calcium sulphide may be orange-yellow, yellow, green or violet, according to the methods of preparation and the material used. Becquerel found that the light given by a specimen of strontium sulphide changed from violet to blue, green, orange and yellow as the temperature during the corresponding periods of isolation was 20, 40, 60, 100 and 200 degrees Centigrade. The duration of the phosphorescent light may range from but a few seconds to many days.

There are many minerals which possess the power of phosphorescing but likewise there are distinct processes which they must pass through in order to bring out this property. Fluorspar, lepidolite and quinine will all phosphoresce when heated below the red hot temperature. Fused calcium chloride will glow when rubbed together. The crystallization of boracic acid after fusion and the crystallization of water on rapid freezing also shows phosphorescence. This property is also manifest in the cleavage of mica. The two split portions become electrified, one positively and the other negatively. Gelatin, celluloid, paraffin and ivory are phosphorescent at very low temperatures, but lose this property at ordinary temperatures. The final explanation of phosphorescence in inorganic substances is that when a phosphorescent body is exposed to light the energy of the light is stored up in some kind of strain energy and the phosphorescent light is given out during a more or less slow recovery from that state of strain. This is necessarily attended with a change in molecular structure or in specific heat. The sulphides of the alkaline earths lose the property of phosphorescence when subjected to heavy pressure. Many fluorescent solutions become highly phosphorescent when rendered solid by gelatin.

A NEW KIND OF FILTER—Great interest was taken in a "stream-line filter" exhibited by Dr. Hele-Shaw at a meeting of the Royal Society of London. Says *Discovery* (London).

"Every one is familiar with the waste of time involved in filtering fluids, containing suspended matter, by ordinary means. Yet filtration is a process which is essential every moment in laboratories. In this new filter a most simple device is employed with extraordinary success. Holes about half an inch in diameter are punched through a series of sheets of paper—the eventual effect being rather as if one had pushed a cheese-scoop through a magazine several times. The dirty water is then forced through these holes by a pump, while the sheets of paper are forced together with a variable strength. The water is only allowed to escape between the leaves of paper, and since that space is exceedingly small, all solid matter remains behind in the large punched-out spaces. Even a dye, such as methylene blue, if put through the filter, comes out colorless, and it must be remarked that this is in no sense the effect of what is called 'adsorption'—a physico-chemical process in which a kind of combination between dye and paper takes place—but a true filtration, or mechanical removal of suspended matter."

SOLUTION FOR STRESS DETERMINATION

When we apply gradually, say, a tension stress, to a strip of nitro-cellulose, the colors appear in the following order with approximately relative values, the color cycle being repeated in nearly the same manner for twice the stress intensity: black, 0; gray, 3.5; white, 5.5; straw, 8; orange, 10; flesh red, 10.5; purple, 11; blue, 13; second order, yellow, 18; red, 21; purple, 22; and so on into subsequent orders.

out of town patrons

Frosting Bulbs

(1109) Edgar A. Castellini, San Francisco, Calif., wants to know how to frost electric light bulbs:

A. 1. The following matte varnish will frost globes, for commercial use, by dipping the bulb into it.

Mastic, ½ oz. avd., sandarac, 2 oz., benzol, 20 oz., and ether, 10 oz. A solution of gutta percha in chloroform may be used in a similar manner.

Nitrogen lamps will not remain colored long if the color is applied superficially, due to the high heat developed in the lamp. The glass may be roughed with sand.

(9953) V. R. K. asks: I would be pleased to have you inform me if there is anything that could be put in water to stop it from freezing. I have used salt, but find that it freezes after it gets a certain amount of cold. It must not contain spirits, so as when heated to cause an explosive gas; it must also flow freely. What action has salt on water against cold? A. Calcium chloride brine, such as is used in cold storage houses for refrigeration, will be what you require. Put 3 to 5 pounds of calcium chloride to the gallon of water, and its freezing point will be reduced to 39 deg. below zero Fahr. Salt and water will freeze at a little below zero. The melting point of a mixture of salt and ice is 7.6 deg. below zero Fahr. Below this temperature the salt and ice are solid; above that point the mixture is liquid. That temperature is its melting point, just as ice has a melting point of 32 deg. Fahr.

Employment of an Optical Illusion in the Study of Prehistoric Rock Sculptures. Marcel Baudouin. (*Comptes Rendus*, June 2, 1924.)—Let a group of cavities in a rock be photographed on a plate whose plane is about parallel to the face of the rock. The positive prepared from this plate shows the hollows as hollows, as would be expected. After one has looked at the print, let him close his eyes a moment, turn it through 180° and then look again at it. He will be surprised to see that now the hollows have become projections, and the projections have transformed themselves into depressions. The effect is ascribed to the play of shadows in the picture. The effect comes with either one or with both eyes open. The position of the light illuminating the print makes a difference. It should be to the right or to the left according to circumstances. Sometimes the effect is obtained by turning through a right angle only.

When, by the prescribed rotation, the cavities have turned into projections, there is a marked advantage for close study of the cavities, for the tiny scratches that were previously likely to escape observation have become quite visible ridges. The eye can more readily distinguish projections than depressions, and in like manner it is found that there is decided advantage in making an impression of a hollow, since the sensitive finger-tip can better discern a ridge than a scratch.

G. F. S.

Colorimetric Standards.—H. V. Arny and Abraham Taub (*J. Am. Pharm. Asso.*, 1923, **12**, 839–849) state that the colors produced in colorimetric determinations can usually be matched by use of two sets of solutions, each of which includes three compounds representing the three primary colors. One set is composed of half-normal solutions of cobaltous chloride, ferric chloride, and cupric sulphate, respectively, in approximately 1 per cent. hydrochloric acid. The other set consists of fiftieth-normal solutions of roseo-cobaltic chloride, ammonium chromate, and cupric sulphate, respectively, in 2.8 per cent. ammonia water. These solutions may be used as standards in the colorimetric determination of carbonizable impurities in liquid petrolatum, and in the assay of suprarenal glands for their epinephrine content.

J. S. H.

to the rapidity of speech. In order to remedy this inconvenience, Mr. Cassagnes employs two small apparatus whose principle we shall describe.

Upon a transmission, the keyboard actuates a perforator, which consists essentially of twenty punches that act vertically upon a band of paper.

This latter on making its exit from the apparatus is therefore perforated with a series of square apertures at the place that would be occupied by the conventional signs, if printing were done.

The band thus obtained (Fig. 6) with the rapidity of speech is placed in another apparatus, which carries it along automatically, and by impulses, and makes it move forward by one line at a time. Twenty spring levers tend constantly to enter the apertures in the band in order to establish a series of contacts and close the circuits of the corresponding relays at the receiving station.

The paper, where it is not perforated, therefore forms an insulator. The motion of the apparatus that carries along the paper is regulated by the distributer of the transmitting station.

In practice, it is not with the keys (as we have above supposed, in order to make the system understood), but with the spring levers of the transmitting station that the sectors of the distributer of this station are connected.

The bands obtained at the other end of the line are identical with those represented in Fig. 5.

Fig. 3 gives the general arrangement of the two stations in the case of transmissions to great distances. The important point to remember is the necessity of the previous perforation and the use of perforated bands with the rapidity of speech for the sending of currents to the receiving station.

The theoretical performance of the apparatus is as follows:

For very great distances, from Paris to Marseilles, for example, the experiments made here demonstrated that it is possible to make use of distributers with two series of sectors. The rubbers making three revolutions per second, and the ratio of the stenographic lines to the words that they represent being about 80 to 100, it will be seen that on this distance it is possible to transmit $2 \times 3 \times 60 \times 0.80 = 288$ words per minute.

For shorter distances, from Paris to Brussels, for example, distributers with three series of sectors may be used. The result in this case is $3 \times 3 \times 60 \times 0.80 = 432$ words per minute.

We shall not dwell longer upon this high theoretical performance. We think the margin is sufficient to permit of a practical performance much greater than that of the most rapid telegraph, which gives from 25 to 30 words per minute at a maximum.

It is true that the telegraph transmits orthographized words, though this is not always necessary. The stenotelegraph also is naturally capable of transmitting in the same way, but with a diminution of *thirty per cent. in the rendering.—La Nature.*

WELDABLE BY ELECTRICITY.

FOLLOWING is a list of the different materials which have been successfully welded together by the Thomson process, which may be of interest, inasmuch as the term welding is ordinarily used with especial reference to the joining of two pieces of material of the same or closely allied composition:

METALS.

Wrought iron,	Tin,	Aluminum,
Cast iron,	Zinc,	Silver,
Malleable iron,	Antimony,	Platinum,
Wrought copper,	Cobalt,	Gold (pure),
Cast copper,	Nickel,	Manganese,
Lead,	Bismuth,	Magnesium.

ALLOYS.

Stubs steel,	Fuse metal,
Cast brass,	Type metal,
Gun metal,	Coin silver,
Chrome steel,	Solder metal,
Mushet steel,	German siver,
Crescent steel,	Silicon bronze,
Bessemer steel,	Aluminum brass,
Steel castings,	Phosphor bronze,
Brass composition,	Aluminum bronze,
Various grades of tool steel,	Various grades of gold,
Various grades of mild steel,	Aluminum alloyed with iron.

COMBINATIONS.

Copper to brass,	Wrought iron to mild steel,
Copper to wrought iron,	Wrought iron to tool steel,
Copper to German silver,	Gold to German silver,
Copper to gold,	Gold to silver,
Copper to silver,	Gold to platinum,
Brass to wrought iron,	Silver to platinum,
Brass to cast iron,	Wrought iron to Mushet steel,
Tin to zinc,	Wrought iron to Stubs steel,
Tin to brass,	Wrought iron to Crescent steel,
Brass to German silver,	Wrought iron to cast brass,
Brass to tin,	Wrought iron to German silver,
Brass to mild steel,	Wrought iron to nickel,
Wrought iron to cast iron,	Tin to lead.
Wrought iron to cast steel,	

It will be seen from the foregoing that materials heretofore impossible to weld to pieces of similar composition have been welded, and not only this, but different combinations have been made, which are entirely impossible by ordinary methods.

BRONZE COVERED PROPELLER BLADE.—A propeller blade consisting of a sheathing of bronze or delta metal cast on a steel core has recently been produced by Mr. John List, M. Inst. C.E., and Mr. Alexander Dick, of the Delta Metal Company, Limited. The advantages of bronze propeller blades have long been recognized. Such blades can be cast with finer edges, which will, moreover, last the whole life of the blade, and have a very much smoother surface than steel or cast iron blades. In spite of this, however, their adoption is still limited to war vessels and fast passenger steamships, as the ordinary shipowner does not care to face the heavy first cost of the bronze, in spite of the fact that it is worth a considerable percentage of its original cost as scrap at the end of its useful life. The new compound propeller will considerably reduce this first cost, as the steel core makes up a large part of the total weight of the blade. The union between the two metals is very perfect, actual test showing that a tensile stress of 15 tons per square inch was required to separate the metals. The new blade would seem to possess all the advantages of the bronze blades at a considerable reduction in the cost of these.

[Continued from SUPPLEMENT, No. 762, page 12177.]

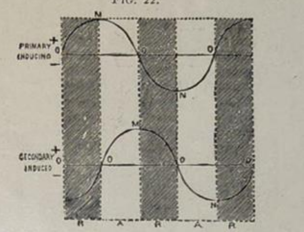
PROFESSOR ELIHU THOMSON'S ELECTROMAGNETIC INDUCTION EXPERIMENTS.*

By J. A. FLEMING, M.A., D.Sc., M.I.E.E., Professor of Electrical Engineering in University College, London.

RETURNING for a moment to the theory of these repulsive and deflective actions, it will repay us to consider it in the form placed before us by Prof. Thomson, in his first paper on the subject, read before the American Institute of Electrical Engineers, May 18, 1887. He says: "It may be stated as certainly true that, were the induced currents in the closed conductor unaffected by any self-induction, the only phenomena exhibited would be alternate equal attractions and repulsions, because currents would be induced in opposite directions to that of the primary current when the latter current was changing from zero to maximum positive or negative current, so producing repulsion; and would be induced in the same direction when changing from maximum positive or negative value to zero, so producing attraction.

"This condition can be illustrated by a diagram, Fig. 22. Here the lines of zero current are the horizon-

FIG. 22.

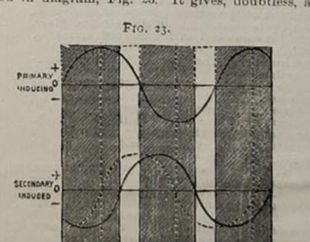


tal straight lines. The wavy lines represent the variations of current strength in each conductor, the current in one direction being indicated by that portion of the curve above the zero line, and in the other direction by that portion below it. The vertical dotted lines simply mark off corresponding portions of phase or succession of times.

"Here it will be seen that in the positive primary current descending from M, its maximum, to the zero line, the secondary current has risen from its ze[ro to] M', its maximum. Attraction will therefore ensue, [as] the currents are in the same direction in the two conductors. When the primary current increases from zero to its negative maximum, N, the positive current in the secondary closed circuit will be decreasing from M', its positive maximum, to zero; but, as the currents are in opposite directions, repulsion will occur. These actions of attraction and repulsion will be reproduced continually, there being a repulsion, then an attraction, then a repulsion, and again an attraction, during one complete wave of the primary current. The letters, R, A, at the foot of the diagram, Fig. 22, indicate this succession. (The shaded portions in the diagrams represent the time during which the force between the primary and secondary circuits is a repulsive force.)

"In reality, however, the effects of self induction in causing a lag, shift, or retardation of phase in the secondary current will considerably modify the results, and especially so when the secondary conductor is constructed so as to give to such self-induction a large value. In other words, the maxima of the primary or inducing current will no longer be found coincident with the zero points of the secondary currents. The effect will be the same as if the line representing the wave of the secondary current in Fig. 22 had been shifted forward to a greater or less extent. This is indicated in diagram, Fig. 23. It gives, doubtless, an

FIG. 23.



exaggerated view of the action, though from the effects of repulsion which I have produced I should say it is by no means an unrealizable condition.

"It will be noticed that the period during which the currents are opposite, and during which repulsion can take place, is lengthened at the expense of the period during which the currents are in the right direction for attractive action. These differing periods are marked *r*, *a*, etc., or the period during which repulsion exists is from the zero of the primary or inducing current to the succeeding zero of the secondary or induced current; and the period during which attraction exists is from the zero of the induced current to the zero of inducing current. (It will be seen that the shaded portions in diagram 23 have been widened out at the expense of the unshaded parts.)

"But far more important still in giving prominence to the repulsive effect than this difference of effective period is the fact that during the period of repulsion both the inducing and induced currents have their greatest values, while during the period of attraction the currents are of small amounts comparatively. This condition may be otherwise expressed by saying that the period during which repulsion occurs includes all the maxima of current, while the period of attraction includes no maxima. There is then a repulsion due to the summative effects of strong opposite currents for a lengthened period against an attraction due to the summative effects of weak currents of the same direction during a shortened period, the resultant effect being a greatly preponderating repulsion

"It is now not difficult to understand all the actions before described, as obtained with the varied relations of coils, magnetic fields, and closed circuits. It will be easily understood, also, that an alternating magnetic field is in all respects the same as an alternating current coil in producing repulsion on the closed conductor, because the repulsions between the two conductors are the result of magnetic repulsions arising from opposing fields produced by the coils when the currents are of opposite directions in them."

One of the most beautiful of Prof. Thomson's experiments illustrating this repulsion can, I think, be shown to you now.

An incandescent lamp is attached to the terminals of a coil of wire, and the coil and lamp floated in water or hung from a scale beam (Fig. 24) over the pole of an

FIG. 24.

[alternating] magnet. The coil and lamp form, as it [were], a balloon and car floating in space, and placed in a magnetic field. When that magnetic field is rapidly alternated by exciting the magnet, the induced currents created in the coil make themselves evident by illuminating the lamp, and the repulsive electrodynamic action shows itself by lifting the lamp and coil upward through the water or the air.

The same experiment renders it possible to show the effect of magnetic screening very prettily. If I introduce a plate of copper between the magnet pole and the induction coil attached to the lamp, the copper "screens" the coil from the inductive action of the pole, and the light of the lamp disappears. I must next direct your attention to some curious effects which are found to exist when two conducting circuits are exposed to the magnetic flux from an alternating magnetic pole, and which depend upon the interaction of the currents induced in each respectively. Professor Thomson embodies these facts now to be considered in four laws, which may be briefly stated as follows:

1. If two or more closed circuits are similarly affected inductively by an alternating magnetic field, they will attract one another, and tend to move into parallelism.

2. Iron or steel masses placed in an alternating field give rise to shifting magnetism or lines of force moving laterally, and may, therefore, act to move closed circuits in the path of such shifting lines.

3. Closed circuits in alternating magnetic fields or fields of varying intensity give rise to shifting magnetism, or lines of force moving laterally to their own direction, and may, therefore, act to move other closed circuits in the path of such lines.

4. Iron or steel masses may, when placed in an alternating magnetic field, interact with other such masses, or with closed electric circuits, so as to produce movement of such masses or circuits relatively, or give rise to tendencies to so move, the effects depending on continual adaptations of shifting magnetism and retained magnetism relatively.

It is a simple matter to illustrate these principles; and the experiments, which are designed so to do, bring before us some striking peculiarities of the action of magnetic force upon closed circuits, and upon masses of conducting and magnetizable matter.

Returning, first, to the simple experiment of a copper ring repelled by an alternating pole, we find that if we add a second ring under the first, they both attract one another, and the two rings are supported and repelled as if they were one ring. It is obvious that at any instant the induced currents in both rings are in the same direction, and hence they attract one another.

Such an attractive action can be made to produce continuous rotation. We have only to place a copper ring or plate over the alternating current coil or pole, and then bring a copper disk, free to revolve on pivots, into proper position relatively thereto. This can best be done by placing the ring or plate so as to be somewhat to one side of the pole, so as to "shade" part of it, as it were, while a part of the pivoted disk is placed under or over it, in front of the alternating pole. The disk then begins to revolve rapidly on its pivot (Fig. 25). A little consideration shows that in this case the fixed copper plate shields a portion of the pivoted plate. The currents induced in the fixed plate attract the non-symmetrically placed induced currents in the other disk, and exert a tangential action or couple upon it tending to pull it round. The continual repetition of this action as each portion of the plate becomes in turn the seat of maximum inductive action results in a continual revolution of the plate. Two pivoted disks may be used in-

* A paper recently read before the Society of Arts, London.

tion.

* * *

If the rubber bulb and tubing begins to harden, immersion for a time in spirits of turpentine will often soften it.

May 24, 1902.

into more general use.

FUSION OF QUARTZ.

Some interesting experiments in connection with the fusing of quartz have been carried out with great success by Mr. R. S. Hutton, of the Owens College, Manchester. Quartz is much preferable to glass for the manufacture of certain physical apparatus, especially those of a delicate nature, and those required for high-temperature gas investigations, but its application is very limited, owing to the great difficulty of fusing it. Hitherto the oxyhydrogen blowpipe only has been used for fusing the quartz, but its success is not very complete, owing to the fact that the temperature thus generated is only a little higher than the melted silica itself. This fact led Prof. Moissan and other prominent French scientists to achieve the desired end by the utilization of the electric furnace, but their researches did not accomplish so great a result as was anticipated. Mr. Hutton, however, was convinced that the electric furnace was the only means by which the silica could be reduced to a molten condition, and he thereupon conducted his experiments upon the lines of Moissan, and some interesting effects of the arc upon the silica were observed. The most salient advantage that molten silica possesses over glass is that it may be plunged into cold water, no matter to what degree of temperature it may have been heated, and it will not crack. Mr. Hutton employed the Moissan furnace for his researches, but incorporated some special features of his own design. The furnace was composed of a lower grooved block of magnesia with arrangements for the arc carbons, placed at right angles to the groove in the lower block, and an upper block plate. The graphitic carbon support—graphitic carbon was employed, as this material is absolutely pure, so that the fused silica cannot become impregnated with ashes—fitted into the groove. The quartz to be fused was granulated and placed upon the carbon support. A current of 300 amperes and 50 volts was brought to play upon the quartz, and in a few seconds it was melted. The support was then pushed further in, so that a fresh quantity of the powdered silica was brought under the influence of the arc. By this means Mr. Hutton has been successful in making rods and tubes one foot long from powdered quartz. In the manufacture of thick tubes of quartz Mr. Hutton employed a quartz mould with a carbon core about one-eighth inch in diameter with carbons to support it at either end. In the course of these experiments Mr. Hutton observed that the silica in the immediate neighborhood of the arc was inclined to change to silicon, but the black stain disappeared immediately the portion was removed from the center of the arc. The silica does not adhere to the carbon, as might be supposed, as it is powdered, so it can be easily separated from the core and the carbon support. Mr. Hutton, however, has not yet succeeded in obtaining a tube quite immune from bubbles, but he found that after the tubes had been made, if they were once more heated in the arc, they were considerably improved.

The Stroh Violin.

The Stroh violin, a new musical instrument, was introduced to a London audience recently by J. E. Muddock, who describes it thus: The vibrations of the strings are conducted by means of an ordinary violin bridge, which rests upon a rocking lever, to the diaphragm and resonator. The lever supporting the bridge oscillates laterally upon the body of the instrument, the end being attached to a diaphragm of aluminum by a small connecting link. The diaphragm is held in

Lever and Rocking Bridge.

THE STROH VIOLIN.

position between two india-rubber cushions by means of a specially-designed holder fixed upon the body of the violin by two brackets. Attached to this holder is the trumpet or resonator. The body or main support of the instrument is in no way employed for sound purposes. It simply holds the various parts of the violin together, and sustains the enormous pressure of the strings when tuned. The disc or diaphragm is perfectly free to vibrate, the result being that when the strings are set in motion by the bow the bridge and rocking lever vibrate accordingly, and thus every vibration is transmitted to the diaphragm. The diaphragm sets in motion the air contained in the resonator, the resonator augmenting and distributing the same to the surrounding atmosphere.

The rich, mellow tones supposed to come only after at least a century's playing of a violin require no forcing. The slightest contact of the bow will bring them forth and make the player imagine himself a far better performer than he is.

The invention consists of an apparatus which can be used either alone or in conjunction with or attached to a firearm and to be used as a weapon of defense by expelling a fluid which will blind the eyes of the opponent for a time and thus render him powerless.

The fluid which I use for this purpose consists of tincture of capsicum and croton-oil in about the proportions of three drams of oil to each pint of tincture of capsicum. The effect of this liquid if entering the eye is to cause immediate loss of sight; but in a short time—say a few hours at most—the effects wear off and sight returns without any permanent injury having been caused to the eyes.

The idea of the steam turbine is quite simple, and is similar to that of the water turbine or impulse wheel. The practical difficulty which has heretofore prevented the development of good steam turbines, lies in the very high velocity which steam can impart to itself in expansion, and the difficulty in efficiently transferring this motion to wheels at speeds practicable for construction or practical use. Steam expanding from 150 pounds gauge pressure per square inch into the atmosphere is capable of imparting to itself a speed of 2,950 feet per second, and if it is expanded from 150 pounds gauge pressure into a 28-inch vacuum it can attain a velocity of 4,010 feet per second. The spouting velocity of water discharged from a nozzle with 100 feet head is 80 feet per second. These figures illustrate the very radical difference of condition between water turbines and steam turbines. The exigency of velocity is satisfactorily controlled in the Curtis turbine.

Group I

Foods with acids

Fruits: Apples, pears, etc., bananas, berries, melons, oranges, lemons.

Vegetables: Salads—lettuce, celery, etc.; potherbs or "greens," potatoes and root vegetables, green peas, beans, etc., tomatoes, squash, etc.

Group II

Foods depended upon for sufficient protein

Milk: Whole milk, skim, buttermilk; cheese of all kinds, eggs, meat.

Fish, poultry, game, peanuts, soy beans.

Group III

Starchy foods

Cereal grains, meals, flours, cereal breakfast foods, bread, crackers, macaroni and other pastes.

Cakes, cookies, starchy puddings, etc., potatoes and other starchy vegetables.

Group IV

Sugar

Sugar, molasses, sirups, honey.

Candies and sweet chocolate, fruits preserved in sugar, jellies, jams, and marmalades.

Group V

Fat

Butter and butter substitutes, cream, lard, suet, and other cooking fats.

Table and salad oils, salt pork and bacon, chocolate, oily nuts.

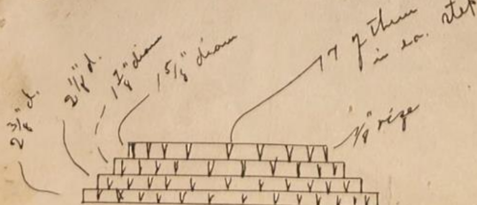
Soap bubbles

Dr. Plateau found that a spherical soap bubble, 4 ins. in diameter, can seldom be preserved in the free air, within a room, for a longer time than two minutes,* a period far too short to enable an observer to study the attendant phenomena. He therefore used for the purpose a mixture of Marseilles soap, glycerine, and water, which he found produced films of great persistence; but various other formulæ for soap solutions have since been used by different experimenters, all depending upon the presence of glycerine for checking the evaporation of the water. We shall refer

8	1	6
3	5	7
4	9	2

Permanent bubbles a film

The substance used by [illegible] Thompson consists of a mixture of colophony resin and Canada balsam in the proportion of 46 per cent. of resin to 54 per cent. of Canada balsam, a few drops of spirits of turpentine being added after. With this mixture the best films are formed at a temperature of 95° C.; below that temperature they are thick and clumsy, and above it they are too thin and fragile, although it is possible to obtain a film from this compound at as high a temperature as 110° C., but it usually bursts before hardening. The tenacity of a film composed of this mixture is very great, in instance of which we may mention that a film formed across a horizontal ring an inch and a half in diameter, composed of iron wire ·035 in. in diameter, sustained, without breaking, the pressure of a circular brass 50 grammes weight (1·765 oz.) of about 1 in. in diameter placed upon its center.



Compressed air escaping thro valve [illegible] gives great heat.

Lettuce Prevents Smallpox.

DON'T forget that lettuce is a preventive of smallpox.

So far as it is possible for a human being to be protected from catching smallpox, lettuce is a protection.

No need for vaccination whatever. Any person who eats a small quantity of lettuce twice a day, morning and evening, is as well protected against smallpox as it is possible for any one to be.

To be sure, one ought to be clean, ought to live in ventilated rooms, and avoid dirt of all sorts. Also avoid contact with people who have smallpox. Foolish exposure to the contagion of smallpox is not to be thought of. But there is no need for vaccination.

Go calmly on about your business. Provide a small quantity of lettuce morning and evening, and you can feel sure that you have protected yourself and your family in the best possible way against smallpox.

Lettuce is one of the oldest vegetable remedies known to the medical profession. Long before it was used as food it was used as medicine. Many times it has been claimed that it has magical or miraculous powers to prevent contagious disease. We believe this is carrying matters altogether too far. But lettuce does furnish to the system exactly what is needed to protect it against the poison of smallpox.

We defy any one to produce a case of smallpox that has been contracted by any person who made daily use of lettuce as a food. If there is any such case on record, we would be glad to hear of it.

Plating of Aluminum
Dec F. I. Journal 1915

Preventing the Oxidization of Iron

Boil the article in a solution of
10-oz iron filings
4-oz phosphoric acid
1 gal water.
Produces a black coating

A Vanishing Photograph.—To make a photograph disappear use a "goldbath" to which has been added 2 grammes of uranium nitrate. The picture will gradually turn pale and soon disappear altogether. Formula for "goldbath": Distilled water, 1,000 cubic centimeters; hypo, 250 grammes; ammonium sulphacyanide, 25 grammes; salommonia, 40 grammes; lead nitrate, 20 grammes; citric acid, 6 grammes, and solution of gold chloride (1 per cent), 60 cubic centimeters. —*Neueste Erfind. u. Erfahr.*

Luminous Colors on Clothing.—Commercial paints and ordinary varnish affect the luminous properties of calcium sulphide. A mass which does not affect the phosphorescence may be obtained in the following manner: Take one pound of borax and two pounds of bleached shellac and boil together with one gallon of water. Add sufficient phosphorescent calcium sulphide and apply to the cloth. Dresses prepared with this mass have been used for stage effects. The paint will not come off and if ordinary care is taken can be used for years.

Printing a Positive from a Positive.—The need occasionally arises to prepare a positive copy from a positive transparency. Ordinarily the only means of effecting this is to first print a negative and then copy this a second time. The following method given by Lumière and Seyewitz is published in *La Nature* and should prove of interest: The plate is first exposed in the usual way and developed rather fully in any suitable developer, such as diamido-phenol, and is then washed for about a minute. It is next laid with its back against a piece of black paper, which is wetted so as to adhere to the glass. The developed plate is then exposed to the light and is immersed in the following solution: Water, 1,000 cubic centimeters; sulphuric acid, 10 cubic centimeters; potassium permanganate, 1 gramme. This dissolves off the silver image. The temperature of the bath should not exceed 20 deg. Cent. After the plate has become entirely transparent, which occurs in about two minutes, the plate is laid in a 2 per cent solution of sodium bisulphite in order to bleach it, and is then washed for one minute. The next step is to fix thoroughly in a 10 per cent solution of sodium bisulphate ("hypo"); finally, the image is developed in the following bath: (a) Water, 1,000 cubic centimeters; anhydrous sodium sulphite, 180 grammes; mercuric bromide, 9 grammes; (b) water, 1,000 cubic centimeters; anhydrous sodium sulphite, 20 grammes; metol, 20 grammes. For a plate measuring 13 × 18, take 150 cubic centimeters of *a* and 40 cubic centimeters of *b*. The image appears in about one minute, but works out rather slowly. After about an hour or an hour and a half the finest details are complete, and the results are as good as those obtained by the usual process. The bath remains clear in spite of the prolonged treatment.

"Electric" Sparklers.—Electric sparklers were imported from Europe a few years ago and were used on the stage of the Hippodrome in one of their productions. They have been found to contain the following ingredients: Barium nitrate, 50 per cent; iron filings, 30 per cent; powdered aluminium, 8 per cent, and dextrin, 12 per cent. To get the largest amount of sparks with very little or no flame it is necessary that the chemicals be mixed thoroughly and that they be in a finely powdered state. Lumps of dextrin will cause the formation of little flames which will spoil the effect. The amount of dextrin seems to be rather high. I obtained the best result by using the proportions as follows: Barium nitrate, 18 parts (by weight); iron filings, 20 parts; powdered aluminium, 2 parts; dextrin, 1½ parts. This mixture is made into a thick paste with water, applied to thick wires or rods and allowed to dry.—A. S. Neumark.

Cupboard Cures.

... people stop to think that Nature has provided in the food products of earth and tree all the medicines really ...ry to overcome a great many of the ...s of the body and to prevent the graver ...s.

...t run to the doctor every time you feel ...che or pain. Learn something about ...ure's remedies. The doctor will give you some nauseating, poisonous drug that will do you more harm than good. Nature's remedies are pleasant to take, leave no harmful after effect, and will save you many a doctor bill.

Right in your own kitchen, in your own cupboard, on your dinner table, is the very remedy that you need.

If it be rheumatism, neuralgia, or nervous dyspepsia that is keeping you awake at night and making your days miserable, provide your table with celery and eat it every day. Nice, white, crisp, juicy stalks of celery. Put a little salt on it and eat three or four pieces at each meal. Better than any nervine the doctor can find in the whole medical pharmacopœia.

If it be kidney trouble that is annoying you, then have set before you at least once a day a dish of spinach or dandelion, and do not be afraid to eat heartily of it.

To induce perspiration and cleanse the system of impurities eat asparagus. For insomnia try lettuce. For a torpid liver, eat tomatoes, which contain vegetable calomel, and then sip water freely between meals.

For coughs, colds, and influenzy, for consumption, scurvy and hydrophobia, eat onions —just the plain, ordinary, commonplace onion. It is cheap and can be had the year round. It is also a splendid nervine and useful in cases of nervous prostration. The red onion is an excellent diuretic. Eaten every day, onions will clear and whiten the complexion. Onions and lettuce are especially valuable as preventatives of all scorbutic diseases, such as scurvy, smallpox, etc.

Cranberries are a splendid remedy for malaria and erysipelas, and blackberries are useful in all cases of diarrhea.

Lemon juice with sugar and the beaten white of an egg will relieve hoarseness. Figs will overcome constipation, and pieplant will purify the blood.

Grandmother remedies, you may say, but they are better than the doctor's dopes. They are the remedies provided by Nature and they are potent and harmless. The next time you are sick, go, like old Mother Hubbard, to your cupboard, and you will doubtless find there the remedy that your system needs, the remedy that will teach you to be your own doctor and will make you healthy, wealthy and wise.

"Police regulations, especially those designed for the protection of life and limb, should be uniform as far as possible in their application, and want of equality in this respect might render the regulations themselves invalid on that account.

"It is not permissible to directly prohibit one person or a class of persons from engaging in an occupation that is open to others similarly situated, nor is it permissible by a process of elimination to discriminate and exempt individuals in classes from the operation of the law and thus single out those to be subjected to a different law from that which is applied in all similar cases.

"These automobile regulations impose a burden upon the exercise of a general right, and while classification whereby exemption may result is allowable, yet the power of selection of classification is not an arbitrary one, but must have a reasonable foundation. It must always rest upon some difference which bears a reasonable and just relation to the act in respect to which the classification is proposed, and can never be made arbitrarily and without such basis.

BEAUTIFUL COLORS.

Changes Wrought in Appearance of Articles by Oxidation.

From the Lancet.

Many color changes are due merely to oxidation, and degrees of color are oftentimes a measure of the extent of this oxidation. The metal copper, for example, goes through a beautiful play of colors as oxidation proceeds, until finally it is black. It may be pointed out, however, that the intermediate stages of color, like the colors in a soap bubble, are due to the mutual interference of the light reflected from the two surfaces of the thin film of oxide formed over the metal. Iron, again, in moist air, will first present a blackish-green film and finally it becomes a bright red as in the familiar rust. Zinc rust is white, mercury rust is red, silver rust is brownish black, and all are simple examples of oxidation. As a rule the higher the degree of oxidation the more intense is the color. The ordinary oxides of manganese and potassium are respectively light brown and white; when they are still further oxidized in company an intense green product is obtained, while still further degree of oxidation produces brilliant purple, as is seen in permanganate of potassium.

The change produced in the color of certain shell fish by boiling is probably also the result of oxidation being promoted. The question is often asked, without a satisfactory answer being supplied, Why do lobsters and certain shrimps and prawns turn red on boiling. One reason, it may be, is that the black pigment of the lobster or the brown pigment of the prawn is an iron compound in the lower state of oxidation. On boiling, the black pigment turns to red perhaps because the iron in it has in the process of boiling been oxidized to the higher state, much in the same way as metallic iron turns to rust or a proto-salt of iron to a per-salt on boiling. It is easy to understand that continuous immersion in sea water would keep the black iron pigment permanent. On the other hand, the change in the iron compound may be one of hydration. Hydrated oxide of copper is, for example, green, while the dry oxide is black, and on simply boiling with water the hydrated green oxide of copper turns black.

Red human hair is said to owe its brilliance to iron existing in the higher oxidized state, and by means of reducing agents such as pyrogallic acid or nut-galls, which are often ingredients of hair dyes, the color may be modified so long as the use of the dyes is continued. In short, oxygen is a great painter, so to speak, though, of course, it is not the only element which fulfills that role. Oxidation, at any rate, probably accounts for the beautiful autumnal tints of plant life, which are lost soon after the leaf reaches the ground, where it rots, and a reducing, as opposed to an oxidizing, process begins.

Ammonium Phosphate (Phosphate of ammonia) for fire proofing

A NEW PAIN KILLER.

Washington Physicians Interested in a Report.

Washington physicians are much interested in a report recently made to this government on "Pain Killed by Light," by United States Consul Liefeld at Freiburg, Germany, and it is said the subject will be brought up for discussion at the next meeting of the Medical Association of the District. It is stated in Consul Freiburg's report that "after three years of patient research Prof. Redard of Geneva, assisted by Prof. Emery, has discovered a new anaesthetic which promises to revolutionize the practice of dentistry.

"Finding that the nervous system is influenced by colored light, the professor experimented with each hue in turn, and soon perceived that blue had an extraordinarily soothing effect on the nerves.

"Putting this discovery to practical use, he now shuts up a patient in a dark room and exposes his eyes to a blue light of sixteen candlepower for three minutes, causing him to lose all sense of pain, although at the same time retaining his senses. A tooth may then be painlessly extracted, with none of the after effects on the system which sometimes follow ether or chloroform."

What is the matter with spectacles or [illegible]

Bottled Grapes

GRAPE-GROWERS in the United States may derive a useful hint from a process, as yet unknown on this side of the water, by which vine-growers in France are enabled to market fresh outdoor grapes all through the winter. The method, which is a recent invention, is both curious and interesting.

Bunches of the finest grapes, when ripe in autumn, are cut in such a way that to each bunch a piece of the vine five or six inches long remains attached. From this piece the stem of the bunch hangs—an arrangement which, as will presently be seen, is essential to the success of the operation.

A large number of wide-necked bottles, filled with water, are ranged in horizontal rows on racks in a cellar, and in the open end of each of these receptacles is placed a bunch of grapes—that is to say, the piece of vine-stem is inserted into the mouth of the bottle, and the grapes hang outside. The grapes do not touch the bottle, but are supplied with moisture through the vine-stem, which is immersed in the water.

In this manner "black Hamburgs" and other choice table grapes are kept fresh and perfect through an entire winter. The temperature of the cellar, being uniform and moderately low, is favorable to the preservation of the fruit, and, to compensate for evaporation, water is supplied daily to the bottles. Naturally, such grapes are expensive, but there are plenty of people, it seems, who are glad to pay two dollars a pound, or even a higher price, for them.

(10451) C. N. asks for a formula for ground glass. A. Sandarac, 90 grains; mastic, 20 grains; ether, 2 ounces; benzole, ½ to 1½ ounce. The proportion of the benzole added determines the nature of the matt obtained.

Ground glass

"The preparation of the formula is simple. Purchase in any drug store a pound of phosphate of ammonia. Dissolve it in water, making a strong solution, and then keep it in the laundry for constant use. Let the laundress, when she is preparing to starch the clothes, pour a little of the solution in the bowl holding the starch and the linen will come out of the wash fireproof. I earnestly recommend the use of this formula ... when it can be prepar...

Chrome Alum Light Filter.—LE ROY W. MCCAY (*J. Am. Chem. Soc.*, 1923, 45, 2958) recommends an aqueous solution of chrome alum as a light filter in qualitative analysis. A solution of 310 grams of chrome alum in one litre of water is prepared with the aid of heat, is cooled to room temperature, and filtered. Square prismatic bottles, having a lateral edge of 4.7 cm. and a height of 10 cm. from bottom to shoulder, are filled with this solution and corked. The resulting permanent filter is held upright, very close to the eye and 5 or 6 cm. from the flame. It completely absorbs the light emitted by sodium, lithium, calcium, strontium, and barium, and transmits that emitted by potassium, cæsium, and rubidium.

J. S. H.

The Detoxication of Tobacco

INNUMERABLE attempts have been made to protect smokers from the harmful effects of nicotine. So far, however, this object has not been achieved without at the same time depriving the tobacco of its aroma and taste. Recently Ambialet, a French physician, read a paper before the Medical Society of the Department of the Rhône on one of these attempts. His plan is to do away with the defects of other remedies, and it deserves publication, particularly because of its simplicity. Dr. Ambialet has found that if the ordinary coltsfoot or butterbur, which is very common in the countryside, is mixed with tobacco the harmful effects of the latter are completely eliminated. He has himself smoked daily some forty cigarettes made of this mixture, without feeling the slightest effect from the nicotine. At any rate the remedy may be worth a trial, coltsfoot leaves being perfectly harmless and cheap.

Dr. Ambialet claims that tobacco mixed with coltsfoot leaves retains its full aroma and taste, the only perceptible change, if any, being an additional flavor like that of Turkish tobacco. This added flavor should render the mixture very acceptable to most smokers.

Plastering by Machine.—A plastering machine forms the subject of patent, No. 1,100,565, to A. G. Higgins, Kansas City, Mo., assignor of one half to R. M. Havens, same place, and provides means by which cement or other plastic composition may be mixed and fed on to the surface of a trowel so it may be spread upon a wall.

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blows, but no splinters will fly, endangering people.

Vulcanizes Tires by Chemical Means.—Although strictly speaking every vulcanization of an automobile tire is a "chemical reaction," the system invented by W. A. Miles deserves this appellation more than any other, because of the application of heat by a new method. Instead of using steam or electricity, Miles takes a small block of a deflagrating substance, as for instance a mixture of charcoal and saltpeter, or chlorate of potassium and wood dust. Putting the mixture, in form of a pill or block, on a metal plate in contact with the tire, it is ignited and the heat developed used to vulcanize the tire repair patch. The size of the "pill" can be regulated to give just as much heat as is needed for the vulcanization.

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seen engaged in work of this kind.

Cheap Substitute for Horn

A CHEAP substitute for horn can be made from wheat flour and sodium silicate. This substitute is very hard and strong, and, by inserting organic dyes into the composition while mixing, it can be colored to imitate almost any kind of horn substance.

The compound is made by mixing ten parts by volume of sodium silicate (40 deg. Baumé) with distilled water, and then stirring the resultant liquid into a thick paste with fine white wheat flour. The mass is then allowed to stand for three weeks, during which time it undergoes a chemical reaction that produces a hard hornlike substance.

This composition can be molded without pressure when first made, and turned and machined like brass after it has set.

Details of the "Cold" Flame Lamp

By Arthur Palme

With a Sketch by the Author

It was with great interest that I read the article by S. B. Doten in the October issue of CAMERA CRAFT, and I am quite sure that a great number of readers, engaged in the scientific branch of photography, appreciated this new idea of producing a safe, quick, actinic, artificial light, thus doing away with the necessity of using the inconvenient, for small pictures at least, magnesium flash. For their possible benefit I would like to pursue the matter still further, from the electrical standpoint, and furnish a few important electrical details.

In this respect, the only advice given by Mr. Doten is his statement covering the connecting of the silver wire to a wiring of two hundred and twenty volts, nothing being said about the current necessary. I am afraid that most readers, trying to duplicate this kind of flash, would cause considerable damage to the house wiring without obtaining the desired effect. Assuming, for example, a

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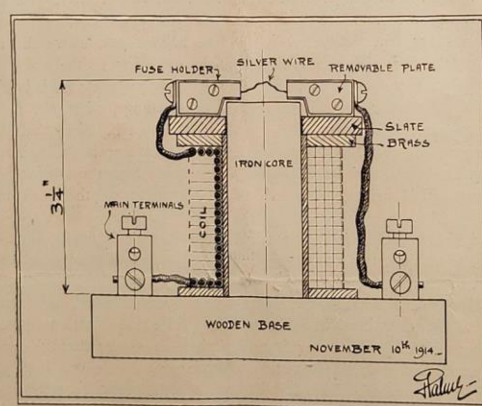
silver wire of only three one-thousandths of an inch in diameter, a thickness of silver wire that may be had in the market under the name of "hair wire," and one inch thereof represents an electric resistance of approximately nine one-hundredths ohms. Connecting this wire directly to a one hundred and ten volt circuit, two hundred and twenty volts being found but rarely, produces a current of twelve hundred and twenty-five amperes, enough to explode the wire in a very small fraction of a second. These twelve hundred and twenty-five amperes are theoretically right; in fact, however, the duration of the explosion is so short that they have, quasi, no time to fully develop. However, one must put a fuse in series with the wire, and it is in doing this that trouble may be



WORKING DRAWING OF THE "COLD" FLAME LAMP—THE ORIGINAL FULL-SIZE DRAWING IS HERE REPRODUCED ONE-HALF DIAMETER

caused. Since the piece of silver wire is nothing more than a fuse, there are two fuses in series and the question arises as to what must be the proper ampere capacity of the real fuse in order to withstand the momentarily heavy current demanded to consume the silver wire, and yet protect the wiring.

After several experiments, the writer has found that a twenty-ampere fuse possesses sufficient heat capacity to remain unchanged during the fusion of the silver wire. This holds true only for a silver wire of three one-thousandths of an inch diameter and one inch in length. Any increase in thickness of wire, besides changing the results to a great extent, would require a very much heavier protective fuse. A wire of No. 31, B. & S. gauge, that is, a silver conductor of approximately one one-hundredth inch in diameter, as recommended by Mr. Doten, requires, momentarily, something about thirteen thousand amperes and would call for a protecting fuse of at least seventy-five amperes. Of course, the fire and light effect in exploding such a comparatively heavy wire is very much stronger than in the example given above.

OVER

d vessel. The under the in- pressure all of the mole- s now hard- the product is non- re-

Varnish
& its removal

main "tacky" for an indefinite time and practically never dry. There is no remedy for this defect but to cut off the poor varnish with some solvent such as, one quart acetone, one quart alcohol, one-half pint of water saturated with washing soda and one quart of benzene, in which a few ounces of paraffin or other wax has been melted. The mixture should be well shaken and then brushed over the surface until the varnish is quite wet. To prevent evaporation, cover over the article with old sacks and let it stand for twenty minutes, giving time for the solution to soften up the varnish. On removing the sacks, the varnish will be found very soft and easy to wipe off with a rag or to scrape off with a straight piece of glass or steel. When the article is cleaned and wiped thoroughly dry, revarnish with a good linseed oil varnish. The receipt given above will remove any varnish whatsoever whether old and hard or soft and sticky.

[illegible] Scratching will never be eliminated from furniture until a harder and tougher varnish is discovered. Scratches which appear white can not be easily obliterated. They may be obscured, however, by rubbing well with a piece of cheese cloth moistened with a solution of nine parts boiled linseed oil and one part lemon oil. Any failure to have this solution work correctly will arise from the fact that too much oil has been applied to the surface and the rubbing has not been sufficient.

contain. One of the best possible furniture revivers is one which every housewife may easily mix and prepare at a cost of a few cents and with no labor whatsoever. One part of lemon oil and two parts of boiled linseed oil well mixed and applied rather sparingly to the varnished furniture with a linen rag, a piece of silk or cheese cloth, free from nap and dust, will do more to preserve good furniture than any veneer sold at the present time.

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Removing Old Lacquers and Varnishes from Oil-Paintings.—The following liquid is recommended by M. Rubini, according to a German patent: 1,000 grammes of weak alcohol (rum) are mixed with 90-120 grammes of oil of cloves and 90-120 grammes of ether; in a separate vessel equal parts (by weight) of paraffin oil and oil of turpentine are mixed; 500 grammes of each of the two solutions are brought together, whereupon a solution of 25-50 grammes table salt in 400-600 grammes of distilled water is added. This liquid must be well shaken until it forms a milky emulsion. It is then ready for use. A piece of cotton wool is wetted with this solution and rubbed over the painting. Fresh pieces of cotton must be used until the tuft remains perfectly clean on going over the painting. If the lacquer should be very old and dark, the surface of the painting may be covered with the liquid and then rubbed off with cotton wool. It will be found that the painting will regain its original fresh and deep colors,

Melted Basalt. (*La Nature*, October 2, 1920.)—This volcanic rock is hard to shape with chisel and hammer. Doctor Ribbe in Auvergne has, however, found that it may be melted and molded with no great difficulty by working at about 1300° C. In his preliminary experiments he obtained a glassy substance, but, fortunately, he has been able to apply a devitrifying process, which restores the crystalline structure of the original rock. The melted rock is superior to the natural basalt in resistance to wear and scratching. It is in consequence valuable for paving, for curbstones and for stairs. This property added to the exactitude of form and dimension achieved in the process of molding points to extended usefulness in building.

Acids do not attack the melted basalt, it is claimed, and it can be used for vats, etc., in the manufacture of chemical products. ... excellent electrical insulator and metallic posts and fit... factory way by inserting them in the

Shellac Varnish
for India rubber

This forms an excellent varnish for rubber shoes &c. It may be applied with a rag. It would act well as a vehicle for a dark pigment, such as lamp-black.

Soak powdered shellac in ten times its weight of strong aqua amonia (26° B)

At first no change beyond a coloring of the solution is perceptible. After many days standing the bottle (should have glass stopper) being tightly closed, the shellac disappears. It may be a month.

For paint marks a vaseline-gasoline treatment is used by the modern laundry; grass stains on woolens and silks are removed with ether; ink spots and rust are treated with an oxalic sour; tea, coffee and wines are most frequently "cured" with special sodium bisulphite or potassium permanganate methods—and so through the whole long list.

This is a supplemental help that modern laundries render—one of the details typical of the thoroughness of all modern laundering service.

by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

Dr. J. [illegible], a Cincinnati, Ohio, dentist, has a process [illegible] which he claims to have perfected a system of tanning all kinds of leather with the x-ray in from ten to fifteen minutes. Samples of leather tanned by this process appear to be in as perfect condition as leather tanned at tanneries by the longer and more expensive methods which have from time immemorial been used.

durance is also an important quality in sea-going s of large size, not merely in structure, but in pro- ing apparatus. The extreme lightness essential in edo vessels obviously does not favor endurance if powers are frequently or continuously required. it cannot be denied that the results obtained in edo vessels show such a wide departure from those l in sea-going ships as to suggest the possibility of e intermediate type of propelling apparatus appli- e to large sea-going ships and securing sufficient bility and economy of fuel in association with her savings of weight.

(To be continued.)

HE POLLAK-VIRÁG SYSTEM OF HIGH SPEED TELEGRAPHY.

TERESTING experiments with the Pollak-Virág em of fast speed telegraphy were made on several

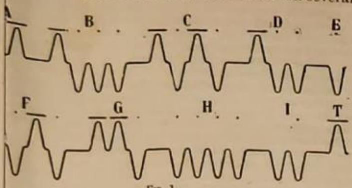


Fig. 1.

ts lately between Budapest and Vienna, when ed of from 1,300 to 1,500 words per minute was at- d. The tests were made, we understand, in pre- e of the German technical officials, and a repre- ative of the French government was also present. following is a technical description of the ap- tus:

e transmission is effected by a perforated strip of r, as in the case of the Wheatstone automatic, and ephone fitted with two small mirrors serves as the ver, the diaphragm of the telephone being set into tion corresponding to the current impulses gen- ed by the transmitter. These oscillations are made le photographically. The dots and dashes of the se code are represented by strokes on either side of central line, as shown in Fig. 1, the strokes being uced by current impulses in different directions. transmitting apparatus, *B*, Fig. 5, consists of a r driven by a motor or clockwork. This roller es the perforated paper forward, and is connected the line. The strip of paper is perforated in two corresponding to the two directions of the cur- and above it two brushes are fixed, one connected e positive pole of one battery, the other to the tive pole of another. The return wire is con- ed with the other two poles of the two batteries. if in consequence of the perforations of the paper of the two brushes comes into contact with the l roller, a positive or negative current flows ugh the roller to the line and thence to the receiv- apparatus.

the receiving station, *B*, the currents, as already tioned, pass through a telephone whose diaphragm oved in a direction determined by the direction e current impulse. The movements of the dia- gm are transmitted to a small mirror with the as- nce of a metal rod. It is necessary that the small ements of the diaphragm should occasion a rela- y large displacement of the mirror. This is done by ning to the mirror a small plate of soft iron, held sition by one pole of a permanent magnet. The pole e magnet ends in two points, and holds the mirror ch a way that the line joining these two points is axis about which the mirror turns. The other pole e magnet is provided with a weak spring, also end- n a point, and forming the third point of support e mirror. This spring is now connected to the hragm by means of a small rod, so that the small ements of the diaphragm cause a rotating motion e mirror, which is relatively large, as the points of port of the mirror are very near to one another. method of magnifying the movements of the dia- gm has the advantage that, in consequence of the l weight of the moving parts, the velocity of vi- ion of the diaphragm is not lessened. The light small glow lamp falls on the small concave mirror mentioned, which throws the image of the fila- t on a piece of paper sensitive to light. In t of this sensitized paper a cylindrical lens is ed which draws together the long narrow image to bright point. In consequence of the current im- es which move the diaphragm and mirror, the spot ght moves out of its original position in one direc- or the other. In this way the up and down kes already mentioned are traced on the sensitized er. The latter is wound on a drum which is nted on a screwed spindle, so that the line traced by the light follows a continuous spiral route. The amplitude of the movements of the spot of light are large enough to make the signals clearly legible.

Although this action appears simple enough, allowance has to be made for one important disturbing factor, viz., the natural period of oscillation of the diaphragm itself. This is done by making the duration of each current impulse equal to the natural period of the telephone diaphragm, so that the current always stops exactly at the moment when the diaphragm is swung back to its original position. By suitably adjusting the velocity of the paper and the dimensions of the perforations, the duration of an impulse can be regulated, and a perfect damping of the membrane so obtained. But in order not to be dependent in practice on the precision of the movement of the paper, another device has been added. If the current impulse is shorter than the natural period of the vibration of the diaphragm, and a condenser is connected in parallel to the telephone, this condenser will be charged during the duration of the current impulse. After the current ceases, the condenser (as shown in Fig. 6) discharges into the telephone circuit, and prolongs the duration of the current. By using a condenser of suitable capacity, it is contrived that the diaphragm returns to its original position without first oscillating to and fro.

It appears that the inventors have not overlooked the fact that the properties of the line, independently of the apparatus, render fast speed telegraphy difficult. An endeavor is made to counteract this influence to some extent by connecting, parallel to the line at the transmitting station, a coil with self-induction, whose dimensions are chosen according to the self-induction, capacity, and resistance of the line.

The first experiments were made through an artificial line whose resistance was 2,000 ohms and capacity 8 to 9 microfarads. These having proved successful, the Hungarian Ministry of Trade kindly allowed tests to be made with four bronze lines of 3 mm. diameter from Budapest to Temesvár. These were connected together at Temesvár, so that a metallic circuit 400 miles long and of 4,000 ohms resistance was obtained. The experiments made both in wet and dry weather, and a speed of 70,000 words per hour, and 20 volts battery pressure, gave clear signals, while with 25 volts a speed of 100,000 words per hour was attained. Other experiments on a metallic circuit of iron wire 210 miles long and of 6,000 ohms resistance were also successful, a speed of 54,000 words per hour being obtained with a 60-volt battery. In the experiments the perforated strip was fastened on a drum in such a way that the same series of letters were constantly repeated. We have referred above to the most recent trials between Budapest and Berlin, which are stated to have given distinct and readable signals at speeds of from 1,300 to 1,500 words per minute. Fig. 2 is a reproduction on a reduced scale of the signals received, Fig. 3 shows the same series of signals without the device for damping the oscillations of the diaphragm, and Fig. 4 shows the disturbing effect of the line itself when the self-induction coil is omitted. The time taken to receive such a sheet with 500 to 600 words is stated to be 22 seconds. We are indebted to The London Electrician for the above interesting facts concerning this system.

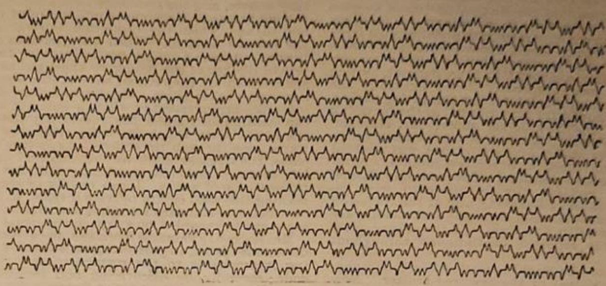


Fig. 2.—REPRODUCTION OF A SAMPLE RECORD.

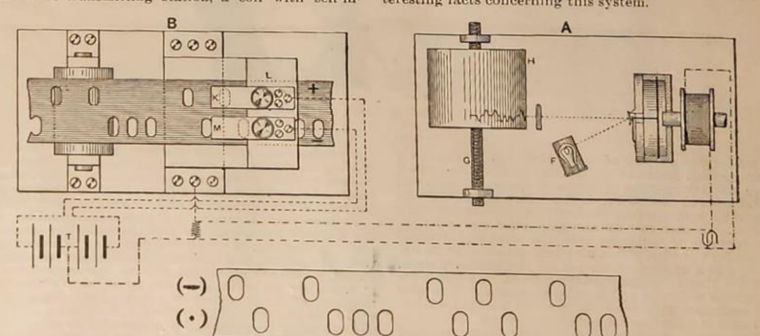


Fig. 5.

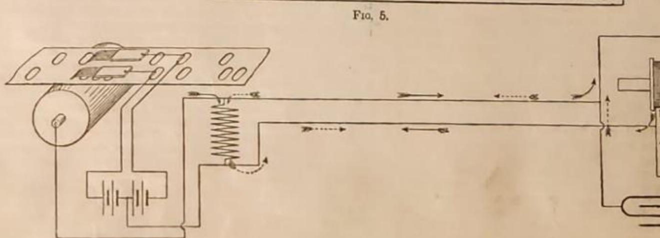


Fig. 6.

Sci. Am. July 17-97

Philadelphia, Pa. April 30,1906.

Mr. C. Francis Jenkins,

Washington, D. C.

My Dear Mr. Nenkins:-

It is very difficult to prescribe an etching ground without knowing the purpose for which it is to be employed. Asphaltum mastic, gutta percha and wax in proportions to suit the requirements of the work can be melted together and the compound dissolved in either chloroform or benzoin and flowed as a varnish. This makes a very good resist for hydrofloric acid, and I trust may meet your requirements.

Yours very truly,

Max Levy

The colors used in the gelatine films appear to be naphthol green in one, and mixture of naphthol red and naphthol yellow in the other. A good pair of complimentaries is naphthol green and naphthol red without the yellow.

Very truly yours,

F. E. Ives

Xylol, a solvent naptha is one of the best solvent for tars, waxes and pitch. It made by Barrett Co New York @ 35¢ gallon

Benedict

1922

AUTOMATIC MONEY ASSORTER.

AUSTRIAN INVENTOR PRODUCES A NEW MECHANICAL DEVICE.

Consul Joseph I. Brittain reports from Prague that a recent issue of an Austrian journal gives an account of an automatic money assorter, which is thus described:

The inventor claims that it will assort metal coins which have been thrown together regardless of their denominations, placing each denomination in a separate basket. The various coins are thrown indiscriminately into a funnel at the top of the machine, and from the funnel they slide downward, alighting on a spiral track. This track has a protecting edge or raised border containing slits corresponding to the various sizes of the coins. As the coins of various denominations glide downward onto the track, through some peculiar mechanism of the machine they pass through the slits corresponding to their various sizes, entering their respective baskets at the bottom of the machine.

It is said that several firms handling large amounts of coin daily have tried the machine with satisfactory results.

ground as far as practicable, and the specifications adopted for these cables require that they should be composed of solid conductors of soft copper of a size corresponding to No. 16 B. & S. gauge. Each conductor shall be tinned, and insulated with a high grade vulcanized rubber compound, the thickness of the insulating wall being not less than 3/64 of an inch and 30 per cent fine Para rubber compound with mineral base will be required.

The central office equipment in the case of the three boroughs in which new buildings have been erected is yet to be designed.

The new installation will be so planned as to enable it to operate in accordance with the present routine of the companies and officers of the department, and to allow for sufficient flexibility so as to be readily adaptable to any changes that may in future be considered necessary.

The fire alarm equipment in the outlying boroughs is a matter of no small importance, especially in consequence of the enormous increase in the number of wires comprising the electrical systems, the majority of which are still carried overhead on pole lines. The interference of electric light wires with those of the fire alarm telegraph is a source of constant menace. In a number of instances on record, street alarm box circuits have for hours been rendered useless through the destruction of the electrical mechanism of the boxes due to the crossing of conductors with wires carrying heavy currents of high potential. The danger of such interference need hardly be stated, though it will bear reiteration to say that the first seconds after the outbreak of a fire are of incalculable importance to the fire department, and anything tending to deprive it of the quickest method of getting such notice may carry with it most disastrous and ruinous consequences.

The only manner in which this constant source of difficulty may permanently be eliminated is by the laying of all conductors underground. This is the chief problem incidental to the completion of modernizing New York City's fire alarm plant, and measures must be taken to proceed with the extension of the underground system in such manner as will enable the work to progress under a uniform plan and not by piecemeal.

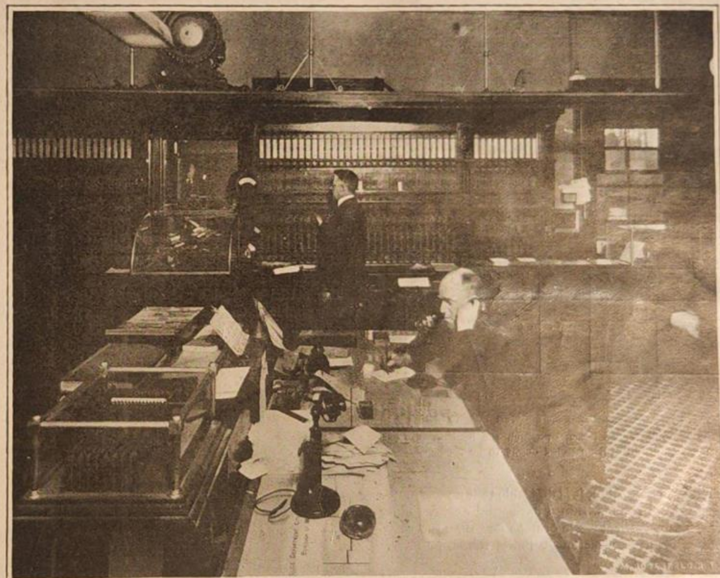
The transferring of the circuits to the subways, which was begun on the island of Manhattan as early as 1888, has to some extent been continued each year, but at

The entire extent of the circuit mileage including both the underground and overhead wires aggregate in the five boroughs between 3,500 and 4,000 miles, and it will be seen from this that the more substantial the method of installing these conductors, the less will be the cost to maintain them.

subway companies.

BROOKLYN.

It is proposed to provide a permanent installation for one-third of this borough, as the vast extent of the borough in itself makes the planning of a modern fire alarm installation a very difficult and expensive problem



Fire Alarm Telegraph Bureau Central Office at Fire Headquarters, Borough of Manhattan.

Showing the alarm box circuit switchboard and receiving instruments. From twelve o'clock midnight until eight in the morning two fire telegraph operators watch over the lives and property on Manhattan Island, and the protection of the borough from the spread of fire depends largely upon the alertness and accuracy of these two individuals.

unless taken up in sub-divisions, and the problem for each solved according to local conditions, owing to the relatively undeveloped character of the property on one side of the borough as against that of the other. Along the water front from Newtown Creek to and including Coney Island, valuable property and many lives are at stake to-day through inadequate fire alarm protection, and in this important section it is contemplated to install, as promptly as appropriations can be obtained, a modern system. This installation will be extended to include practically one-third of the entire area of the borough, leaving the remaining portion to be treated after the first undertaking is well under way.

RICHMOND AND QUEENS

These boroughs present quite an undeveloped aspect when compared with the other boroughs and, except for those extensions which are needed to rectify unsafe conditions, it is not my intention to prepare plans at this time for extensive improvements. However, a considerable number of additional boxes will be installed and the circuits in the well built up sections are to be laid underground in cables of sufficient capacity for the growing needs of the territory served for many years.

The cost of installing the complete fire alarm system in all boroughs, I have estimated at $5,000,000. However, to carry out the plan on the basis of the recommendations I have recently submitted to the Fire Commissioner would involve an immediate expenditure of approximately $2,000,000, and this installation when completed would result in a material reduction in the cost of maintenance, and would vastly increase the protection to life and property through the improved reliability of the fire alarm service.

Stereoscopic Drawing*

A Training for Accurate Workmanship

By Charles E. Benham

If a test were required for the accurate workmanship of a student in mechanical drawing, no better one could be devised than to set him the task of representing an object in perspective as seen by the right and left eye respectively. The two drawings, when placed in the stereoscope, should show a perfect effect of solidity; but the slightest deviation from exactness in either drawing would manifest itself in the stereoscope very distinctly, and there are few amateurs whose first attempt would not be a failure.

Fig. 1.—Showing method of stereoscopic drawing.
The dotted lines represent the pencilled construction lines.

By care and practice, however, very good results may be obtained; and for many scientific diagrams, in which a three-dimensional representation is necessary, stereograms are very useful, and may be substituted with advantage for clumsy models. As examples may be mentioned the forms of crystals, the imaginary planes that have to be explained to students of perspective, the diagrams required to illustrate the polarization of light, reflection, refraction, and other branches of optics, or, for speculative students, the mysteries of the hypercube.

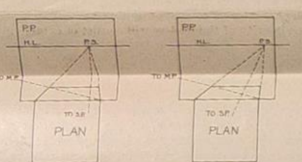


Fig. 2.—The left-hand figure shows the ordinary perspective paper as figured in the text books.
How the diagram should be thought of by the student is revealed by the stereoscopic view.

A difficulty occurs in the limited field allowed by the refracting stereoscope. This necessitates rather small drawing, and, as the lenses of the instrument magnify, the smallest errors are unpleasantly enlarged. Moreover, to avoid distortion, it is desirable that a perspective drawing should come within a horizontal angle of sixty degrees, and a vertical angle of not more than forty-five degrees, which, again, seriously limits the scope of the drawing.

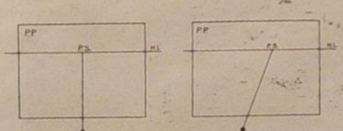


Fig. 3.—Another perspective diagram.
Showing the relative positions in which the horizon line picture plane and station point ought to be regarded.

It would be better undoubtedly to construct a special stereoscope with plane prisms allowing of an extensive distant unmagnified field; and, though such an instrument would have to be rather a bulky affair, it would answer the purpose much better for the exhibition of hand-work, and would enable the draughtsman to make his drawings on a less diminutive scale.

Another way is to draw large and reduce by photography to stereoscopic dimensions. With intricate diagrams this is much the best way, and very beautiful results can be produced.

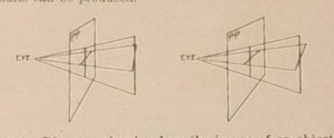


Fig. 4.—Diagram showing how the image of an object is formed on the picture plane by lines drawn from all points of the object to the eye.

The red-and-green-spectacle method of stereoscopic representation is another way out of the difficulty. The two drawings, which may then be of any size, are drawn (almost superposed), the one in green ink, the other in red. Two gelatine films, stained respectively with the same red and green inks, are used for the spectacles, and the figure is seen like a solid wire model in front of the paper. The process, however, is imperfect. With the red gelatine complete extinction of the red lines is easily obtained, but the green lines always show faintly through the green film, unless the dye is so dense as to obscure vision, or unless the color-screen is a liquid one, which is obviously inconvenient, though extremely perfect in its effects.

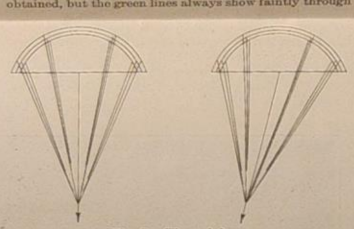


Fig. 5.—The rainbow.
A line is shown, which, if produced, would pass through the spectator to the sun. It will be seen in the stereoscope how the refracted rays form an angle with this line on all sides. The original of this diagram is in colors, making it all the more instructive.

The actual method for drawing for the stereoscope is very simple, extreme accuracy being the main essential of success.

Bearing in mind the prescribed limitations of size and angle of vision to which reference has already been made, the object is first drawn in perspective in the ordinary way. Take, as a simple illustration, a cube. The perspective representation is drawn as on the left in Fig. 1. Pencil lines are drawn horizontally from each determining point of the figure, as shown by the dotted lines in the illustration. These are guides for the position of the corresponding points in the right-hand figure. By this means no measuring point is required for the second drawing, as it is obvious that all these corresponding points must lie in a horizontal line with those of the first figure. The right-hand drawing is placed two and a half inches to the right on the picture-plane, the point of sight being moved an additional half-inch, that is, three inches to the right of the original point of sight.

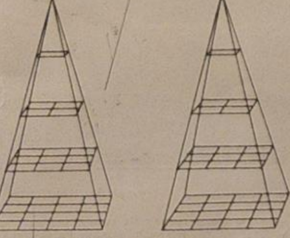


Fig. 6.—The law of inverse squares.

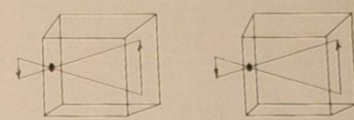


Fig. 7.—The pinhole camera, illustrating the formation of the inverted image.

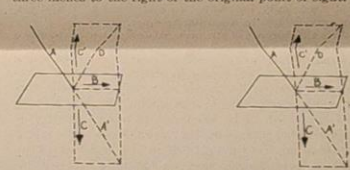


Fig. 8.—Reflection of elastic bodies.
Diagram showing how the principle of the parallelogram of forces explains the angle of reflection.

The limits of stereoscopic separation range between two and a half inches and nearly three inches, so that if the vanishing points are separated by three inches, and the nearest points of the drawing by two and a half inches, the whole picture will be seen comfortably without strain. Even a separation of three inches is too wide for some people; but, as the vanishing points themselves do not figure in the finished drawing, it is safe to give them that amount of separation; for probably no part of the actual drawings will be more than about two and three-quarter inches apart.

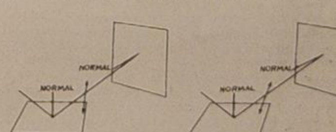
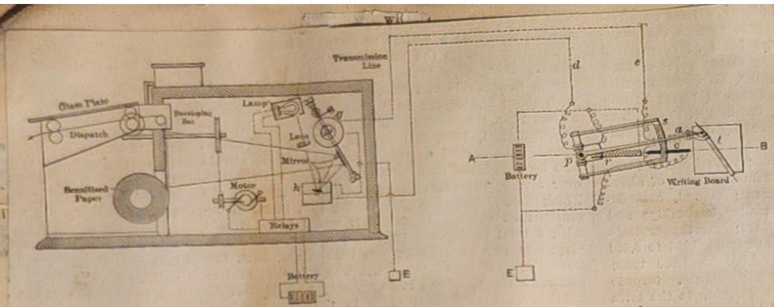


Fig. 9.—Polarized ray reflected from a horizontal plate, but unreflected from a vertical plate when incident upon it at the same angle with the normal, viz., 54½ degrees.

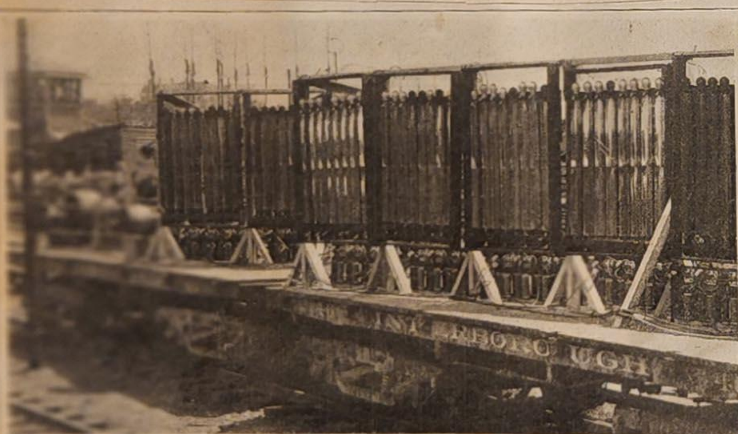
It will be seen from Fig. 1 that by drawing the receding lines to the new vanishing point for the right-hand figure they will be measured off by the horizontal lines. If an angular or oblique vanishing point enters into the left-hand drawing, it must similarly be moved on three inches for the right-hand drawing.

Accuracy is best insured by pricking the paper with a fine needle at each determining point that is established, and then drawing to these needle-pricks.

* From *Knowledge*.



The Combined Transmitter and Receiver of the Gruhn Telautograph.



THE 54,000 CANDLE POWER COOPER HEWITT MERCURY ARC LAMPS.

SUMMER BATHING.

Refreshing Baths Act as Tonics in Hot Weather.

Whether or not a hot or cool bath (not cold) is the better for refreshing one in warm weather is open to discussion. The theory that a hot tub reduces the temperature of the body is certainly true, but on the other hand there are conditions under which a hot bath is not to be considered. A person of little vitality, already partially exhausted by warm weather, will be in a condition verging on fainting after taking a warm tub. If the same person sits in a tub of water which is chilly, or of which only the chill is taken off, the water will draw the heat from the body and the result is cooling.

For this reason each individual must decide which is best for herself. There is, however, no question but that a bath, in summer, may be made more invigorating by the addition of stimulating properties, the best known of which is sea salt. This may be bought at any druggist's, and a couple of pounds or more dissolved in the tub make the bath like a dip in the ocean. Soap should not be used with it, and a salt bath is far more tonicizing taken cold than hot.

Nothing is more refreshing when exhausted by heat than a camphor bath. The action of the gum upon the skin and head is highly beneficial and may be had by mixing two ounces of tincture of camphor, half an ounce of tincture of bezoin and four ounces of cologne or alcohol. Enough of this is put into the tub to make the water aromatic, and the body is immersed for fifteen minutes or more.

More stimulating than plain sea salt is a combination of one pound of muriate of soda, one-half pound of sulphate of soda, a quarter of a pound of chloride of lime and a quarter of a pound of chloride of magnesia.

The ingredients are dissolved in two or three gallons of water and put into the usual tub of water.

A soda bath is especially cooling when the blood and skin are heated and has beneficial results. Common bicarbonate of soda is used, and four or five ounces are put into the tub of clear water, the temperature of which is not high. Soap may be used with this, but a long soaking of the body is better.

The length of time that a person may remain in a tub must be decided by the individual, for too long immersion is weakening. At the same time the body should have all the refreshment it can get.

Fifteen minutes is not too long for the average person, and twenty minutes may usually be indulged in without danger. More than that should not be had by any except those with great physical strength.

Such a bath taken just before going to bed will refresh one sufficiently to insure a good night's rest many times, and a shower on getting up in the morning is worth many times what the apparatus costs.

Almost every tub is now fitted for a hand spray, but when this is lacking spraying arrangements are to be found at any toilet department or druggist. The shower taken should be a cold, or at least cool, one, and need not consume more than two minutes if one is pressed for time. It is as invigorating as fresh water to a drooping flower.

[illegible] I was informed that two hours had elapsed since the [illegible] and that steam was taken on at 170 pounds pres[illegible] The [illegible] engineer of the works stated that the boiler could [illegible] steam pressure as low as one-half [illegible]

[illegible] steam is not taken on at high [illegible] pounds per square inch; in other [illegible] locomotive a steam pressure prac[illegible] power station. In order to [illegible] filled with water to about [illegible] superheated. Steam is ad[illegible] the power plant at the for[illegible] passes through a steam ad[illegible] locomotive boiler and the [illegible] either a revolving pipe con[illegible] or it may be effected by a [illegible] hydrants.

[illegible]

[illegible]ly with the water in the [illegible] tension in the locomotive

[illegible] cements may however be [illegible] affected by the hot [illegible] oxychlorid of zinc and [illegible] manufacture is impor[illegible] cement may be made, [illegible] work, consisting of [illegible] glacial phosphoric acid, [illegible] a few minutes. But all [illegible] except for the time re[illegible] Portland cement, in [illegible] divided condition, to be [illegible] results in a harder [illegible] because more per[illegible] therefrom. After present atte[illegible]

Dry Battery Filler

1/4 lb Sal ammoniac

1/4 lb. chloride of Zinc (paste form)

1/4 lb oxide of Zinc

1/4 lb plaster Paris

Thoroughly mix

HYDROGEN.

ITS ECONOMICAL PREPARATION FOR TECHNICAL PURPOSES.

In transmitting the following report, Consul Thomas H. Norton, of Chemnitz, says that much interest is felt in aeronautic and in certain mechanical circles in the perfection by a German professor of a method for the economical preparation of hydrogen gas on a large scale:

The materials employed in the new process of manufacturing hydrogen gas are water, coke, and calcium carbide. The first step is the production of "water gas," the well-known gaseous mixture obtained when a current of steam is passed through a thick layer of red-hot carbon. For some years past this cheap gas has been employed as a fuel and also for illuminating purposes, either when saturated with volatile hydrocarbons or in connection with incandescent mantles. Its own flame when burning in the air is almost destitute of luminous properties. Water gas consists of a mixture of hydrogen and carbon monoxide gases, with small amounts of nitrogen, etc. Theoretically the two gases should be present in equal volumes, but in practice the amount of free hydrogen is far behind the theory.

The professor has solved the problem of the elimination of the carbon monoxide from the mixture by bringing into play a very simple and elegant reaction. The gaseous mixture is conducted over glowing calcium carbide in the form of powder. As a result the carbon monoxide is completely decomposed in contact with the calcium carbide. Lime (calcium oxide) is formed, and carbon in the form of crystalline graphite is separated. This by-product of artificial graphite is itself capable of utilization for most of the purposes where the natural mineral substance is employed. The minor impurities of the original mixtures are likewise removed in the reaction, and as a result, hydrogen containing but 1 per cent of other gases is isolated.

COST OF PRODUCTION.

The process is one of extreme simplicity and cheapness, and allows of the easy and rapid production of large quantities of nearly pure hydrogen. An installation capable of evolving daily a volume of 70,000 cubic feet of hydrogen occupies a very small space. Hitherto those requiring the gas for balloons or the like have been forced to use the expensive process of preparation based upon the action of acids (hydrochloric or sulphuric) upon metals, usually upon iron. The transportation of acids to remote points is also attended with much inconvenience and difficulty.

In its notable lessening of the cost of hydrogen, the new process has accomplished for this gas what another scientist a few years ago did for oxygen when he introduced the method of the fractional distillation of liquid air, and thus secured an "air," consisting of oxygen with but a slight admixture of nitrogen.

Cheap hydrogen is of great value at the present stage in the development of aeronautics, where, in many cases, it is of prime importance to have a much lighter gas than illuminating gas; for example, in polar exploration. This increased availability of hydrogen for technical purposes will likewise be of distinct value in extending its use for autogenetic welding.

A Paper which is especially Sensitive to Ultra-violet Rays: is prepared with nitrate of para-phenylene-diamine, and turns blue when exposed to the ultra-violet rays.

VALUABLE CEMENT RULE DISCOVERED

Bureau of Standards' New Commercial Formula of Use All Over U. S.

A recent shortage of cement in Washington for use in construction work by the Army engineers brought about experiments at the bureau of standards which may have great commercial value, not only here, but in all parts of the United States, scientists say.

Cement deteriorates in strength with storage. The bureau of standards was asked to find the strength of cement which had been stored for about a year and a half to be used in making concrete. Following experiments a formula was worked out to show the comparative strength of cement which had been stored and fresh cement.

The old cement was received by the bureau of standards and put through a sieving process to remove the lumps. The cement, after seiving, as well as the crushed lumps, were then made into separate concretes, which were compared with concretes made from cement recently purchased. It was found that a mixture of one part of cement (aged) to one and one-quarter sand and two and one-half gravel would give approximately the same strength as a mixture of one part of cement (new) to two parts of gravel and four parts of sand. The bureau of standards recommended that lumps be seived out of the old cement before using.

This formula, it is stated, would, of course, vary with the length of time the cement was in storage, and the condition of the place stored. For instance, cement stored in a dry place, shut off from damp air, will last longer than cement in a leaky, damp warehouse.

The commercial value of the experiment would apply in few cases comparatively, it is stated, because cement usually is used immediately after the receipt.

New Test to Detect Traces of Moisture.

A new and delicate test for traces of moisture is based on the fact that the nearly colorless lead-potassium iodide is partially decomposed by water, yellow lead iodide being set free. Lead-potassium iodide is precipitated when 4 parts lead nitrate dissolved in 15 parts water are mixed with 15 parts potassium iodide dissolved in 15 parts water. The dried precipitate is dissolved in 15 or 20 parts of acetone, again precipitated by adding water, washed with ether and dried *in vacuo*. The compound iodide, thus prepared, is nearly white, but becomes pale yellow on keeping.

In tests for moisture a 20 per cent solution of the salt in acetone is dropped on filter paper. The paper turns deep yellow rapidly on exposure to moist air, and instantly when breathed upon. Moistening [illegible] acetone reproduces the original solution and de[illegible] the color, so that the paper can be used repe[illegible] In experiments with air dried by sulphuric acid of various strengths the moisture in air drawn from the outer atmosphere at 64½ deg. F. and passed through 78 per cent sulphuric acid was clearly detected, although it corresponded to a vapor tension of only 0.3 millimeter or little more than 1/100 inch. To detect water in liquids, the test paper is dried in a stream of dry air and the liquid is poured over it. The yellow coloration is produced instantly by commercial ether and "absolute" alcohol, dehydrated by the usual methods. Traces of water can be removed from alcohol by agitating it with solid lead-potassium iodide.

FOOD IN NEW FORM.

An important discovery in economic botany, which it is believed will have a very far-reaching application to human food, was announced at one of the conferences of heads of departments, visiting botanists, etc., which are held weekly in the museum building of the New York Botanical Garden.

The author of the discovery is Dr. Alexander P. Anderson, now curator of the herbarium at Columbia University. The discovery may be described as a dry process of cooking cereal grains and starchy products. Realizing the importance of investigations along this line, he began in the spring of 1901 a series of experiments on the effect of temperatures of 100 degrees and above on the cereal grains, to determine what effect dry heat under different conditions would have on the starch granules.

When air-dry powdered starches, like corn starch, tapioca flour, sago flour or starchy preparations like pearl sago and pearl tapioca, are treated, the resulting swelled dry white masses become enlarged copies of the original, which increases in volume from six to nine times. When pure starches are thus treated and expanded, and the resulting dry products afterward placed in water, they go into suspension, forming a starch paste similar in every respect to one formed by boiling starch in water.

The only difference between starch paste or starchy food products prepared by the ordinary methods of boiling or cooking with water, and the dry method of expanding them, is that the resulting products expanded when dry can be kept indefinitely in their dry condition, while the products prepared with water easily spoil and ferment when not afterward sterilized and kept in closed vessels.

The dry method is simply a dry cooking process, where the air-dry starchy products and air-dry cereal grains are taken and, after a short period of heating in a saturated atmosphere, at a temperature not exceeding that of the baker's oven, come out in a dry state, thoroughly and uniformly cooked, as well as absolutely sterilized.

Dr. Anderson says that his process may be varied to produce a great variety of flavors with any given cereal, by regulating the degree and duration of the heat applied. The products can, of course, be salted or otherwise seasoned or artificially flavored either at the time of the process or afterward, to suit individual tastes.

Pearl barley, once treated, is all ready to be used for thickening soups and would be palatable with cream or milk. The expanded rice grains could be prepared like salted almonds or sugar-coated as a confection, or placed in hot milk, ready as a table vegetable or for invalids' food.

On account of their great digestibility it is believed that the products of the new

Rapid Speed Photographs.

From the St. Louis Republic.

Prof. C. V. Boys says that to take photographs of a bullet as it is being projected through the air at a maximum possible speed it is necessary to have recourse to a method of illumination infinitely more rapid than that given by an electric spark. For this purpose a steel mirror, so mounted as to revolve at the enormous speed of 1,000 times per second, is used. This mirror is not larger than a silver 25-cent piece, and the beams of light given off from it pass across the screen at such an unthinkable rate of speed that it enables the photographers to take pictures of the bullet on exposures of only one-millionth of a second.

Selenium

(8659) C. S. asks: 1. Please answer the following questions. I do not know whether the name is correct, but I have heard that selenium, a metal, changes its resistance to electricity when light strikes it. Kindly inform me about the price, the resistance it offers per square meter of surface, and whether the supposition that it increases its resistance when light strikes it is correct; also how sensitive it is. A. Selenium is not a metal, but an elementary substance which in its ordinary condition is a brittle solid of a glassy luster and fracture and a brown color. It melts at about 430 deg. Fahr., vaporizes at about 1300 deg., and burns with a blue flame, giving out an odor resembling that of putrid horseradish. Ordinary selenium is a very poor conductor, having an electrical resistance 37,500,000,000 times that of copper. When annealed for several hours at a temperature just below its melting point, with subsequent slow cooling, it forms a crystalline substance with a lower resistance. It is now sensitive to light. Its resistance is reduced, not increased, in proportion to the square root of the illumination; and also the effect is greater with a high electromotive force than with a low one. Narrow strips of annealed selenium are formed between the edges of broad plates of metal, so that the cross section is considerable, and thus the resistance is reduced while the area exposed to light is considerable. This is a "selenium cell." When the light strikes it, its resistance may be reduced as much as one-half. A cell whose resistance in the dark was 300 ohms dropped to 150 ohms in the light. Such a cell is not a generator of electricity, but a measuring instrument for determining the intensity of light. 2. Also in what numbers of your SCIENTIFIC AMERICAN is there any article which treats on similar subjects as Stepianek's pictorial telegraphy? 2. We can send you six numbers of the SCIENTIFIC AMERICAN SUPPLEMENT containing articles upon the transmission of pictures by electricity.

A Simple Air Test.

From Health.

It is highly important to determine whether the air of a room contains too much carbonic acid. Air is impure and injurious in proportion to the displacement of oxygen by carbonic acid. The following simple method will enable any one to detect readily a dangerous proportion of carbondiozide in a room: Bring into the room a half-pint bottle entirely full of water; pour out this water in the room, when the empty bottle will immediately be filled with the air of the room; now put into the bottle one tablespoonful of pure lime water, cork and shake it. If it turns milky white in a few minutes the ventilation is imperfect.

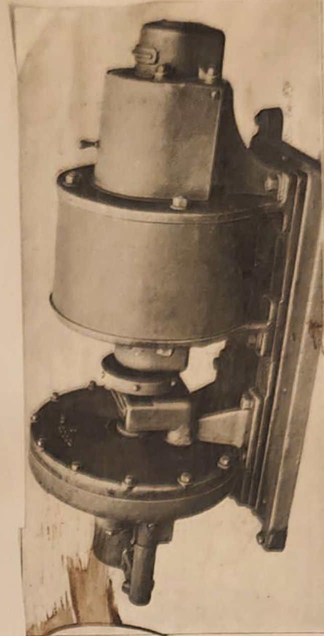
Radium.

At the recent annual exhibition of the Societe de Physique in Paris, Prof. Curie exhibibited a piece of pure metallic radium. It was about an inch in diameter each way, and it had cost $2,000 to extract this small quantity from several tons of barium salts. The radium shines like a lamp, and also causes various other substances to glow when brought near it.

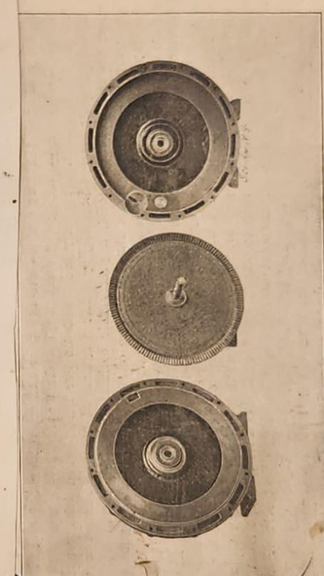
Red Spectacles for Seasickness.

Bright red spectacles, accompanied by internal doses of calomel, form a new German specific against seasickness. It is deduced from Epstein's investigations on the influence of color on the blood vessels in the brain. Seasickness is due to lack of blood in the brain, while red sends blood to the brain with a rush.

(3686) N. J. R. asks: What are the per proportions of gas and air to use for the greatest explosive force of acetylene, gasoline and crude oil gas. A. The strongest explosive power of acetylene gas is made by a mixture of 1 part acetylene to 9 parts air; of gasoline vapor, 1 part vapor to 8 parts air; crude oil illuminating gas, 1 part gas to of air. See Hiscox's book on "Gas, Gasoline and Oil Engines," $2.50 by mail.



THE MINIATURE TURBINE AND DYNAMO.



THE TURBINE ENGINE DISASSEMBLED.

Chicago milwaukee & St Pa

HOW THE FARMER "SALTED" HIS CORN FIELD EXHIBIT.

He related the story a few days ago to a friend. The big ears were, of course, a fake, but one of the most artistic of fakes. They were made for him by a basketmaker of his neighborhood merely to show what he could do. An ear of corn of normal size was sliced down between the rows with a thin, sharp knife to the center of the cob. Then these rows from many similar ears were built up into one gigantic ear, fastened together with glue. A solid tip and butt from a single ear finished the two extremities for the manufactured ear and hid the joining of rows. The workmanship was so excellent that the deception was complete.

... ...nous photographs."

Some Water Uses Well to Remember.

The Phrenological Journal gives the following useful hints on the applications of water in severe attacks of illness. The adult members of a family should keep them in mind for an emergency.

A strip of flannel or a soft napkin, folded lengthwise and dipped in hot water and wrung out, and then applied around the neck of a child that has the croup, will usually bring relief in a few minutes.

A proper towel folded several times, and dipped in hot water, quickly wrung and applied over the site of toothache or neuralgia, will generally afford prompt relief.

This treatment for colic has been found to work like magic.

Nothing so promptly cuts short a congestion of the lungs, sore throat, or rheumatism as hot water, when applied early in the case and thoroughly.

Hot water taken freely half an hour before bedtime is an excellent cathartic in the case of constipation, while it has a soothing effect upon the stomach and bowels.

This treatment, continued a few months, with the addition of a cup of hot water slowly sipped half an hour before each meal, with proper attention to diet, will cure most cases of dyspepsia.

Ordinary headaches almost always yield to the simultaneous application of hot water to the feet and back of the neck.

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or on applying reagents. Of the sympathetic inks, the color of which is developed by heat, those containing a cobalt salt become blue, while a nickel salt turns green and onion juice brown. Lead acetate in ink is ...

The lightest substance known is said to be the pith of the sunflower, with a specific gravity 0·028, while elder pith—hitherto recognized as the lightest substance—has a specific gravity of 0·09, reindeer's hair 0·1, and cork 0·24. For life-saving appliances at sea, cork, with a buoyancy of one to five, or reindeer's hair with one of one to ten, has been used, while the pith of the sunflower has a buoyancy of one to thirty-five.

Apples for Sleeplessness.

The apple is such a common fruit that very few persons are familiar with its remarkably efficacious medicinal properties. Everybody ought to know that the very best thing they can do is to eat apples just before retiring for the night. Persons uninitiated in the mysteries of the fruit are liable to throw up their hands in horror at the visions of dyspepsia which such a suggestion may summon up, but no harm can come even to a delicate system by the eating of ripe and juicy apples before going to bed. The apple is excellent brain food because it has more phosphoric acid in easily digested shape than any other fruits. It excites the action of the liver, promotes sound and healthy sleep, and thoroughly disinfects the mouth. This is not all; the apple prevents indigestion and throat diseases.

G. 1.—ELECTRIC DISCHARGE IN VACUUM TUBE.

(7470) H. C. asks how many cubic feet of air a person breathes per minute and in how small a space that amount of air can be confined, or in how small a space can enough air be confined to last a man ten or twelve hours, and how much would that amount of air weigh? A. An average man or woman requires not less than 3,000 cubic feet of fresh air per hour, continuously supplied during that period, when asleep or in repose; about 4,950 cubic feet per hour when engaged in light work; 10,000 cubic feet per hour if engaged in heavy work—this exclusive of the air consumed by lights and heating appliances. Neither is this applicable to all individuals, since some require more than others, depending upon lung area and expansion. In close rooms, 6,000 cubic feet of air per hour (100 feet per minute) is generally required, allowing for lights and heat, stoves, etc. A single candle, to give its full light, requires 100 cubic feet of air per hour. In sickness these figures should be increased at least one-third. Air cannot be confined for purposes of respiration, for it is contaminated with carbonic oxide with every expiration. Certain air storage tanks, which may be utilized for a brief period by divers, provide for air expansion, but the expiration is not into the tank, but outside thereof; consequently, if the air were not compressed, it would not serve the purpose of respiration, as there would be no expansion. Your final query is answered by the foregoing. To place any individual in a perfectly airtight room would be to insure his or her death by asphyxiation, if therein long enough; in time all the vital constituents of the air would be consumed and replaced by deadly carbonic oxide. Proper ventilation is the first essential of proper respiration. Air presents different weights at different temperatures and elevations.

(7430) J. C. asks: What is the cause of a bottle of ale or porter freezing in winter when it is very cold, when you draw the cork? What I mean is, on a cold day if you take a bottle of ale, before you draw the cork, it is liquid, and if you take it into a warm room and draw the cork, it immediately freezes solid. A. The sudden freezing of water (ale is not necessary; it is the water in the ale which freezes) under these circumstances is due to cooling it considerably below the freezing point, while it stands quiet. If then it receives a sudden jar, it changes to ice almost instantly, and the temperature of the mass rises to the freezing point. Water has been cooled to 4° Fah. below zero without freezing. It is ready to freeze, but seems unable to begin to freeze. A bit of ice, or any other solid, dropped into the water, will start the particles, and they then jump into the solid form with great rapidity. It is a very pretty experiment.

... C. E. asks: Can the core of an ...

FABRICE ON CATALYSIS

Famous Frenchman's Experiments With Ignition Plug of Peculiar Construction.

Catalysis is a term used in chemical physics to denote a force supposed to be exerted by one substance upon another, whereby the latter is subject to decomposition, while the former remains unaltered and uncombined. The effect of hydrocarbon vapor upon spongy platinum, and the advantage taken thereof in the construction of the Deschamp auto-incandescent igniter, has often been described. The impingement of the vapor upon the spongy platinum once heated retains the same at incandescence, and the Deschamps apparatus was designed to embody this.

Marking Blue Prints.

It has become the custom to use a soda solution, using it as ink, and the result is a white line not very different from the print. The soda on the surface of the paper collects dirt and the lines fade and lose their original intensity. The right way is to write your figure in ink—ordinary Carter's or any other fluid that is acid-proof—then take your ruling pen and put a blot of soda over the spot. This whitens the background and turns the ink jet black, and it is done in half the time and twice as nicely as any other way. The white spot is there to stay and the ink will never fade.—The Draftsman.

Use Color Judiciously.

There are colors that are refreshing and broadening, others that absorb light and give a boxed-up appearance to a room, others that make a room with a bleak northern exposure, or with no exposure at all, appear bright and cheerful; some that make a room appear warm, some that make it cold.

The thermometer seems to fall six degrees when you walk into a blue room. Yellow is an advancing color; therefore a room fitted up in yellow will appear smaller than it is.

On the other hand, blue of a certain shade introduced generously into a room will give an idea of space. Red makes no difference in regard to size. Green makes very little.

If a bright, sunny room gets its light from a space obtruded upon by russet colored or yellow painted houses, or else looks out upon a stretch of green grass, it should be decorated in a color very different from the shade chosen if the light comes from only an unbroken expanse of sky.

Red brings out in a room whatever hint of green lurks in the composition of the other colors employed.

Green needs sunlight to develop the yellow in it and make it seem cheerful.

If olive or red brown be used in conjunction with mahogany furniture, the effect is very different from what it would be if blue were used. Blue would develop the tawny orange lurking in the mahogany.

If a ceiling is to be made higher, leave it light, that it may appear to recede. Deepening the color used on the ceiling would make it lower—an effect desirable if the room is small and the ceiling very high. Various tones of yellow are substitutes for sunlight.—The Upholsterer.

Size of a Spider's Thread.

Leeuwenhoek, the first microscopist, wrote in 1685 as follows: "I have often compared the size of the thread spun by full grown spiders with a hair of my beard. I placed the thickest part of the hair before the microscope, and, from the most accurate judgment I could form, more than a hundred of such threads placed side by side could not equal the diameter of one such hair. If, then, we suppose such a hair to be of a round form, it follows that 10,000 threads spun by the full grown spider when taken together will not be equal in substance to the size of a single hair. To this, if we add that 400 young spiders, at the time when they begin to spin their webs, are not larger than one full grown one, and that each of these minute spiders possesses the same organs as the larger ones, it follows that the exceeding small threads spun by these little creatures must be still 400 times slenderer; and, consequently, that 4,000,000 of these minute spiders' threads cannot equal in substance the size of a single hair."—Microscope.

Experiments show that a light of one candle power is plainly visible at one mile, and one of three candle power at two miles. A ten candle power light was seen with a binocular at four miles, one of 29 at five miles, though faintly, and one of 33 candles at the same distance without difficulty. On an exceptionally clear night a white light of 3·2 candle power can be distinguished at three miles, one of 5·6 at four, and one of 1·2 at five miles.

The Visibility of Colors at Great Distances.

In view of the accuracy of the long range small cal... ber rifles, interesting experiments were recently co... ducted by the Society of Civil Engineers in Paris, i... order to determine the visibility of different colors. T... designate the visibility of colors at great distance... numbers from one to eight were taken, eight signifyin... invisibility. It was regarded as a matter of import... ance to determine how these numbers compare in clea... weather, in cloudy weather and at night. The resul... of observation at 600 meters (650 yards) is given as fo... ws: In clear weather white is most distinctly visibl... (1), then comes hussar blue, light blue (2), scarlet (3)... green (4); gray and the color of dry foliage are almos... invisible and were marked 7. Dark blue was called 6... In cloudy weather nothing was altered in case of white... blue, green and brown. Hussar blue becomes less visi... ble (3), so also scarlet (4); on the other hand, green be... comes more visible (3). At night the results were th... same as in cloudy weather, except that white become...

EVERYBODY'S BUSINESS

By FLOYD W. PARSONS

Color

WHAT is it in the nature and temperament of certain races that makes them prefer certain colors? Why do Orientals select clear rich colors, and savages display a marked preference for brilliant hues? Centuries ago among the ancients there were schools of color. Green was dedicated to piety, black to intellect, white to inspiration and gold to understanding.

The average person remains faithful throughout life to the color or colors he first preferred. In other words, certain colors attract certain individuals. People respond to color as plants do to the sun. We are told that the colors of the surrounding landscape influence our lives by creating in us certain types of thought and varying degrees of mental and physical activity. A plant would be seriously injured by being subjected to the same degree of light continuously. The same thing is true of an individual, and for that reason the average person benefits largely through a change of environment which surrounds him with a new and different set of color waves. The city dweller who goes to the country and the ruralite who visits the city are likely to respond favorably to the changes in surrounding colors.

The progress of civilization represents a slow advance from an understanding of simple truths and elementary principles to an attempt to master such mysterious forces as light and electricity. We have now come to the science of color, which subject presents a field of interesting possibilities. In addition to its use in the art of illumination color is being applied to the treatment of human disease. It is likely that before many years intelligent people will seriously consider the hygienic value of colored lights the same as they do the health factor in proper ventilation at the present time. In the past we demanded that light should be given us in sufficient quantity; in the future we shall insist that it be of proper quality. Some day we shall look back with amazement on our present lighting practice, which condemns most human beings to live and work in a dead level of color which not only impairs personal efficiency but which injures human eyes and nerves. One reason for the health resulting from an outdoor life is that the individual is subjected to the ever-changing vibrations of Nature's color rays.

One of the pioneers in the rapidly expanding group of color scientists is Beatrice Irwin, whose research has been carried on in many parts of the world and whose work in this new art, or industry, has been recognized by various scientific and technical organizations. A talk with Miss Irwin developed a number of points that will be likely to interest many people.

There are three fundamental scales of color, reacting respectively on our physical, mental and nervous systems. Each one of these is divided, in turn, in accordance with its affective values, into sedative, recuperative and stimulant colors. Respiration is affected by color. The sedative colors induce deeper respiration; they soothe and calm us. The recuperative colors induce a more superficial or more even respiration; they equalize and refresh us. The stimulant colors excite a more rapid respiration; they quicken our activities. The sedative, recuperative and stimulant colors of the three systems are classified as follows:

THE PHYSICAL	THE MENTAL	THE NERVOUS
SEDATIVE	SEDATIVE	SEDATIVE
Lead Gray	Olive Green	Moonlight Blue
Prune		
Terra Cotta		
Moss Green		
RECUPERATIVE	RECUPERATIVE	RECUPERATIVE
Golden Brown	Rose Madder	Orange
Turquoise	Fawn	Flame Rose
	Royal Blue	
	Emerald Green	
STIMULANT	STIMULANT	STIMULANT
Vermilion	Violet	Eau de Nil
	Chrome	Mauve
		Citron
		Azure Blue

The theory is that people lean toward those colors which represent qualities or aspirations in which they are deficient. The people of primitive races prefer the hard, brilliant, mental colors. Individuals or races handicapped physically show an affinity for the colors which represent physical power, while as a general rule people who are highly materialistic turn to the nervous, or spiritual colors, which furnish the vibrations in which they are lacking.

The retina of the eye, color scientists affirm, is capable of only three color sensations—blue, red and yellow. All other sensations result in combinations of these colors. Each eye has an individual appreciation of color; the left eye generally prefers physical and the right eye mental colors. The nervous or spiritual colors are actually intensities of vibration, and are discerned by most people in a diffused sensation rather than as an actual vision. Each individual responds more quickly to colors with which his own development is concerned.

Many people are deeply affected by displays of color without noting or analyzing the reaction on the human system. Certain colors make one draw a deep breath, as if one were drinking in those colors. Sometimes we observe a color scheme that makes us hold our breath, or perhaps causes an involuntary exclamation. Frequently a vision of color unfolds before us, and the sensation causes us for an instant to remain speechless, and our eyes involuntarily close. Such is the effect on many urban dwellers when they view the pool of color which opens before them at the seashore after many months spent in the city.

Red has been called a stimulant, blue a sedative and green an exhilarating color. The modern belief is that red can be recuperative, blue a stimulant and green a sedative, according to the composition of these three colors or their combination with other colors. It should be remembered that the terms "red," "blue" and "green" are only symbols for long ranges of vibratory phenomena.

The use of color in the preservation and restoration of health is gaining recognition in many quarters. Screens and color filters which absorb certain color rays and allow other rays to pass through are being employed in the treatment of diseases of the eyes and the nerves. There are good reasons for the statement that a change of color is often of as much benefit to an invalid or convalescent as a change of air. The green of the ocean or of the woods is a physical sedative, soothing nerves and giving fresh life to people who are mentally tired. In medicine, reds, greens and yellows are the most powerful in healing properties. The records show that insomnia and dipsomania have been materially relieved by color treatments. Practically all the color cures are based on the therapeutic effect of light when filtered through color mediums. Since respiration is affected in different ways by different colors, it follows that color science may be used in the treatment of various nervous conditions, such as shell shock and other inflammatory nervous ailments.

The most immediate use of color rays, however, is in the illumination of our homes, offices and public buildings. One authority says, "The lighting of the future which does not take into account the value of color effects may be likened to a scheme of decoration in black and white—a scheme that is sufficient and satisfactory only to those who are color-blind." Since the absolute necessities of lighting, especially in the matter of quantity, have now been supplied, the time is opportune for the development of a decorative art in illumination. We have reached the day when we must have lighting artists as well as illuminating engineers. Lighting schemes in our homes and offices will be carried out in accordance with plans which take into account the effects of the light rays on health and efficiency. Most everyone is aware that opaque colors such as those on walls and ceilings exert an influence on the temperament of people; luminous colors have far more decided affective powers than those which are nonluminous. A discriminating alliance of color with illumination is becoming a constructive necessity.

Because of the large item of cost many people cannot afford to redecorate their homes and offices at frequent intervals. However, when we acquire a better understanding of color science and the application of its principles to illumination we shall be able to remove much of the depression caused by the monotony of light and color that now surrounds us. The rooms in our homes will radiate sedative, recuperative or stimulant colors, according to their location and use or the demands of any occasion. The color schemes in bedrooms will be sedative and recuperative, while hall entrances and reception rooms, instead of being somber, will be alive with stimulant colors.

In the future illumination will no longer be the outcome of mechanical minds. In considering every lighting scheme the engineer or artist will carefully consider the psychological as well as the physiological value of color. Though we shall have diffused, semi-indirect lighting for the first or general installation, we shall also have side lights—possibly globes sunk in the wall—to give us color effects. Though the primary installation will be tinted to produce the proper vibratory color values in a room, the tint will be so delicate as to be unobtrusive. The globes or lamps producing the color effect will be likely to be located in natural recesses of shadow, and if such do not exist in a room they can be created by masses of silk, which has high reflective value. The impression received should be from the color itself rather than from the fixture. In future lighting installations, especially in ballrooms, pools of colored light will be installed in the floor under glass translucencies.

In the to-morrow of lighting, when color rays will have become an important factor in most illumination schemes, careful attention will be given to seeing that the colors in the plan are well balanced. For example, if a room is worked out in sedative gray for the first or primary installation, the illumination engineer will see that the secondary installation consists of such colors as recuperative orange and stimulant green. Lighting installations which completely eliminate shadows will be regarded as bad engineering, especially in sick rooms. Shadows reduce monotony and relieve eyestrain. In schemes where the light is reflected through a room from pools in the floor the owner will be able to change the color of each pool whenever he desires.

The whole subject of the color qualities of light is intensely interesting, and will prove a fruitful field of study for investigating minds. Let those who deny that color rays have an effect on people prove the strength of their opinion by experimenting first with animals. One simple test is to climb the fence of a pasture and wave a red flag at an observing bull.

There is much we have yet to learn concerning light and its effect on life. Compared with the lower animals man is possessed of limited powers of vision. Above the absolute zero of temperature all bodies continuously radiate rays of light, invisible to humans, except when reënforced by daylight, but doubtless perceptible to many animals and birds. The phosphorescent qualities of the eyes of a cat, so apparent at night, doubtless enable the animal to see the invisible rays that all objects emit. The cat can clearly see the outlines of the bodies of other animals in the black of night, whereas human eyes would not be able to discern the long wave radiations from these same objects at all.

Some day there will be rooms dedicated to certain color schemes, so that regardless of season or location the dweller in the city will be able to surround himself with the green of the forest or the blue of the sea.

Eventually, when women understand the full value of color as a force of attraction, men will be more helpless than ever in resisting the artifices of the fair sex. In that day many people will surround themselves, physically and mentally, with colors whose potencies they desire. Also, in the future, we shall profit greatly through our better understanding of how colorful Nature, coöperating with climate, has molded the temperaments of peoples and largely shaped the destinies of the races of the earth.

certainty by placing some of the salt that melts at the required temperature on the bar when it is put into the furnace and heating until the salt fuses.

THE RIEDER ELECTRO-ENGRAVING APPARATUS.

On the first story of the Gallery of Machines of the Exposition there may be seen, in the German section, the first specimen of a very curious apparatus invented by Herr J. Rieder, of Leipzig. It is a machine that permits of electrically sinking the steel dies employed for striking medals and coins or embossing sheet metal, leather, or cardboard. With the ordinary processes, the production of such dies requires special skill on the part of the artisan, and their net cost is consequently very high. So, for a long time, there has been sought a mechanical process of manufacture that should do away with, or at least reduce the manual labor. The object of Herr Rieder's apparatus is to solve the problem by effecting the progressive corrosion of a plate of steel through electrolysis, that is to say, through the action of an electro-chemical bath.

The principle of the operation is represented in the diagram given in the accompanying figure.

The block of plaster (Gipsblock), bearing at its upper part a raised impression of the figure to be reproduced, is half immersed in a solution of chloride of ammonium. Upon the relief of the block of plaster is placed the steel plate (Stahlanode) that it is desired to engrave. This plate is connected with the positive pole of a source of electricity, and consequently constitutes what is called the anode. The negative pole, or cathode, consists of a sheet of copper immersed in the solution and arranged beneath the block of plaster. The electric circuit is closed through the intermedium of the bath of chloride (electrolyte), which, as a consequence of the porosity of the plaster, soon ascends through capillarity to the steel plate. As soon as the current is turned on, the chloride is decomposed, and the chlorine that is set free attacks the steel plate at the points where it is in contact with the plaster relief. The chloride of iron thus formed is dissolved and the plate is gradually hollowed out. Other points of the relief come successively into contact with the metal, and there is finally obtained a steel mould of the plaster model.

We shall not enter into the details of all the difficulties met with by Herr Rieder in the application of this ingenious process and which he had to surmount in order to reach the remarkable results obtained with his apparatus. It will suffice for us to make known the principle of it. The first experiments showed that the steel to be engraved must not be applied to the model permanently, since the insoluble substances, such as carbon, contained in the metal deposit in the form of a black adherent powder that must be periodically removed. To this effect, there is given to the apparatus a to and fro motion that separates the steel from the block of plaster every twelve seconds and replaces it, after the cleaning (which is likewise automatic), in the mathematically exact position that it previously occupied.

With the Rieder apparatus, the engraving of an 8×12 inch steel plate requires about fifteen hours, while it often takes more than a month to do the same work by hand.

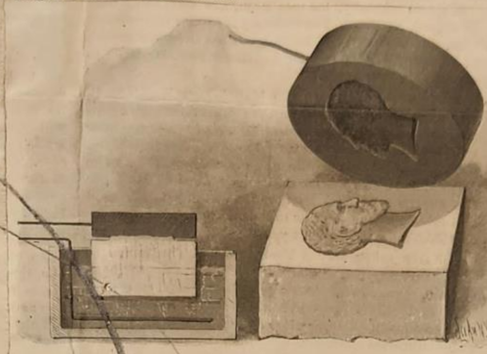
The apparatus permits of the reproduction of any model of plastic material, such as wax, plaster or wood, and preserves in the mould, with absolute fidelity, the most delicate details created by the hand of the artist.

At the Exposition, the operation of the apparatus is entirely electric, the machine being actuated by a motor that receives the current from the general distribution of electricity.

Let us add that since the surveillance of the automatic operation is very simple, it is possible for one man to run several apparatus at once, and thereby effect a great saving in manual labor.

After the operation is finished, it requires but a few retouches executed by the hand of an engraver to remove all the traces left by the plaster model.

The field of the applications of this process is very vast, since it embraces all the industries that manufacture ornaments obtained by stamping, and, in the first rank, the cardboard, leather and metal industries.—L'Illustration.



METHOD OF ELECTRO-ENGRAVING AND SAMPLE OF WORK.

A Sensitive Detector for X-rays. H. BEHNKEN, G. JAECKEL and W. KUTZNER. (*Zeits. f. Phys.*, Dec. 22, 1923.)—Geiger, in 1913, showed that a fine point, kept negatively charged, experienced a sharp discharge shock when a beta particle passed in the vicinity. As X-rays set free electrons when they fall on matter, it seemed likely that such a point could be used to detect the presence of X-rays. This proved to be true. A beam of X-rays one mm. in diameter emitted from a tube with a current of .5 milliampere was found to give an effect 10 m. from the source. Only one-billionth of the total radiation reached the point, the power there being about 10^{-11} watt. In another instance one c.c. of paraffin was placed 1 m. from a Coolidge tube. To one side of the paraffin block was located the point within a chamber. X-radiation diffused by the block fell on the point and produced a series of changes of charge that were made visible by a string galvanometer or other suitable device. The number of impulses per minute was found closely proportional to the current in the tube. The authors feel that they have developed a method of value for research.

G. F. S.

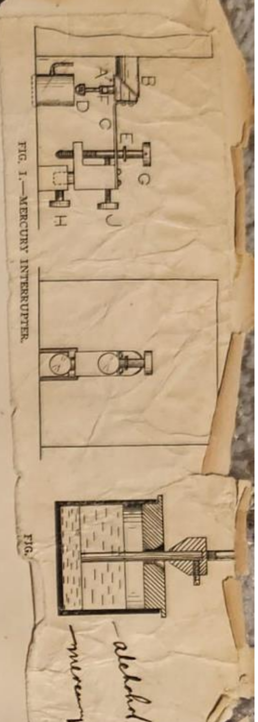


FIG. 1.—MERCURY INTERRUPTER.

FIG.

Dry Water.

A ring or coin is thrown into a basin filled with water; the performer announces that he will take it out of the water without wetting his hand.

Solution: Get a few cents' worth of lycopodium powder and strew it over the surface of the water. The hand when being

immersed will have to go through the layer of powder. The powder clinging to the hand forms a sort of water-tight cover. As the powder is invisible at some distance the performer can show his hand without fear of detection.

If current is passed into electro-chemically prepared paper and out again from one point to another point, both resting on the paper, that point, or contact marks ~~the~~ from which the current is flowing to the other.

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ETCHING GLASS BY MEANS OF GLUE.

CERTAIN substances adhere to glass with such tenacity that, upon being abruptly separated therefrom, vitreous scales are often detached. This fact, says Prof. Cailletet, in La Nature, I noticed a long time ago while studying a process that should permit me to solder glass to metals. The method of soldering then discovered I now employ for adapting cocks or other metallic fittings to tubes designed to conduct gases under high pressures. In order to solder a piece of metal to a glass tube it suffices, in fact, to silver the latter in order to render it a conductor of electricity, and then to deposit upon the silvered portion a ring of galvanic copper, to which any metal whatever may be soldered with tin. The galvanic copper thus deposited adheres so tenaciously to the glass that, upon being detached, flakes of glass are removed at the same time.

Silicate of soda, which is often used for uniting two pieces of glass, exhibits the same phenomena; but the detaching of the surface of glass objects becomes particularly easy when we employ either common glue or isinglass.

It is only necessary to cover a piece of ordinary or flint glass with a coat of glue dissolved in water in order to see that the layer of glue, upon contracting through the effect of desiccation, becomes detached from the glass and removes therefrom numerous scales of varying thickness. The glass thus etched presents a sort of regular and decorative design that reminds us of the flowers of frost deposited upon our window panes in winter. When salts that are readily crystallizable and that exert no chemical action upon the gelatine are dissolved in the latter the figures etched upon the glass exhibit a crystalline appearance that recalls fern fronds.

Hyposulphite of soda and chlorate and nitrate of potash produce pretty nearly the same effects. A large number of mineral substances are attacked by gelatine. What is called "toughened" glass is easily etched, and the same is the case with fluorspar and polished marble. A piece of rock crystal, cut at right angles with the axis and coated with isinglass, the action of which seems to be particularly energetic, is likewise attacked at different points, and the parts detached present a conchoidal appearance. The contraction of the gelatine may be rendered visible by applying a coating of glue to plane sheets of cardboard or lead, which bend backward in drying and assume the form of an irregular cylinder.

Such etching of glass and different mineral substances by the action of gelatine may be employed for the decoration of numerous objects.

Should any of our readers be desirous of trying this process of decoration he may obtain perfect success by conforming to the following very simple directions: Dissolve some common glue in ordinary water heated by a water-bath and add thereto six per cent of its weight of potash alum. After the glue has become perfectly melted, homogeneous and of the consistency of sirup, apply a layer, while it is still hot, to a glass object by means of a brush. If the object is of ground glass the action of the glue will be still more energetic. About half an hour afterward apply a second coat in such a way as to obtain a smooth, transparent surface destitute of air bubbles. Now leave the object to itself, and after the glue has become so hard that it no longer yields to the pressure of the fingernail (say, in about twenty-four hours), put the article in a warmer place, say, for example, in a kitchen range, in which the temperature must not exceed 105 deg. F. When the object is removed from the oven, after a few hours' stay therein, the glue will detach itself with a noise and removes with it numerous flakes of glass. All that the piece then requires is to be carefully washed and dried.

The designs thus obtained are not always the same, the thickness of the coat of glue, the time of desiccation and various other conditions seeming to act

fore was apparent.

The experiment is very easy to perform. First, make a cold saturated solution of saltpeter, and then, having procured a sheet of thin paper, draw upon it any sort of a design with a splint of wood or a quill pen dipped in the solution. The lines of the drawing should be rather heavy. After the paper has become dry, all that is necessary is to apply a light to some point of the drawing, as above mentioned.—Tissandier, in La Chimie sans Laboratoire.

FIG. 1.—A. GLASS VESSEL ETCHED BY THE ACTION OF GLUE AND ALUM. B. [illegible] BY PURE GLUE.

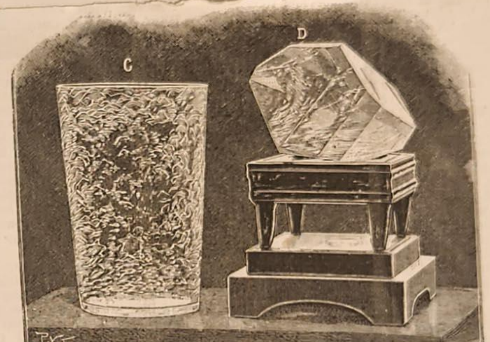


FIG. 2.—C. TOUGHENED-GLASS VESSEL ETCHED BY GLUE AND HYPOSULPHITE OF SODA. D. ROCK CRYSTAL ETCHED BY THE ACTION OF ISINGLASS.

A Superior Whitewash.

Every spring the lighthouses of the country are given a coat of whitewash of a composition which is enduring and able to withstand the attack, not only of the elements, but also the corrosive action of salt water. The east end of the White House, which bears the brunt of the strong moisture-laden winds of Washington, [illegible]s annually coated with this wash.

The [illegible]sh is made as follows: Slake half a bushel [illegible] lin[illegible] boiling water, covering during the process [illegible] keep in the steam. After straining this through a fine sieve or strainer add to it a peck of common salt, previously dissolved in warm water. Three pounds of ground rice should then be boiled to a thin pasty mass and, while hot, stirred into the above; one-half pound of Spanish whiting should also be added and then one pound of glue, melted in a glue pot, should be put into the composition. After adding five gallons of hot water to the mixture, it should be allowed to stand for a few days, securely covered to keep out the dirt.

It is claimed that this whitewash is very efficient if heated before applying. In order to make a careful estimate of the amount of wash needed, it must be remembered that a pint properly applied will cover a square yard. Farmers will find this wash very useful, not only in the dairy, home, barn or any interior work, but also for applying to wood or stone work out of doors. If, however, white is undesirable for coating a barn or other out-buildings, an addition of paint powder such as painters use in preparing their paints, may be made, and the results are very satisfactory.

Label Paste.—We have published so many formulas for label pastes within the past year that it is very difficult to make choice of the best. The Photographische Zeitung claims this formula as a "universal sticker, acting equally well with tin, glass, porcelain," etc. :

Gum arabic	42 parts.
Tragacanth in powder	32 "
Glycerin	180 "
Alcohol	15 "
Thymol, sufficient, or say	1 "
Water, sufficient to make	500 "

Dissolve the gum arabic in 60 parts of water; rub up tragacanth with 120 parts of water; mix the two liquids, pass the mixture through a fine sieve, and add the glycerin. Dissolve the thymol in the alcohol, and add to the mixture, and work thoroughly up together, adding the remainder of the water in the meantime. For a simpler paste the following will answer. It makes a pure white product of excellent adhesive power :

Tragacanth in powder	2 parts.
Boiling water	16 "
Wheat flour	6 "
White dextrin	1 "
Cold water	4 "

Mix the tragacanth and boiling water, stir, and set aside. Mix the flour, dextrin, and cold water, and add to the tragacanth. Have twenty-four parts of water in active ebullition, and into it pour the mixture. Add one part of glycerin and about one-half of one per cent. of salicylic acid, and let the whole boil from three to four minutes, then remove and let cool.

Whitewash for Brick Walls.—For brickwork, especially where exposed to damp, take half a peck of well burned quicklime, fresh from the kiln, slake with hot water sufficient to reduce it to a paste, and pass it through a fine sieve; add a gallon of clean white salt, which has been dissolved in a small quantity of boiling water, and a thin, smooth paste, also hot, made from 1 pound of fine rice flour; also ¼ of a pound of the best white glue, made in the water bath. Mix, stir well, and add ¼ of a pound of the best Spanish whiting in 5 quarts of boiling water; stir, cover to retain heat and exclude dust, and let it stand a week. Heat to boiling, stir, and apply hot. The above proportions will cover forty square yards.

Mucilage.—The Era Formulary gives these :

1. Rye flour	4 ounces.
Powdered alum	½ "

Rub to a smooth paste with 8 ounces of cold water, strain through a cheese cloth, and pour into 1 pint of boiling water. Continue heat until thickened to suit. When nearly cold, add :

Glycerin	1 ounce.
Oil of cloves	30 drops.

This is suitable for tin or wood boxes or bottles, and keeps sweet for a long time.

2. Gum tragacanth	1 ounce.
Gum arabic	4 "
Dissolve in	
Water	1 pint.
Strain, and add	
Thymol	14 grains.
Suspended in	
Glycerin	4 ounces.
Add water to make	2 pints.

3.—POSTAGE STAMP MUCILAGE.

Dissolve 1 pint of gum dextrin in a pint of boiling water, strain through flannel and add 2 ounces of acetic acid. When nearly cold add 4 ounces of alcohol, stir constantly, and finally add enough warm water to make 1 quart.

STANDARD ADHESIVE MUCILAGE.

4. Gum arabic in fine powder	8 ounces.
Glucose	2 pounds.
Boiling water	20 fl. ounces.
Acetic acid	1 ounce.

Dissolve the gum arabic in the water, then add the glucose, and bring the whole to a good boil, stirring well. Remove from the fire, and, lastly, add the acetic acid.—Pharmaceutical Era.

Almondkleie.—

Almond meal	700 grammes.
Rice starch	160 "
Orris root	70 "
Soap	60 "
Oil of bitter almonds	1 "

Lotion for Baldness.—

Ammonium carbonate	2·5 grammes.
Orange flower water	15·0 "
Glycerin	30·0 "
Tincture cantharides	0·5 "
Oleo-balsamic mixture	50·0 "
Dilute alcohol (0·895)	100·0 "

—Pharmaceutical Era.

(8643) H. S. L. asks: 1. About an ink which can be used with a drawing pen upon zinc and which when dry or burned in will be acid-proof. A. Ink for Zinc Labels: Take 1 drachm verdigris, 1 drachm sal-ammoniac powder and ½ drachm lamp black, and mix them with 10 drachms water. This will form an indelible ink for writing on zinc. 2. ...

(7166) S. G. says: Can you tell me how I can mount photographs and other pictures on glass the same as to be seen in the picture store windows? A. To mount prints on glass, take 4 ounces of gelatine; soak one half hour in cold water, then place in a glass jar, adding 16 ounces of water; put the jar in a large dish of warm water and dissolve the gelatine. When dissolved pour in a shallow tray; have the prints rolled on a roller, albumen side up; take the print by the corners and pass rapidly through the gelatine, taking great care to avoid air bubbles. Squeeze carefully onto the glass. The better the quality of glass, the finer the effect.

(7111) S. R. says: Can you give me the recipe for cleaning gloves, kid and suede, in quantities? A. Damp them slightly, stretch them gently over a wooden hand of appropriate size, and clean them with a sponge dipped in benzole, recently rectified oil of turpentine, or camphine. As soon as they are dry, withdraw them gently from the stretcher, and suspend them in a current of air for a few days, or until they cease to smell of the cleaning liquid used. Heat must be avoided. The cleaning liquid should be used liberally, and the first dirty portion should be sponged off with clea[illegible] [illegible]id.

(7150) C. W. K. says: Can you put me in the way of obtaining a transparent waterproof cement that will unite two flat surfaces of mica? A. A colorless cement for joining sheets of mica is prepared as follows: Clear gelatine is softened by soaking it in a little cold water, and the excess of water is pressed out by gently squeezing it in a cloth. It is then heated over a water bath until it begins to melt, and just enough hot proof spirit (not in excess) stirred in to make it fluid. To each pint of this solution is gradually added, while stirring, ¼ ounce of gum ammoniac and 1⅓ ounce of gum mastic previously dissolved in 4 ounces of rectified spirit. It must be warmed to liquefy it for use and kept in stoppered bottles when not required. This cement, when properly prepared, resists cold water.

vered.

(7173) A. H. G. says: Will you kindly give me the recipe for making the composition that takes fire by merely putting a drop of water on it? What I have reference to is an article sold on the streets, that looks like strips of cardboard, and all you have to do is to tear a piece off and wet it to obtain a light. Can it be made in a form that can be painted on, or cardboard or paper dipped into it? A. The substance you refer to is undoubtedly metallic sodium which is cut in thin strips. It flames violently on coming in contact with water. We do not consider its use safe. It could probably be used only in strips or chips.

(7073) S. A. says: Please give me a good formula for making white frosting, such as painters use on windows, that will stand a considerable heat. A. Put a piece of putty in muslin, twist the fabric tight and tie it into the shape of a pad; well clean the glass first, and then pat it over. The putty will exude sufficiently through the muslin to render the stain opaque. Let it dry hard and then varnish. If a pattern is required, cut it out in paper as a stencil; place it so as not to slip and proceed as above, removing the stencil when finished. If there should be any objection to the existence of the clear spaces, cover with slightly opaque varnish.

(7453) R. M. G. asks [illegible] can I make a fountain that will deliver a thin sheet of water in the form of a bubble? A. If the bubble is to be hemispherical, discharge the water on the center of a thin metal disk, having sharp edges. The disk must be held in a horizontal position, and the water should not strike the disk with too much force. A wide, thin film of water is produced by discharging the water on a flat plate with a straight, sharp edge.

(7515) R. B. C. asks for a formula for a good cheap liquid laundry bluing. I wish to manufacture it on a small scale. A. Water, 15 parts; dissolve in this 1½ parts indigo carmine. Add ¾ part gum arabic.

(6879) C. L. says: Can you give me th[e] formula and method of preparation of the so-called fi[re] extinguishers in powder form? If not, can you advi[se] materials to experiment with? A. 1. Fire Extinguishin[g] Powder.—Eight parts common salt, 6 parts sodium b[i]carbonate, 2 parts Glauber's salt, 2 parts calcium chlorid[e], 2 parts sodium silicate. 2. Common salt, 60 per cen[t]; sal ammoniac, 60 per cent; sodium bicarbonate, 80 p[er] cent. 3. Sal ammoniac, 100 per cent; sodium sulphat[e], 60 per cent ...

Picture Transferrer.—A very weak solution of soft soap and pearlashes is used to transfer recent prints, such as illustrations from papers, etc., to unglazed paper. Such a solution as—

Soft soap	½ oz.
Pearlash	2 dr.
Distilled water	16 fl. oz.

The print is laid upon a flat surface, such as a drawing board, and moistened with the liquid. The paper on which the reproduction is required is laid over this, and then a sheet of thicker paper placed on the top, and the whole rubbed evenly and hard with a blunt instrument, such as the bowl of a spoon, until the desired depth of color in the transfer is obtained. Another and more artistic process is to cover the print with a transparent sheet of material coated with wax, to trace out the pictures with a point, and to take rubbings of the same after powdering with plumbago.—Brit. and Col. Drug.

Miscellaneous Notes and Receipts.

Paint for Blackboards.—Slate is imitated by the following coat of paint. Boil 5 liters of water in a kettle and add 500 grammes of borax. When this is dissolved add 2 kilogrammes of shellac, stirring constantly, then 1,250 grammes of very fine pumice stone and after some time 500 grammes of lampblack. After all is well mixed, strain the mixture through a fine brass sieve and cool off.—Färben Zeitung.

HOW TO HARDEN CAST IRON.

CAST iron may be hardened as follows: Heat the iron to a cherry red, then sprinkle on it cyanide of potassium and heat to a little above red, then dip. The end of a rod that had been treated in this way could not be cut with a file. Upon breaking off a piece about one-half an inch long, it was found that the hardening had penetrated to the interior, upon which the file made no more impression than upon the surface. The same salt may be used to caseharden wrought ...

(7495) S. M. R. says: Please answer through inquiry column the following: Formula for glue or paste which will adhere firmly, like the adhesive substance on envelops, at once it is applied. A. Postage stamp mucilage is said to be made as follows: Gum dextrine, 2 parts; water, 4 parts; acetic acid, 1 part. Dissolve with the aid of heat and add one part of ninety per cent alcohol.

SELECTED FORMULÆ.

Bed-bug Poisons.—The best of bug destroyers with which we have made personal experiment, says The National Druggist, is ordinary kerosene or coal oil. This instantly kills the developed insect and permeates and destroys the eggs. It has, moreover, the property of "creeping," or permeating narrow openings or crevices, thus following the creatures to their last resorts. It is cheap enough, but it has a disagreeable and offensive odor. Gasolin or benzene has the same properties, but is open to the same objection. The following is an excellent destroyer of the bugs and eggs :

Corrosive sublimate	1 part.
Camphor	2 "
Oil of turpentine	4 "
Alcohol, sufficient to make	16 "

Mix.

This is efficient, has an odor of camphor and oil of turpentine, which is not offensive, but it is relatively not cheap.

Here is another :

Corrosive sublimate	1 part.
Ammonium hydrochlorate	1 "
Glycerin	1 "
Water	16 "
Wood alcohol, sufficient to make	32 "

Mix.

Ink for Use on Colored or Black Paper.—Rub [into] thin mucilage of gum arabic, either zinc white, [pre]pared ammonia, alum, flake white or any similar impalpable powder. When you have the whole well incorporated, dilute with very weak mucilage or water, until you get a fluid that flows easily from the pen. The addition of a little ultramarine improves the color, which is otherwise inclined to be yellowish.—National Druggist.

(7251) W. M. says: Will you kindly give me some information regarding a formula for a black dip for brass in which ammonia and copper are used? We have an acid dip which is used for this purpose, but believe the other would be more desirable. A. Dissolve in 4⅜ fluid ounces of ammonia ½ ounce of copper carbonate, stirring constantly while dissolving. Add ½ pint of water. The article should be suspended in this solution by brass or copper wires for a short time.

(7473) J. H. W. L. says: Will you advise me what is a good tonic to prevent hair from falling out of the head?

A.	Quinine sulphate	20 grn.
	Tincture of cantharides	2 fl. drm.
	Fluid extract of jaborandi	2 "
	Alcohol	2 fl. oz.
	Glycerine	2 "
	Bay rum	6 "
	Rose water—enough to make	.15 "

The quinine is dissolved in the alcoholic liquids by warming slightly, then the other ingredients are added.

marked or labeled.

(7477) A. G. asks: Would you be so kind as inform me which is the best method of hardening plaster casts (in my case a medallion) in imitation of Parian marble? A. To Make Plaster Casts Hard.—To a thin milk of lime or lime water add 10 or 15 drops of liquid silicate of soda for every pint of fluid used; this is then thickened with plaster to a thick cream. Plaster thus prepared will set in five minutes or thereabout, according to the thickness of the cream. If too much silicate is used, the soda will effloresce on the surface, and spoil the sharpness of the impression. When the cast is already made, it may be soaked for a few hours in a hot, rather thin solution of gelatine, to which has been added a preservative, such as oil of cloves or carbolic acid, and then dried.

(7285) M. L. F. asks for the best receipt for a powder or dry mixture fire extinguisher—something to throw into the fire that will put it out, and that will keep a long time without losing its strength. A. Vienna Fire Extinguishing Agent: A solution of 5 parts ferrous sulphate (copperas), 20 parts ammonium sulphate, 125 parts water. Johnstone's: Make a mixture of equal parts of pyrolusite (manganese dioxide), potassium chlorate, potassium nitrate. Moisten with water glass and press into a block. Place the block in a pasteboard box. Several boxes, connected by fuses, are suspended from the ceiling of a room.

(7286) W. J. A. says: A few evenings ago, a friend of mine took out of his pocket a box containing long white "pills," tapered at each end. Laying one of these on the edge of a table, he applied a match and lit the end of it. Burning slowly, the "pill" transformed itself into gray material about 5 inches long. This gray matter seemed to writhe like the body of a snake while forming. After the "pill" stopped burning, their formation would fall in pieces if touched. Can you give me a receipt for making them? A. Pharaoh's serpents are made as follows: One grain of dry mercury sulphocyanide is mixed with some gum tragacanth which has previously been soaked in hot water. When the gum is completely softened, it is transferred to a mortar and the mercury sulphocyanide (in fine powder) is mixed with it by aid of a little water, so as to turn out a somewhat dry pill mass. This is then formed and cut into pellets of the desired size, which are dried on glass. These are very poisonous, and must be handled with care. Do not inhale the fumes.

Can aluminum be

(7128) H. K. C. says: I am anxious to secure the formula for etching on steel plate or iron, and do not know where I can learn it, unless you will give it to me. If you will do this, I will be very much indebted to you. A. 1. Two ounces copper sulphate, alum ½ ounce, salt ½ ounce, mixed with ½ pint vinegar, and 40 drops nitric acid can be used for frosting the steel. 2. Glacial acetic acid, 4 parts; absolute alcohol, 1 part; nitric acid (s. g. 1·28), 1 part; allow the acetic acid and alcohol to remain for half hour, then add nitric acid carefully. Etch from one to fifteen minutes. 3. Alcohol, 8 parts; water (distilled), 5 parts; nitric acid, 8 parts; silver nitrate, 8 parts. Wash the plate with very dilute nitrate acid, then apply the solution for three minutes, and wash with 6 per cent solution of alcohol. Repeat if necessary. 4. (Deleschamp's for vertical bite.) Silver acetate, 2 parts; rectified spirits, 125 parts; distilled water, 125 parts; nitric acid, 65 parts; nitric ether (see No. 5 of copper etching above), 16 parts; oxalic acid, 1 part. 5. Iodine, 4 parts; potassium iodide, 10 parts; water, 80 parts. This is very highly recommended.

Nitrate of lead is the cheapest disinfectant known that fulfills its intent. It does not, however, prevent putrefaction. The chloride of lead is much more effective in all directions. It is made by dissolving a small teaspoonful of the nitrate of lead in a pint of boiling water; then dissolving two teaspoonfuls of common salt in eight quarts of water. When both are thoroughly dissolved, mix the solution. When the sediments have settled, you have two gallons of clear fluid, which is a saturated solution of chloride of lead in water. A pound of nitrate of lead will make several barrels of the liquid and cost fifty cents retail.

Gum Arabic.—The gluing agents which are found in commerce under the name of gum arabic consist only for the smallest part of genuine Arabian gum, and we mostly receive in their stead substitutes containing dextrine; partly also gum resins resembling gum arabic; for instance, the gum exuding profusely from the Flinderria maculosa, indigenous in Australia. The fact that the powdered gum is frequently adulterated with entirely worthless substances, such as pulverized cherry pits, also deserves mention. Rock sugar mixed with milk and soda waterglass is likewise sold, in lumps and powder form, as gum arabic. Such a surrogate anybody may prepare at home by very finely powdering 3 parts (by weight) of rock candy and dissolving by boiling in one part (by weight) of fresh cow's milk, which must not be skimmed. To the boiling solution add 7 parts (by weight) of soda waterglass of 33° to 36° Be. Cause a thorough mixture by stirring, allow the whole to cool off to 36° to 38° Reaumur (=115° to 118° F.), pour out on a tin plate with upturned edges, allow to harden and knock with a hammer on the back of the tin, whereby the gluing material separates in grains.—Maler Zeitung.

For the purpose of cleaning bottles from fatty substances a very simple and practical process has been found. Pour warm water into the bottle, fill in ordinary hay and rub the inside of the bottle with this thoroughly, using a small stick. Now rinse the bottle out with clean water, and not a trace of the odor and the grease will remain. Large bottles which had contained petroleum were successfully cleaned in this way.—Oesterreichische Brauer- und Hopfen-Zeitung.

Miscellaneous Notes and Receipts.

Picric acid excited popular interest for some time when this substance was employed in France for the production of the melinite bombs. Now the acid formerly used for an explosive assumes the rôle of a peaceful remedy against the so-called eczema, a cutaneous eruption which is sometimes quite malicious. According to the Paris Bulletin Médicale, a solution of 1 part picric acid in 86 parts pure water, applied with a brush on the diseased portions of the skin, is said to allay the painful itching at once. It forms a sort of protective covering over the sore spot, under which the healing and cicatrization progress quickly.

Non-Corroding Soldering Fluid.—The Iron and Coal Trades Review states that a reliable soldering fluid, free from rusting properties, may be made with four pounds of hydrochloric acid and about four pounds of ordinary zinc cuttings; if old zinc is used, a rather larger quantity will be required. It is best to add the zinc in two or three lots. When the acid is saturated—

How to Transfer Newspaper Pictures.—The liquid to be used is made by dissolving one and one-half drachms common yellow soap in one pint of hot water, adding when nearly cold three and one-fourth fluid ounces spirit of turpentine, and shaking thoroughly together. This fluid is applied liberally to the surface of the printed matter with a soft brush or sponge (being careful not to smear the ink, which soon becomes softened), and allowed to soak for a few minutes; then well damp the plain paper on which the transfer is to be made, place it upon the engraving and subject the whole to moderate pressure for about one minute. On separating them, a reversed transfer will be found on the paper.—Allentown (Pa.) National Educator.

Miscellaneous Notes and Receipts.

Removal of Rust Spots.—To remove rust spots from stuffs the following methods are recommended: 1. Moistening with potassium cyanide. 2. Soaking in solutio sodium pyrophosphate. 3. Moistening with stannic chloride and immediate washing after the disappearance of the spot. 4. The best and cheapest: Take a bright piece of galvanized iron, lay it on a pot with boiling water, put the wet material with the rust spot on top, dab the spot with diluted sulphuric acid and rub out with the finger. The spot will disappear in a few seconds; after that, wash immediately with ordinary water. Instead of sulphuric acid, oxalic or tartaric acid may be employed.—Neueste Erfindungen und Erfahrungen.

To Deodorize Petroleum and Benzine.—To mask the unpleasant odor of petroleum, etc., an addition of 1 per cent of amyl-acetate is recommended. To destroy the nasty smell of benzine, and at the same time render the benzine colorless, Berninger proceeds as follows: To a mixture of ¼ liter of sulphuric acid and 1·75 liters of water add, after cooling, 30 grammes of potassium permanganate, next mix with 4·5 liters of benzine and allow to stand for 24 hours, shaking occasionally. After this period the benzine is lifted off and agitated for several hours with a solution of 7·5 grammes of potassium permanganate and 15 grammes of sodium carbonate in 1 liter of water. The separating benzine is said to be odorless and colorless, without having to be again distilled.—Wiener Drogisten Zeitung.

Artificial Caoutchouc.—An artificial product, which for certain purposes can take the place of India rubber and gutta percha, is obtained by mixing oxidizable vegetable oils (linseed oil, cotton-seed oil, palm oil, etc.) with tar, creosote, or wood vinegar. Melted or pulverized shellac or shellac solution may, besides, be added. Next the mixture is treated with diluted nitric acid and a non-viscid, elastic, tough product is obtained which can be vulcanized.

According to another, somewhat modified process, the mass is exposed to the action of nitric acid for a short time only and then heated on plates. The artificial caoutchouc is used either alone or mixed with natural caoutchouc, and is chiefly employed as an insulating material for electric conduits and for waterproofing fabrics.—Deutsche Malerzeitung.

To Render Fabrics Fireproof.—16 pounds pure ammonium sulphate, 5 pounds pure ammonium carbonate, 6 pounds boracic acid, 4 pounds pure borax, 4 pounds starch or ½ pound dextrine or gelatine, 200 pounds water. Into this liquid the fabrics are dipped at 86° F., so that they are well saturated; then they are wrung out lightly and sufficiently dried for ironing. The quantity of the starch or the dextrine and gelatine may be changed according to the degree of stiffness the stuffs are to possess. One quart of the liquid will impregnate about fifteen square yards of stuff.—Färber Zeitung.

Weatherproof Coating for Diaphanies.—For producing this weatherproof coating proceed as follows: Unite by shaking 100 parts absolute alcohol and 2 to 3 parts of thick turpentine and after the latter has dissolved add about 5 parts of camphor. Now add about 10 parts of pyroxylin which has been moistened with a mixture of 10 parts of glacial acetic acid and methylic alcohol and soaked lightly into the above described solution. The whole is allowed to settle in the warm, whereby the parts of water which are contained in the ready product can separate out. The supernatant liquid is ready for use. A picture provided with this coating is said to be impervious to all influences of the weather and to be able to even withstand slight mechanical actions.

Simple fire-extinguishers can be produced by anybody at a slight cost, says Technische Berichte. Dissolve 20 pounds of common salt and 10 pounds of sal-ammoniac in 30 liters of water and fill the mixture in quart bottles of thin glass. The extinguishers thus prepared are highly suitable to smother small fires. The bottles, which should be securely corked up and sealed, to prevent the contents from evaporating, are thrown into the flames of the starting fire or its immediate vicinity with enough vehemence to cause them to break.

(7486) O. S. K. writes: I believe I saw at one time in your publication the method of placing an egg in a bottle. Think some acid or something was used to soften the shell and then the egg was placed through the neck of the bottle. A. In order to make eggs enter a decanter or a bottle, it is necessary to soak an egg for about twenty-four hours in acetic acid or strong vinegar. The shell of the egg thus becomes soft, but must be handled with care. It will be an easy matter for the egg while in this state to enter the mouth of the bottle. It can be helped along greatly by the use of a funnel, as wide as possible as will just enter the bottle. If the egg is now placed in the funnel, it gradually finds its way and by its own weight drops into the bottle. The bottle should be about half full of water, both to check the fall of the egg and to prevent its breaking and at the same time it hardens the shell, which after the operation is very thin, more so than originally. An egg can also be passed half way through a finger ring, and in that condition placed in water, and it presents a very curious appearance—an egg with a ring around its center.

(7132) T. P. W. asks: Will you be so kind as to explain, if possible, for the benefit of one of your readers, the process by which a sheet of paper may be split so as to preserve both sides. For example: A page of a magazine has cuts on each side which it is desired to preserve so both can be mounted. A. The paper to be split is pasted between two sheets of compact, strong paper. The best flour paste should be used. Mucilage is unreliable. When nearly dry, if the two outer pieces of paper are pulled apart, the central one will split, and one-half of the central piece will adhere to each. By soaking in water they can be removed. Some kinds of paper work better than others. If the outer paper is of a loose texture, it may split instead of the desired one. But the best plan is to paste a piece of cloth to each side of the sheet to be split. When dry, violently and without hesitation pull the two pieces asunder, when part of the sheet will be found to have adhered to one and part to the other. Soften the paste in water, and the pieces can be easily removed from the cloth. The process is generally demonstrated as a matter of curiosity, yet it can be utilized in various ways. If we want to paste in a scrap book a newspaper article printed on both sides of the paper, and possess only one copy, it is very convenient to know how to detach the one side from the other. The paper, when split, as may be imagined, is more transparent than it was before being subjected to the operation, and the printing ink is somewhat duller; otherwise the two pieces present the appearance of the original if again brought together.

(7348) L. H. B. says: Can you furnish me the formula for making seal metal, such as is used for the "counters" in notarial and corporate seals? A. Use the following for the counters for seals: Lead, 3 lb.; tin, 2 lb.; bismuth, 5 lb; melt in the order named.

(7346) C. B. W. asks how the paper is prepared of which dresses of dolls are made so that the color changes with the weather. A. Cobalt chloride dissolved in alcohol applied to artificial flowers or to the dresses of dolls to which you refer turns the paper or fabric pink when the air is humid; when the air is warm and dry, the paper will be purple or blue. A solution of the same constitutes one of the sympathetic inks.

(6987) G. M. asks for a recipe for making modeling wax such as sculptors use? A. Melt over a moderate fire 100 parts yellow wax, and add 13 parts Venetian turpentine, 6½ parts lard, 72½ parts elutriated bole. Mix thoroughly, pour the mixture gradually into a vessel containing water, and knead it several times with the hands. The wax must be melted at a temperature sufficiently low not to create bubbles. Add Indian red if desired for color.

(6988) C. J. S. asks for a receipt for a brass sign polish, such brass work as is used in front of store windows and exposed to all sorts of weather. A. Rottenstone made into a paste with sweet oil makes a good polish for brass. The following may also be used: Rottenstone, 4 ounces; oxalic acid in fine powder, sweet oil, 1½ ounces; turpentine, a sufficient quantity to make a paste.

(6989) C. A. F. asks what compound may be used to braze casting (cast iron) successfully. A. Cast iron is very difficult to braze. Make the surfaces that are to be brazed very clean by using file or scraper. Rub up some borax with water on a piece of slate and rub the surfaces to be brazed with a piece of zinc wet with the borax. Then bind the surfaces together, apply a strip of brass or the spelter and additional borax, and proceed as with other metals.

(6990) T. L. R. asks for a formula for liquid bluing. A. Water, 15 parts; dissolve in this 1½ parts indigo carmine. Add ¾ part gum arabic.

To Render Brass or Nickel Fixtures Iridescent.—To give a beautiful iridescence to nickel, brass or copper fixtures, prepare a solution of 1 part of lead acetate to 3 parts of sodium hyposulphite in 48 parts of water and into this plunge the articles and let stand. Remove from time to time, and as soon as the requisite depth of color is obtained, rinse off and let dry spontaneously. The iridescence is very beautiful and quite lasting

Substitute for Fire Grenades.—A common quart bottle filled with a saturated solution of common salt makes a cheap and efficient substitute for the ordinary hand grenade. The salt forms a coating on all that the water touches and makes it nearly incombustible.

New Liquid Glue.—The following is the subject of an English patent, and is said to yield a glue liquid at all ordinary temperatures, of great adhesive properties, and which does not mould: Let any desired amount of gelatin or glue swell in cold water until it has taken up the maximum of that substance. Pour off and work out all excessive moisture, then liquefy by the application of heat (in a water bath). To the solution add 10 per cent. of the original weight of the gelatin or glue, of sodium salicylate, and dissolve. A small addition of oil of clove is recommended. This, as we understand the description, constitutes a stock, which is to be diluted for use as desired.—National Druggist.

...ound for the preservation ...e has the fol-

Witch Hazel Jelly.—A recent formula said to possess merit is the following:

WITCH HAZEL JELLY.

Gum tragacanth, in pieces	4 ounces.
Glycerin	15 "
Alcohol	20 "
Distilled extract of witch hazel	20 "

Soak the gum in 80 ounces of water for 48 hours, stirring frequently, add the rest of the ingredients, and make up to 10 pints with water; then press through cheese cloth, and perfume with otto of rose, heliotropin, or any other scent.

Put up in collapsible tubes, this makes a good selling specialty for use after shaving, and is a first class remedy for chaps, sunburns, roughness of skin, etc.—American Druggist.

According to a French patent of Anquetil, ink of the following composition gives copies on unmoistened copying paper without application of pressure:

Aniline color	30 grammes.
Water	2000 "
Glycerine	1000 "
Alum	15 "

It suffices, in order to obtain good copies, to lay a sheet of paper written on with such ink in the copy book, and to close the latter. It is only necessary to see to it that the writing comes into contact with the copying paper throughout.—Papier Zeitung.

Miscellaneous Notes and Receipts.

Uninflammable Celluloid.—According to Asselot, dissolve 25 parts ordinary celluloidine in 250 parts acetone and add a solution of 50 grammes of magnesium chloride in 150 grammes of alcohol until a paste results, which occurs with a proportion of about 100 parts of the former solution to 20 parts of the latter solution. This paste is carefully mixed and worked through, then dried, and gives an absolutely incombustible material.—Chemische Industrie.

Petroleum as Fuel.—To the endless number of recipes for the production of petroleum briquettes may be added the following: Petroleum, 10 liters; resin, 1 liter (?); soap powder, 1·5 kilos.; caustic soda, 3·3 kilos.; sawdust, 3 liters; and sand are heated with constant stirring. After ten minutes the mass begins to solidify. If liquid is still present, add soda. The mass thus obtained is formed into briquettes and cooled. Their heating value is said to be three times as great as that of coal briquettes.—Kraft und Licht.

Production of Stamping Ink for Linen.—Moisten 10 grammes of powdered dragon's blood resin and 10 grammes of powdered silver nitrate—lapis infernalis—throughout with a few drops of distilled water and increase the mixture by 10 grammes of white dextrine and enough glycerine so as to give the mass the consistency of a good printing ink. The rubber stamps employed should be rubbed before use with a few drops of sweet almond oil. Spread the ink on pieces of velvet for transferring purposes.—Färben Zeitung.

A Method of Detecting Alterations in Manuscripts.

A new use for the vapor of iodine has been found by Prof. Bruylants, of Louvain. By its aid alterations in manuscripts can be detected. It appears that when a sheet of paper which has been sized and finished is moistened and then exposed, after thorough drying, to the action of vapor of iodine, the portion which has been moistened assumes a violet tint, while the remaining portion of the surface appears a brownish yellow. This principle may be used to produce a sympathetic writing, since if we write with water upon the surface of paper treated with ordinary size, the writing will appear in a violet color when the dry paper is exposed to the vapor of iodine. The pale violet upon a yellow ground becomes a deep blue on a pale blue surface, when the paper is again moistened and the characters disappear altogether under the action of sulphurous acid. When a manuscript is suspected of having been fraudulently retouched or altered, the use of the vapor of iodine will often serve to reveal the nature and extent of the alterations. Those portions which have been rubbed will become brownish in tint, and, when a rubbed surface is moistened after exposure to the iodine, it takes a blue color, varying in intensity according to the duration of the exposure. The outline of the rubbed portions remains perfectly distinct after drying, being paler in tint than the rest of the surface. This action is evidently due to the removal of a portion of the starch contained in the size.

These reactions also appear upon paper which has been entirely moistened and dried, as in the case of a letter copied in a press, but the indications are somewhat less distinct. The process will also reveal the existence of pencil marks erased by rubbing. Apart from any traces of plumbago which may have remained, the path of the pencil point disturbs the surface of the paper, as would any blunt instrument, and even when the rubbing has been so carefully performed that it has not removed any portion of the surface paper, the marks are made entirely legible when exposed to the iodine vapor. The clearness of all these reactions depends upon the character of the paper, and that which contains the smallest quantity of sizing material will naturally give the least brilliant effects; but in every case the changes above described will appear to a greater or less degree, and the use of the reagent in skillful hands should give material aid in clearing up disputed questions of this nature.—The (London) Archi-

To Clean Door Bells, Their Mountings, and Similar Articles.—Der Stein der Weisen recommends plain ammonia water, or this mixed with whiting. Moisten a woolen rag, and with it rub the articles strongly, then rinse. Nothing cleans up old brass as quickly and as satisfactorily. When a large surface is to be cleaned, the best plan is to moisten the surface with ammonia, then, with a good stiff brush, rub strongly, and afterward rinsing it off with clear water and drying.

Producing Reliefs by Electricity.—An electrolytic process to produce reliefs in steel has been invented and patented by Joseph Riedu, in Munich. This process is described as follows with regard to dies: An impression of the relief of a coin is made in plaster of Paris in such a manner as to form a column several centimeters in height. This column is insulated at the circumference by hard rubber and placed in a vessel with a suitable electrolyte so that the relief side is above, while the lower side reaches into the electrolytic liquid. In consequence of its great porosity, the gypsum absorbs the same until saturated. Now a piece of steel is placed upon the picture side of the gypsum column and the electrolyte is connected with the negative pole, the steel with the positive pole. The galleries of the steel which come into contact with the saturated gypsum are dissolved and by its own weight the piece of steel sinks down to the deepest galleries of the plaster model, which finishes the copy. Although the respective experiments are not yet closed, it may be asserted that not only steel but most of the other metals may be worked according to the above method. This electrogravure can, of course, also be employed for copying antique chased works of art, and will most likely soon be employed to produce counterfeits of antique articles of virtu which it will be difficult to distinguish from the originals.

A cheap and simple cleaning compound for typewriters is composed of the following ingredients:

Paraffin oil	1 pint
Benzol	5 ounces
Cresol	1 drachm
Kerosene	4 ounces

Mix thoroughly.

This compound was for years a secret confined to ... or two of the large companies that rebuild typewriters. The machine is immersed in the compound ...h quickly and thoroughly dissolves and removes dirt, gum, grease, etc. It does not injure the ...nel, but on the contrary improves its appearance, ...ing it as bright as when new. ...

November 28, 1914 — SCIENTIFIC AMERICAN SUPPLEMENT No. 2030 — 340

Tetrichloride of Carbon
Greatest possible Solvent

Star 2/28/24

FIND LIQUID USEFUL TO THE INDUSTRIES

New Properties of Selenium Oxychloride Discovered Powerful as Solvent.

ONCE ALCHEMISTS' DREAM

So Vigorous It Will Remove Bitumen From Soft Coal, University Professor Says.

By the Associated Press.

LINCOLN, Neb., February 28.—New properties of a liquid described before the students of the department of chemistry of the University of Nebraska show that it almost realizes the dream of the alchemists of old who sought the universal solvent. As described by Dr. Victor Lenher, professor of chemistry at the University of Wisconsin, who has come here to deliver a series of addresses on the subject, further tests have shown that selenium oyxchloride, as the solvent is called, is more powerful even than was indicated in his preliminary announcement made before the American Chemical Society.

It dissolves rubber, glues, enamels, hydrocarbons and many other substances, which hitherto have been regarded as most resistant to all chemical agencies except fire.

Products Easily Dissolved.

Such products as redmanol, bakelite and condensite, which are used as substitutes for amber in the making of tobacco pipes and for many other industrial purposes, and have been until now regarded as insoluble in all known solvents, are readily dissolved by selenium oxychloride, according to the announcement of Dr. Lenher. By its use ordinary paints, varnishes and shellacs can be removed from furniture, carriages and other objects without injuring the wood, and enamels can be taken from automobiles without affecting the steel body.

"Its solvent powers are so vigorous," said Dr. Lenher, "that it will remove the bitumen from soft coal, but will not attack the pure carbon of anthracite."

Dr. Lenher also sees a military power in this powerful solvent, as it can be employed in making more porous charcoals contained in the filter material of war gas masks, a process known as activation.

"The cocoanut charcoal used in the gas mask," continued Dr. Lenher, "can be activated by this new reagent by ...

In tests recently made in extinguishing oil fires, wet sawdust impregnated with sal ammoniac has been found to have considerable merit.

Carbon tetrachloride has shown up well as an extinguishing fluid and has the advantage of being a non-conductor to a high degree, which is a very valuable attribute. In modern plants the liability of structural fires is vastly less than the liability of the occurrence of fire in apparatus, and much of this apparatus is so constructed that in case of fire occurring in the interior it is very difficult or impossible to use an extinguishing agent with success. Then, again, many fires on apparatus and conductors flash and quickly burn out, affording no time nor necessity for action.

It is impossible within the scope of this brief treatment of the subject to cover the entire field of operations; the operator must be depended upon to exercise his good judgment, which, in practically all cases, should be sufficient to master the situation.

Carbon Tetrachloride as a Cleaning and Solvent Agent.

Associated Factory Mutual Fire Insurance Companies.

(Member N. F. P. A.)

In recent years the use of carbon tetrachloride as a cleaning and solvent agent has considerably increased, owing partly to a decrease in its cost of production, and partly to a more widespread knowledge of its properties. The advantages which it possesses over naphtha in point of safety, with respect to both fire and explosion hazard, make this substance of considerable interest.

Carbon tetrachloride is a water white liquid, having, when pure, a pleasant, agreeable odor quite similar to that of chloroform. The commercial product usually contains sulphur impurities which impart a slightly disagreeable odor. The specific gravity of the liquid at 32°F. is 1.632 and the boiling point is 169°F. The specific gravity of the vapor is about five and one-half times as great as that of air and about twice as great as that of the lightest naphthas. The difference in specific gravities of the vapors of carbon tetrachloride and naphtha is not sufficiently great, however, to overcome the tendency which all vapors have to diffuse, one within the other, and the two vapors do not separate once they have become thoroughly mixed. The two liquids show no tendency to separate once they have been mixed.

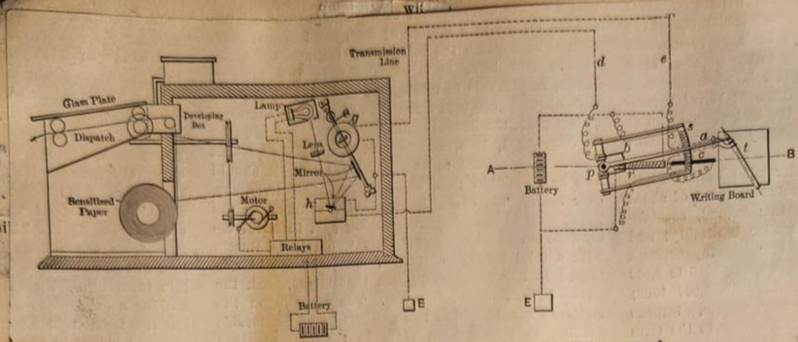
Carbon tetrachloride is an excellent solvent of animal and vegetable fats, oils, varnishes, waxes, resins, mineral oils, paraffin, tar, etc.

It is non-inflammable and non-explosive. Combustion cannot take place in its vapor due to the absence of oxygen. For this reason it extinguishes small fires in enclosed spaces, when thrown upon them.

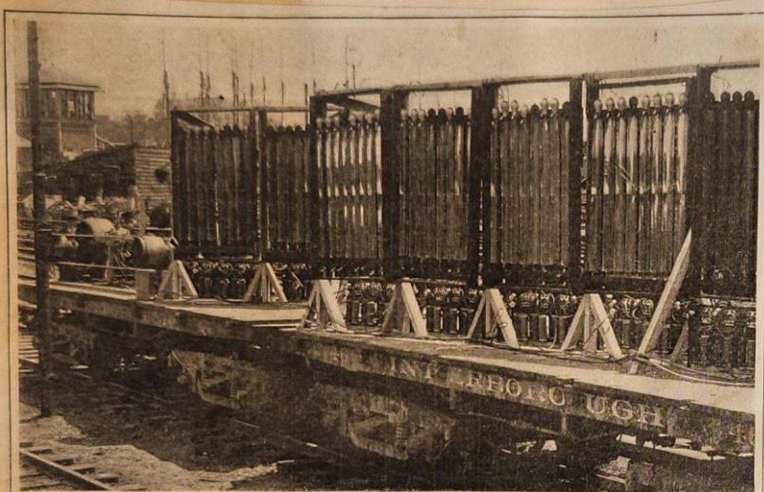
...red
...n add
...ght) H_2O at 160°

Paraffine and essential oils (oil birch. wintergreen, etc) one to four per cent.

Wax and palm oil



The Combined Transmitter and Receiver of the Gruhn Telautograph.



THE 54,000 CANDLE POWER COOPER HEWITT MERCURY ARC LAMPS.

of 45 pounds. I was informed that two hours had elapsed since the boiler was charged and that steam was taken on at 170 pounds pressure. The chief engineer of the works stated that the boiler could limp back to its station even with steam pressure as low as one-half an atmosphere.

Contrary to one's natural impression steam is not taken on at high pressure. The pressure is about 170 pounds per square inch; in other words, it is proposed to afford the locomotive a steam pressure practically the same as that in the boiler of the power station. In order to effect this result the locomotive boiler is filled with water to about three-fourths its capacity. This water is superheated. Steam is admitted by means of a steam coupling from the power plant at the forward end of the boiler, where low down it passes through a steam admission valve. This juncture between the locomotive boiler and the boiler of the power plant is effected by either a revolving pipe connection or by means of a swaying arm, or it may be effected by a collecting pipe such as is peculiar to hydrants.

STEAM MIXED WITH WATER.

The steam on entering is mixed thoroughly with the water in the boiler tank, and the effect is to raise the tension in the locomotive

Patent 775839
Cement

therefrom. Other cements may however be used which will not be affected by the hot material, such as oxychlorid of zinc and magnesia; or if rapid manufacture is important, a quick setting cement may be made, such as is used in dental work, consisting of oxid of zinc and glacial phosphoric acid, which hardens in a few minutes. But all things considered, except for the time required to set, I consider Portland cement, in exceedingly finely divided condition, to be preferable, both because it results in a harder and superior matrix and because more perfect records can be made therefrom. After

SUMMER BATHING.

Refreshing Baths Act as Tonics in Hot Weather.

Whether or not a hot or cool bath (not cold) is the better for refreshing one in warm weather is open to discussion. The theory that a hot tub reduces the temperature of the body is certainly true, but on the other hand there are conditions under which a hot bath is not to be considered. A person of little vitality, already partially exhausted by warm weather, will be in a condition verging on fainting after taking a warm tub. If the same person sits in a tub of water which is chilly, or of which only the chill is taken off, the water will draw the heat from the body and the result is cooling.

For this reason each individual must decide which is best for herself. There is, however, no question but that a bath, in summer, may be made more invigorating by the addition of stimulating properties, the best known of which is sea salt. This may be bought at any druggist's, and a couple of pounds or more dissolved in the tub make the bath like a dip in the ocean. Soap should not be used with it, and a salt bath is far more tonicizing taken cold than hot.

Nothing is more refreshing when exhausted by heat than a camphor bath. The action of the gum upon the skin and head is highly beneficial and may be had by mixing two ounces of tincture of camphor, half an ounce of tincture of bezoin and four ounces of cologne or alcohol. Enough of this is put into the tub to make the water aromatic, and the body is immersed for fifteen minutes or more.

More stimulating than plain sea salt is a combination of one pound of muriate of soda, one-half pound of sulphate of soda, a quarter of a pound of chloride of lime and a quarter of a pound of chloride of magnesia.

The ingredients are dissolved in two or three gallons of water and put into the usual tub of water.

A soda bath is especially cooling when the blood and skin are heated and has beneficial results. Common bicarbonate of soda is used, and four or five ounces are put into the tub of clear water, the temperature of which is not high. Soap may be used with this, but a long soaking of the body is better.

The length of time that a person may remain in a tub must be decided by the individual, for too long immersion is weakening. At the same time the body should have all the refreshment it can get.

Fifteen minutes is not too long for the average person, and twenty minutes may usually be indulged in without danger. More than that should not be had by any except those with great physical strength.

Such a bath taken just before going to bed will refresh one sufficiently to insure a good night's rest many times, and a shower on getting up in the morning is worth many times what the apparatus costs.

Almost every tub is now fitted for a hand spray, but when this is lacking spraying arrangements are to be found at any toilet department or druggist's. The shower taken should be a cold, or at least cool, one, and need not consume more than two minutes if one is pressed for time. It is as invigorating as fresh water to a drooping flower.

Dry Battery Filler

1/4 lb Sal ammoniac
1/4 lb. Chloride of Zinc (paste form)
1/4 lb Oxide of Zinc
1/4 lb Plaster Paris
Thoroughly mix

this after

This tel
bridge, at
Osborne.

New Sympathetic Ink.—Phenolphthalein, as is well known, produces with alkalies a most beautiful color reaction, assuming an intense red color. Writing done with a weak solution of phenolphthalein is hardly visible on the paper but appears at once if the paper be wiped over with a cotton pad wetted with soda or some other alkaline solution. No precautions are thereby necessary to prevent blurring, for the alkaline solution soaks into the paper and does not remain on the surface; for important documents, however, such as bills of exchange, etc., it is suitable, because, under the influence of acids, even the carbonic acid present in the air, it will in time disappear. The solution of phenolphthalein should be prepared with dilute alcohol.

Acid-Proof Coating.—Mix a strongly concentrated solution of 20 parts of water glass with 10 parts of heavy spar and 20 parts of finely pulverized asbestos. The specific gravity of the water-glass solution must range between 30 deg. and 40 deg. Bé. We thus obtain a dough-like mass that speedily hardens and can be applied to all vessels used to contain strong acids, as it will withstand even concentrated sulphuric and fuming nitric acids.

REAL USES FOR KALEIDOSCOPES—THEY DESIGN LACE AND MAY SOON DESIGN WALL-PAPER, TOO.

A CURIOUS method of utilizing an instrument hitherto regarded merely as a toy has been devised by lace-makers, who at the present time are employing for their own purposes the contrivance familiarly known as the "kaleidoscope."

The optical principle on which the kaleidoscope depends is well known and extremely simple, small mirrors being so arranged as to multiply the images of a few little bits of glass of different colors which are jostled about as the instrument is turned on its axis, so as to fall into different arrangements with relation to each other.

In this way patterns exquisitely symmetrical and beautiful to the eye are produced, changing with every turn of the tube through which one looks. On the whole it seems surprising that nobody until recently should have thought of using them for ornamental purposes; but the lace-makers have found that in this way they can obtain unlimited new designs.

So many thousands of combinations are possible in the arrangement of the bits of glass that one might turn the kaleidoscope for a year without seeing the same pattern appear twice. The saving of imaginative ingenuity to the designer is great, and one may reasonably expect to see the instrument used before long in the making of wall-papers, carpets and oilcloths, the adapted toy affording suggestions for color schemes as well as for patterns.

DANGEROUS TINTS.

Some Colors That Will Eventually Drive a Person Mad.

From Tit-Bits.

If purple walls and a red-tinted window surrounded you for a month, with no color but purple around you, by the end of that time you would be a madman. No matter how strong your brain might be it would not stand the strain, and it is doubtful if you would ever recover your reason. For purple is the most dangerous color there is—in its effects on the brain, which it reaches by way of the nerves of the eye.

A splash or two of any other color in the room would save your reason for some time longer; but dead purple would kill you eventually, as surely as would foul air. Scarlet is as bad, but scarlet has a different effect. It produces what is called homicidal mania—a madness that drives its victims to kill his fellows, especially his nearest relatives. Even on animals scarlet has this effect. It will drive a bull or a tiger to charge a naked spear. But purple, on the contrary, brings on melancholy or suicidal mania.

Blue, as long as there is no trace of red in it, stimulates the brain, and helps it; but its effect on your nerves, if you are saturated with it and cannot get away from it, is terrible. Scientists class blue as a kind of drug in its effects on the brain. It excites the imagination and gives a craving for music and stagecraft, but it has a reaction that wrecks the nerves. If you doubt it, stare hard for a few minutes at a large sheet of bright blue paper or cloth—not flowers, for there is a good deal of green in their blue—and you will find that it will make your eyes ache and give you a restless, uneasy feeling.

Green, on the other hand, is the king of colors, and no amount of it can do any harm. On the contrary, it soothes the whole system, and preserves the eyesight. If you were shut up in an artificial green light for a month it would develop your eyesight immensely; but it would be fatal, because when you returned to the world you would be utterly unable to stand ordinary lights and colors, and you would certainly contract ophthalmia, or possibly destroy the optic nerve altogether, unless you were very mindful to take great care.

Most people imagine the sky, in clear weather, to be blue. It is really white, tinged with green. It is only the distance and clearness that make it seem blue. Green is so soothing that it makes a big difference in the length of an illness, helping the system to fight the disease, and nearly all hospital wards have every possible detail about them colored green. Sage green is the most soothing tint of all; metallic green, however, is by no means good.

Solitary confinement in a yellow cell for six weeks will hopelessly weaken any system and produce chronic hysteria. A long enough course of it will produce foolish lunacy, and even on a guinea pig or a rabbit will drive the animal at last to either bite and wound itself, or reduce it to such a state of nervousness that it will die of sheer fright if suddenly startled. On the other hand, if you are not smothered with it, yellow is the healthiest, cheeriest color there is, and will make a dark room bright and habitable, when even green would be cold and depressing. But to be well "soused" with yellow, day and night, and to be unable to get away from it, would bring you to nervous madness within two months at the outside.

Sheer dead white, unbroken, will destroy your eyesight as surely as "cataract" would if you are exposed to it for a few days—a week at latest. It kills the optic nerves, and the sight goes out like a candle, while the effect on the brain is so maddening that blindness is almost a relief. This is why arctic explorers have to wear colored "goggles" of green-tinted glass; otherwise "snow blindness," as it is called, and which is really "white blindness," is almost a certainty. Even in the polar regions, though, the white is not complete. The sky breaks it. If it did not, no man could keep his eyesight there without glasses.

PAINTING THE LILY—NATURE'S PALETTE HOLDS ONLY THREE COLORING SUBSTANCES.

RECENT investigations have shown that for all fruits and flowers only three coloring substances are furnished by Nature. One of these is the familiar "chlorophyll," which paints the beans and peas, the watermelon and the leaves of the trees so vivid a green. Another is "xanthophyll," which exhibits its intense yellow in the carrot, for example. The third is "erythrophyll," which shows its rich red in the beet. The last two are only modified "chlorophyll," however. But it is quite wonderful to realize that all of the varied hues of flowers and fruits are due to these three substances, mixed in different proportions.

Beets contain enormous quantities of "erythrophyll" (as might be judged from their intense redness), and their juice was formerly employed to some extent as a coloring agent. But vegetable dyes, which were extensively used in earlier days, have the disadvantage of lacking permanency. There are some exceptions, it is true—such as indigo, which is a definite chemical compound stored in the plant; and the same may be said of madder. Turmeric and saffron, too, yield important pigments, which are commonly utilized for dyeing.

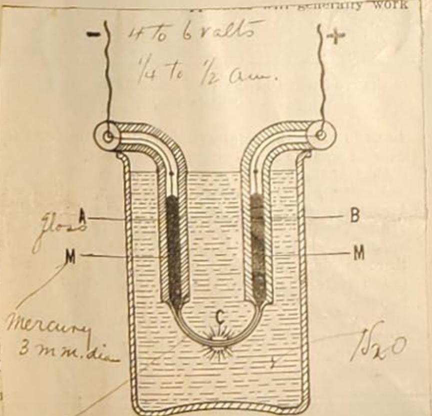
Several kinds of dyes, by the way, are obtained from trees. In the South the brown juice of "butternut" bark is used to this day for staining cloth.

To Solder Glass Together.—This is effected with the aid of a metal alloy consisting of 95 parts of tin and 5 parts of zinc. The melting point of this alloy is about 425 deg. F. The glass to be soldered is first carefully heated to the above temperature and the alloy is then spread on the glass with the aid of a soldering iron and on cooling it will be firmly attached to the glass. An alloy of 90 parts of tin and 10 parts of aluminium can also be used for the same purpose, but not so conveniently, as it does not melt until it reaches 830 deg. F.

Duodecaplex Telegraphy.

Experiments are at present being conducted on the Paris-Bordeaux line with some very interesting machines, which the inventor, M. Mercadier, has been working on for many years. With these instruments, called duodecaplex, twelve Morse transmitters can work simultaneously on a single wire, each sending its signals to the proper receiver at the end of the line. This result is brought about by the use of alternating or, at any rate, interrupted currents.

Each transmitter receives its current through a tuning fork having a special note, its vibrations being electrically maintained. These vibrations furnish a current of the proper period to cause resonance at each application in the proper receiving circuit, which has its self-induction and capacity adjusted for this result. This receiver is a telephone (a monotelephone, as it is called by M. Mercadier) so constructed and arranged that the acoustic resonant qualities also help to damp out from the signals received everything not intended for it. These signals are read in the ordinary way by ear, aided by rubber tubes like those used on phonographs. The sifting out of the signals, it seems, is very perfect, each receiver giving no evidence of those signals not intended for it except a slight murmuring very indefinite and not at all bothersome.—Electrical World.



A NEW INTERRUPTER.

HYDROGEN.

ITS ECONOMICAL PREPARATION FOR TECHNICAL PURPOSES.

In transmitting the following report, Consul Thomas H. Norton, of Chemnitz, says that much interest is felt in aeronautic and in certain mechanical circles in the perfection by a German professor of a method for the economical preparation of hydrogen gas on a large scale:

The materials employed in the new process of manufacturing hydrogen gas are water, coke, and calcium carbide. The first step is the production of "water gas," the well-known gaseous mixture obtained when a current of steam is passed through a thick layer of red-hot carbon. For some years past this cheap gas has been employed as a fuel and also for illuminating purposes, either when saturated with volatile hydrocarbons or in connection with incandescent mantles. Its own flame when burning in the air is almost destitute of luminous properties. Water gas consists of a mixture of hydrogen and carbon monoxide gases, with small amounts of nitrogen, etc. Theoretically the two gases should be present in equal volumes, but in practice the amount of free hydrogen is far behind the theory.

The professor has solved the problem of the elimination of the carbon monoxide from the mixture by bringing into play a very simple and elegant reaction. The gaseous mixture is conducted over glowing calcium carbide in the form of powder. As a result the carbon monoxide is completely decomposed in contact with the calcium carbide. Lime (calcium oxide) is formed, and carbon in the form of crystalline graphite is separated. This by-product of artificial graphite is itself capable of utilization for most of the purposes where the natural mineral substance is employed. The minor impurities of the original mixtures are likewise removed in the reaction, and as a result, hydrogen containing but 1 per cent of other gases is isolated.

COST OF PRODUCTION.

The process is one of extreme simplicity and cheapness, and allows of the easy and rapid production of large quantities of nearly pure hydrogen. An installation capable of evolving daily a volume of 70,[illegible]ubic feet of hydrogen occupies a very small space. Hitherto those requiring the gas for balloons or the like have been forced to use the expensive process of preparation based upon the action of acids (hydrochloric or sulphuric) upon metals, usually upon iron. The transportation of acids to remote points is also attended with much inconvenience and difficulty.

In its notable lessening of the cost of hydrogen, the new process has accomplished for this gas what another scientist a few years ago did for oxygen when he introduced the method of the fractional distillation of liquid air, and thus secured an "air," consisting of oxygen with but a slight admixture of nitrogen.

Cheap hydrogen is of great value at the present stage in the development of aeronautics, where, in many cases, it is of prime importance to have a much lighter gas than illuminating gas; for example, in polar exploration. This increased availability of hydrogen for technical purposes will likewise be of distinct value in extending its use for autogenetic welding.

A Paper which is especially Sensitive to Ultra-violet Rays: is prepared with nitrate of para-phenylene-diamine, and turns blue when exposed to the ultra-violet rays.

VALUABLE CEMENT RULE DISCOVERED

Bureau of Standards' New Commercial Formula of Use All Over U. S.

A recent shortage of cement in Washington for use in construction work by the Army engineers brought about experiments at the bureau of standards which may have great commercial value, not only here, but in all parts of the United States, scientists say.

Cement deteriorates in strength with storage. The bureau of standards was asked to find the strength of cement which had been stored for about a year and a half to be used in making concrete. Following experiments a formula was worked out to show the comparative strength of cement which had been stored and fresh cement.

The old cement was received by the bureau of standards and put through a sieving process to remove the lumps. The cement, after seiving, as well as the crushed lumps, were then made into separate concretes, which were compared with concretes made from cement recently purchased. It was found that a mixture [illegible] part of cement (aged) to one [illegible] one-quarter sand and two and [illegible] half gravel would give approxi[illegible]ly the same strength as a mix[illegible] of one part of cement (new) to [illegible] parts of gravel and four parts [illegible] sand. The bureau of standards [illegible]commended that lumps be seived out of the old cement before using.

This formula, it is stated, would, of course, vary with the length of time the cement was in storage, and the condition of the place stored. For instance, cement stored in a dry place, shut off from damp air, will last longer than cement in a leaky, damp warehouse.

The commercial value of the experiment would apply in few cases, comparatively, it is stated, because cement usually is used immediately after the receipt.

New Test to Detect Traces of Moisture.

A new and delicate test for traces of moisture is based on the fact that the nearly colorless lead-potassium iodide is partially decomposed by water, yellow lead iodide being set free. Lead-potassium iodide is precipitated when 4 parts lead nitrate dissolved in 15 parts water are mixed with 15 parts potassium iodide dissolved in 15 parts water. The dried precipitate is dissolved in 15 or 20 parts of acetone, again precipitated by adding water, washed with ether and dried *in vacuo*. The compound iodide, thus prepared, is nearly white, but becomes pale yellow on keeping.

In tests for moisture a 20 per cent solution of the salt in acetone is dropped on filter paper. The paper turns deep yellow rapidly on exposure to moist air, and instantly when breathed upon. Moistening [illegible] acetone reproduces the original solution and de[illegible] the color, so that the paper can be used repe[illegible] In experiments with air dried by sulphuric acid of various strengths the moisture in air drawn from the outer atmosphere at 64½ deg. F. and passed through 78 per cent sulphuric acid was clearly detected, although it corresponded to a vapor tension of only 0.3 millimeter or little more than 1/100 inch. To detect water in liquids, the test paper is dried in a stream of dry air and the liquid is poured over it. The yellow coloration is produced instantly by commercial ether and "absolute" alcohol, dehydrated by the usual methods. Traces of water can be removed from alcohol by agitating it with solid lead-potassium iodide.

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ALCOHOL FROM NATURAL GAS.

A NEW PROCESS INVENTED TO PROVIDE FOR CHEAPER PRODUCT.

A patent has been issued to Dr. Henry Spencer Blackmore, an industrial chemist of Washington, D. C., for converting natural gas into alcohol. Manufacturing interests of the United States are making inquiry to the Bureau of Manufactures in regard to this new method of producing alcohol, and the following abstract of a letter from Doctor Blackmore is therefore presented:

I have devised a process of converting natural gas, which contains on an average 96 per cent methane, into alcohol by the action of limited portions of oxygen or air in the presence of a heat-absorbing fluid, such as steam, which prevents complete combustion and maintains the temperature below the decomposing point of alcohol, the oxidation being induced and maintained by passing the gaseous ingredients through an electrically heated gauze.

By subjecting natural gas to a limited or restrained oxidation or combustion in this manner, it is converted directly into alcohols and dehydrogenated alcohols known as aldehydes, the aldehyde of methane alcohol (wood alcohol) being known as formaldehyde. The product, therefore, is a mixture methyl alcohol, containing a small portion of formaldehyde, which can be readily separated. If the combustion is properly regulated and controlled, 5,000 feet of natural gas will produce approximately 50 gallons of alcohol, and as natural gas can be readily obtained in unlimited quantities at from 5 to 10 cents per thousand feet, it follows that the cost of 50 gallons of alcohol produced in this manner would only be 25 to 50 cents for raw material.

A plant demonstrating the commercial value of this process will shortly be erected in western Pennsylvania, probably at Bradford.

A Heat-storing Water Bag

THE bag described in the following paragraphs is a great improvement over the ordinary hot water bag. Besides its property of retaining heat longer, it can be prepared so that it will store heat, be set aside and then used at a future time. It is then ready for any emergency. Fill an ordinary hot water bag with either sodium sulphate crystals or hypo crystals. The crystals cost about ten cents per pound at the drug store. Sodium sulphate is preferable. To use, place the bag, which should be tightly corked, into a vessel of boiling water, and boil for about fifteen minutes. The crystals in the bag are now in a liquid state, i. e., a super-saturated solution has been formed. The bag is now ready for immediate use. It will now impart its heat steadily about four times as long as the same weight of water. If the bag becomes cold in too short a time, it is a sign that it has been boiled too long.

To prepare the bag for future use, boil twice as long as you did for immediate use. You can if you wish, use the bag while it is giving off its temporary heat in cooling, and then later utilize its latent heat. The storing qualities of the bag depend upon the heat of crystallization. The solution in the bag has become super-saturated by long boiling of the bag. Upon cooling it remains a liquid, but if it is touched by the cold fingers or suddenly jarred, or if one of its crystals is inserted in the solution, the whole mass crystallizes, and the heat of crystallization is given off. Sometimes the solution on solidifying forms in one hard lump. This does no particular harm, but it may be prevented by kneading the bag at intervals while in use.

Demand for Metallic Mirrors.

The production of metallic mirrors for searchlights and other such uses is now in demand in Europe, according to the London Times. Those made of glass, now used, are objectionable owing to their liability to fracture when the guns are fired on ships, and to the silvering on the mirrors blistering and separating from the glass. A new metallic mirror, partially made by electro-deposition, is being introduced. The mirror has a surface composed of alternate bands or rings of gold and white reflecting surfaces. It is claimed that this mirror gives a more penetrating beam of light both at night and in foggy weather, that objects on which such a beam of light is thrown stand out in greater relief than in a light thrown from a silver white metal mirror, and that the intensity of the light is so great that it is impossible to aim accurately at the projector. Another advantage claimed for the new mirrors is that they are not fractured by concussion, and that even when penetrated by bullets the area of distortion is very small.

Butter Without Churning.

A committee of the Franklin Institute of Philadelphia has just made public its report on the Taylor process for butter-making. It is recommended that Mr. Taylor receive the John Scott Medal and Premium in recognition of the value of his invention. In this new process sweet cream is poured into shallow pans, the bottoms of which are covered with absorbent pads. The pads are composed of heavy, white blotting paper supported on Turkish toweling, and absorb from the cream nearly all of its constituents except the fat.

The cream fat remains as a layer on the surface of the pads and after several hours' standing may be rolled off. In this condition the product contains rather too much water and milk proteids; on this account and because of the absence of salt, it does not keep very well. If, however, the separated butter fat be worked and salted in the same way as the ordinary churned product, the result is a very fine butter.

The process has the advantage of cheapness, since the pads may be used over and over again, lasting, it is said, for six months of daily use. The labor of churning is avoided and, on account of the use of fresh cream instead of that which has stood several days, the product keeps better than butter made in the ordinary way.

Ink for Writing on Photographs.—Dissolve 10 parts iodide of potassium and 1 part each of iodine and gum arabic in 30 parts of distilled water. With this solution white writing is produced on dark photographs.

Molding wax (artists)

{ ½ lb. sulphur (flowers)
¼ lb Kaolin
¼ lb talc

{ ⅓ wax
⅔ tallow } #2

heat on water bath and mix to such consistency that it "spatters" falling from spoon. Stir vigorously while cooling

New Monetary Standard.—At the Science Congress held at Nimes, France, a report made by M. Gobin was adopted, namely that a monetary standard be used by all countries which is adapted to the values now in use. The unit is known as the "mono" and has the value of \$0.05. It corresponds to the well-known monetary units as follows: Franc, 4 monos; mark, 5 monos; florin, 8 monos; shilling, 5 monos; piastre, 10 monos; yen, 10 monos; lire, 4 monos; peseta, 4 monos. The dollar would correspond to 20 monos.

An interesting form of dry battery has recently been invented, which is inactive unless exposed to a beam of light. The cell consists of a glass tube in which a platinum strip forms one electrode, and an amalgam of potassium and sodium the other. The air is exhausted from the tube, leaving a high vacuum. When the amalgam is exposed to a strong light, a current flows from the platinum to the amalgam through the vacuum tube. The internal resistance of this cell, which is known as a "photo-electric cell," is about 75,000 ohms.

This article should have followed // Sci. Am. Sup.
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Demonstration of the Behavior of Bodies with Non-conducting Surfaces in Electrostatic Fields. L. G. VEDY. (*Proc. Physical Soc.*, London, 39, Pt. 2.)—The actions here considered were noted a year or two ago by S. W. Richardson. It seems that they were described as early as 1921 in V. E. Johnson's "Modern High Influence Machines."

Any body, free to rotate and consisting of a dielectric or covered with such material, starts to rotate when placed between the poles of a Wimshurst machine. This was demonstrated by suspending on threads bits of paraffin or sealing wax and a glass beaker between the knobs of a machine. Better results were attained by mounting the experimental bodies on bearings such as needles in glass sockets. Brass balls covered with paraffin rotated, the thicker the layer the faster being the rotation. Covering the insulator with conducting foil caused the rotation to disappear. Also a partial conductor, such as cork, was set in rotation. Without the brush discharge the effect is not found. The rotating body generally becomes charged with electricity of the same kind as that on the knob contributing the greater discharge. If the test body be hung within a glass beaker or between two plates of ebonite, no rotation occurs. G. F. S.

various wave lengths simultaneously; hence it is sugg... the most perfect definition will be secured by using monochromatic light; for this purpose the mercury vapor lamp and flame arcs, which are approximately monochromatic, are good. Experiments with an acuity photometer support the view that monochromatic light possesses a power of revealing detail greater than its photometrically measured brightness would indicate.

Alloys for Permanent Magnets. ANON. (*Amer. Machinist*, xxxiv, 1075.)—The addition of chromium to pure iron without carbon does not give good results, according to *Génie Civil*. An alloy containing 5 to 6 per cent. of chromium with 0.75 to 1 per cent. of silicon and 0.3 to 0.5 per cent. of carbon is excellent. An alloy containing 8 per cent. of molybdenum, 0.3 per cent. of vanadium and 0.6 per cent. of carbon makes good permanent magnets, which preserve their magnetic properties above 1000° C. Alloys of tungsten and iron are useless, except one which contains 4 per cent. of tungsten and 0.4 per cent. of vanadium; this makes an excellent permanent magnet.

Plastic slate, that is to say, moldable slate, is a mixture formed by combining about 1 part of coal tar and 4 parts of slate dust and is recommended for covering large wounds in trees. This mass must be of about the consistency of a not too thick glazier's putty, so that it can be balled and rolled out in the hand. Slate dust can easily be made by crushing small pieces of slate. The mass sticks to wood, to metal, to stone, and in fact to everything that is not greasy and closes every opening air-tight. Even if applied in a very thin layer, it hardens only on the surface, remains elastic, does not chip off in winter or run in summer. It is excellent as a tightening agent for water pipes whether of wood, metal, or stone, for casks and many kinds of vessels. If the ordinary putty cracks away from the window panes of green-houses and hot frames the damage can be repaired without delay with the aid of this preparation. If extensive wounds on trees are covered with this mixture, which can best be applied by means of a knife or a flat stick, they will remain for years absolutely protected from air and moisture. The edges of the wounds heal over rapidly. If the black color is objectionable, sand, ashes, etc., can be scattered over it and pressed in.

SOME EXTRAORDINARY DENSITIES.

BY PROF. GUSTAVE MICHAUD, COSTA RICA STATE COLLEGE.

Pick up any common heavy stone, such as granite or compact limestone. Lay it at the bottom of a vessel filled with a fluid, transparent liquid. Common sense tells you that the stone will stay there. Modern

A COMMON HEAVY STONE FLOATING IN A GLASSFUL OF BROMOFORM.

chemistry tells us that, if the liquid has been selected for such a purpose, the stone will spring up to the surface as if it had been forced into mercury instead of being immersed in what seems to be water.

Liquids which are denser than glass, marble, or common stones are not numerous. Leaving aside the metals mercury and gallium, and the metalloid bromine, which is opaque, caustic, and emits suffocating vapors, the most interesting of such liquids are the aqueous solutions of the tungstoborates. Their densities reach 3.3 (saturated solution of cadmium tungstoborate). An idea of the meaning of such a number can be gathered from the fact that a man, with his shoes weighted so as to lower his center of gravity, could stand erect in such a solution with more than half of his body out of it. The chemist Klein, who studied the tungstoborates, proposed to use them for the sorting of ores and other minerals, as, in most cases, useful or precious stones only will go to the bottom of their solutions. Their price however (the saturated solution of cadmium tungstoborate is sold at two cents a gramme) will for some time to come preclude such an application.

Solid aluminium remains on the surface of such liquids. To see a metal floating over a watery fluid is however no new spectacle for the chemist, several of the rarer metals being lighter than water. The cheapest of them (80 cents a pound) is sodium. The experiment should not be made with a piece larger than a corn seed, for it is sometimes attended with unexpected explosions and projections of caustic soda. As a rule, however, the metal runs swiftly and quietly over the water while decomposing it.

Sodium is the cheapest of the extremely light metals, but it is not the lightest. Lithium, a beautiful metal of a silvery white color, is lighter than dry pine wood. Yet, from the chemical standpoint, it is more metallic in its properties than the heavy osmium, which occupies the other extreme position in the list of solid elements arranged according to their increasing densities.

Such extreme differences in density are not found among liquids, yet organic chemistry gives us two colorless, transparent liquids which so differ that a vessel filled with the lighter of them, amyl hydride or pentane, and easily carried by one man, could not be lifted by four men when filled with bromoform. The density of pentane is 0.6, that of bromoform, 2.9. Both liquids are apparently more fluid than water, and it is always amusing to watch the countenance of the unaware person who is requested to remove a glass full of bromoform from one place to another. Bromoform is sometimes prescribed by physicians against whooping cough. It is found at every drug store and costs but $1.75 a pound.

But it is with gases that the greatest divergences in density occur. Iodoform vapor, which causes the intense stench of that well-known antiseptic, is 197 times heavier than hydrogen. When some iodoform is vaporized in a porcelain dish placed over an alcohol or gas lamp, it is partially decomposed. Iodine vapor is set free, and remains mixed with iodoform vapor. As iodine vapor is itself one of the heaviest of gases, the experiment remains very beautiful. If the air is quiet, a lateral jerk given to the dish causes the layer of violet gas to oscillate heavily, just as a liquid would do in similar circumstances.

New phenomena apparatus

The "Lines" in the Magneto's Field.

A New Method of Showing Graphically the Existence and Forms of the "Lines of Force." An Apparatus for Demonstrating the Distortion of the Field in All Its Details.

By P. Okill.

In the able article entitled "How a Magneto Makes Electricity," which appeared in MoToR some few months ago, Mr. P. S. Tice has succeeded in making clear the action of a magneto. The method employed for making the illustrations used in this article, that of sprinkling fine iron fillings on glass within the influence of the magnetic field,

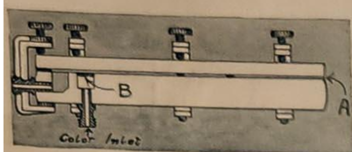

Fig. 1. Sectional elevation of the apparatus.

was largely used by Faraday in his numerous and classic researches in magnetism. While this is a popular and simple method of proving the existence of magnetic lines of force, it is also a somewhat limited method. There are other ways of tracing out magnetic lines and of showing the intensity of the field, but only in the simplest cases are these methods of any value; and such a complex and ever changing field as that existing between the poles of a magneto are beyond demonstration by any of them.

The most recent and graphical method of demonstrating the forms of the lines and the relative intensities in a magnetic field is due to Dr. H. S. Hele-Shaw, LL.D., F.R.S. This method is a very beautiful one and is largely used by modern workers in electrical research. The writer was privileged to assist in the experimental work connected with the discovery of this method, and it is hoped that a short description of the apparatus will prove of interest, in view of the article referred to above.

The Hele-Shaw method is remarkable in that no electrical power or measuring instruments of any kind are necessary for illustrat-

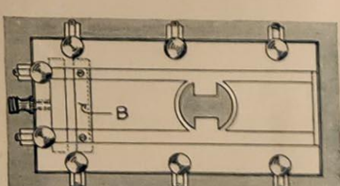

Fig. 2. The apparatus in plan.

ing the conventional lines of flow or force. The principle upon which the apparatus is based is that two dimensional cases of magnetic lines of force, those lines lying in a single plane, may be accurately represented by the flow of a thin film of viscous liquid, under certain experimental conditions.

The apparatus used is very simple, consisting as it does of two sheets of plate glass, size 10 x 5 x 1 inch and 10 x 5 x ½ inch, respectively, these plates being kept apart by a border of thin paper. A viscous liquid, such as glycerine, is caused to flow between these plates from a suitable pressure reservoir. The extreme thinness of the liquid film has the effect of destroying the inertia of the liquid particles and causes the flow to correspond exactly with the flow of theoretical stream lines in a perfect fluid. Magnetism is itself now thought of as such flow in a perfect fluid medium.

If clear liquid or one of one color is caused to flow between the plates, there will be no indication as to the path the fluid is taking. Indeed, if it were not for the stray bubbles present, we would be unable to tell whether the liquid were in motion or not. But by allowing or causing another liquid of different color to flow along with the main body of the stream, the lines of flow become at once clearly defined. In the apparatus the colored liquid is admitted to the film space between the glass plates through a series of very small holes drilled in a thin brass plate, as shown at B in Figs. 1 and 2. A chamber is formed in the glass under the strip of brass in which the holes are bored, the surface of the brass plate being flush with the top surface of the lower glass. The colored glycerine is supplied to this chamber under pressure. The construction of the apparatus is clearly shown in Figs. 1 and 2.

Fig. 3. The color streams do not mingle.

A very interesting phenomenon in connection with this experiment is that the differently colored liquids flow together as one solid stream without displaying the slightest tendency to mix with each other. This is well shown by the photograph of Fig. 3, which represents the lines of flow in a film of uniform thickness but of varying width. In this photograph the color streams have just been admitted, thus rendering the paths and forms of flow visible for a certain portion of the length. It will be observed that the colored streams have not yet reached the bottom of the film channel and that the lines of flow in this part are invisible in consequence. By graduating the thickness of the film, or the space between the glass plates, through which the liquid is flowing, to such dimensions that the resistance to the passage of the liquid correspon[illegible] to the resistance to magnetic flow in any [illegible]icular case, as through soft iron and [illegible]ir e[illegible] t[illegible] s[illegible]

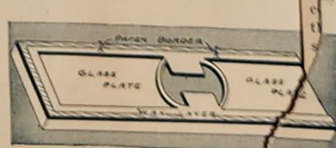

Fig. 4. How the plates are [illegible]epared.

space, many problems involving magnetic lines of flow can be solved that are otherwise incapable of solution, either by calculation or

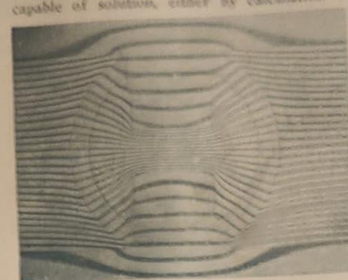

Fig. 5. How the "lines" concentrate through the armature.

any of the experimental methods involving the use of iron fillings or electrical measuring instruments*.

The variations in thickness of the liquid film for use in the apparatus in magnetic research work, as above, are obtained by coating the glass cover plate with paraffine and then accurately planing this coating down to the correct thickness, the outline desired being afterward shaped. A perspective view of a plate thus prepared is shown in Fig. 4. It will be noted that this plate, Fig. 4, represents the relationship of the magneto pole pieces and the armature when the latter is in the position of zero inductance. The stream lines obtained with this plate in the apparatus are shown in Fig. 5. It will be noted that most of the lines concentrate and pass through the core of the armature, the remainder being so located that they are not cut by the winding. It should be pointed out that the lines here shown define the courses actually taken by the real magnetic lines.

In Fig. 6 the armature is nearing its maximum position and the winding is now cutting the lines at an ever increasing rate. The lines are shown in this view as moving across the winding so that when the armature is in

Fig. 6. Distortion of the "lines" just before maximum inductance.

a vertical position equal numbers of lines will pass through the curved end pieces of the armature, this latter position being that of maximum inductance, neglecting lag. For demonstrating purposes as before a class of automobile students a series of lantern slides showing the distribution of the lines for a complete revolution of the armature, obtained by the above method, is most useful and instructive.

*Royal Society Philosophical Transactions, Vol. 195.

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Density of Aluminum. F. J. BISLEE. (*Faraday Soc.*, May 7, 1913.)—The density of aluminum varies considerably, according to the previous treatment, and under certain conditions the density of the cast metal may exceed that of the worked metal, though the density of the worked metal increases again on annealing. The worked metal etched with hydrofluoric acid shows under the micro-

To Attach Celluloid to Metal.—The best adhesive for celluloid to metal is, according to experience, 98 per cent acetic acid. It is, however, advisable to immerse the celluloid articles for about 30 seconds in the acid and then, when the upper stratum is somewhat dissolved, to press it on the metal, and, if possible, to subject it for a time to a light pressure. If, however, we wish to make perfectly sure, mix the acetic acid with some celluloid shavings so that a mixture of about the consistency of mucilage is obtained; this insures the closest adhesion of the two substances.

Insoluble Adhesive for Envelopes and Postage Stamps.—Two solutions are required, one to be applied to the inside of the flap of the envelopes, one to the part of the envelope to which this is to stick. The latter solution (which must not be moistened with the tongue) consists of 30 parts of crystallized chromic acid dissolved in 15.5 parts of water and about 15.5 parts of strong ammonia with about 10 drops of sulphuric acid. 31 parts of cupric oxide of ammonia and 4 parts of fine white paper added. First solution: Dissolve isinglass in acetic acid (1 part acid to 7 parts water) at 212 deg. F.

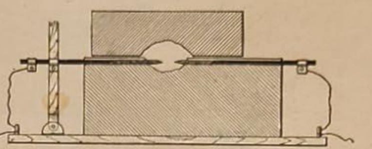
Polish for Pressed Brass Goods.—Substances of a slimy character that are not actually fats, are better suited than soap and are more easily removed from the finished goods. Water and ox-gall, boiled together in equal parts, furnish an excellent polishing material. After cooling, this fluid may be corked up in bottles and when needed used in a glass or porcelain dish. It should be applied with a small brush and the burnishing tool may also be dipped in it. Brass articles can also be brilliantly polished with a mixture of ½ pint of buttermilk and a tablespoonful of common salt. Soak a rag in the mixture and vigorously polish the object. Afterward dry it off and the article will look like new.

A SMALL ELECTRIC FURNACE.

BY A. E. PARKINS.

The accompanying cut shows the cross section of a small electric furnace made from a description of th Moissan furnace. In this one the brick and lime cavity are replaced by a block of limestone about 5 x 5 x 9 inches. In the top face of the base is hewn a cavity about 1 x 1 x 2 inches, also two longitudinal grooves to receive the carbon electrodes.

The cover is a similar stone with a cavity hewn in its lower face. Both base and cover should be bound with a piece of sheet iron or tin to keep the pieces in place should the heat be great enough to crack the stones. The carbons are regulated by means of the vertical lever, hinged at the base and attached to the carbon by means of a clamp. This clamp is attached to the lever at one place only. This allows



A SMALL ELECTRIC FURNACE.

sufficient horizontal movement. The electrodes are connected to a lantern circuit (alternating current 212 volts) by means of clamps. These clamps and other metal work are made from sheet aluminium—easy to cut and easy to shape. The bolts used are short stove bolts.

In such a contrivance calcium carbide, calcium phosphate, phosphorus, brass, and alloys are easily prepared.

Calcium carbide requires intense heat; the cavity should be small. Gas carbon or powdered arc light carbon is best to use.

Calcium phosphide is prepared by heating calcium oxide, carbon, and red phosphorus. The phosphorus is placed in first, in small quantities; this is covered by the other ingredients, well mixed and pulverized. Some kinds of animal charcoal and calcium oxide will produce calcium phosphide.

Phosphorus is prepared as directed in Newell by heating a phosphate, charcoal, and sand. Phosphorus is separated and burns at the top. It sometimes sublimes on the faces of the stones and bursts into flame when the cover is lifted. The glass-like slag remains in the furnace. This is exceedingly hot. Pieces of porcelain are easily melted when pushed into this plastic mass.

Brass is easily made by heating zinc and copper. The stones may be obtained from the refuse heap at a stone cutter's. The corner of an old ax will prove a good instrument for cutting the grooves and cavities.—School Science and Mathematics.

Casts Made with the Electric Arc

By G. Worts

Owing to the great amount of heat that is developed in any form of the electric arc, it has been commercially adapted for a number of devices where excessive heat is necessary. In cutting metals in manufacturing silicon and such products, it is found invaluable. A method is suggested below for making small casts in which the electric arc is used as the heat source. Casts in brass, zinc, aluminium, silver, gold, etc., can be

Making a cast with the electric arc

made. Preparations for the casting should be made in the ordinary manner. Form the mold of sand or plaster as advisable, and then over the pour hole place a tablet or slab of carbon about ¼ inch thick. This should have a round tapering hole, the small end of which opens above the pour hole of the mold. A terminal should be bolted to one side of the carbon slab and lead to the current source through a series of heavy resistances. The carbon slab comprises one electrode of the arc, the other being a ⅜-inch hard round carbon fitted with a fiber or wood handle.

A small block of the metal to be melted is placed in the depression of the carbon surface, and touched by the other electrode to form an arc. The metal will flow into the mold quickly, dependent on the amount of current supplied to the arc. Casts obtained by this method are very smooth and regular. It is necessary to wear a hood fitted with dense blue lenses, or the fumes and dazzling light will prove detrimental to the operator's lungs and eyesight.

Memoranda in Glass.—A reader tells us that with the use of gum tragacanth, allowing a week for drying, two sheets of glass can be joined with a sheet of paper between them, without the slightest staining of the paper. It is suggested that this provides a new and useful means of making paperweights and other glass articles with calendars, etc., embedded in them. The gum, while still wet, appears to have stained the paper; but every trace of this disappears as the drying out proceeds.

A NEW PHONOGRAPH.

COMPRESSED AIR USED IN CYLINDERS FOR REPRODUCING SOUNDS.

In a siren, openings of various sizes allow the production of all musical notes with any desired degree of intensity or length. In the new instrument, perforations in the disk of a siren are replaced by tangential incisions on the surface of a large record cylinder. A second perfectly smooth cylinder rests close upon the surface of the first cylinder and revolves in unison with it as the two cylinders are set in movement. A constantly varying succession of minute openings between their surfaces is presented, due to the incisions on the record cylinder. When a powerful blast of compressed air is directed upon the line of contact between the two cylinders, at such an angle as to be an exact tangent to the surfaces of both, sounds are evoked identically as in the case of an ordinary siren. It is possible to communicate signals and even words which can be readily heard miles away.

It is already evident that a field of usefulness is open to this new invention as an adjunct to the equipment of seagoing vessels. Its availability for musical purposes has not yet been tested sufficiently to determine whether it can successfully vie with the gramophone, phonograph, etc., or even replace them.

... will serve all purposes that

... might very ... prophecy.

MAKING MILK ARTIFICIALLY.

BY A. J. JARMAN.

We have heard so much about the synthetic production of perfumes, syrups, dyes, and what not, from coal-tar products, that we are not easily surprised by the information that milk may be artificially made. The method described below, however, is not a chemical one, but consists merely in the mechanical admixture of distilled water with crushed and finely ground sweet almonds. Practically the only difference between cow's milk and that made of almonds is that cow's milk contains animal casein, while the artificial milk contains vegetable casein. The latter will produce a good supply of cream, and if allowed to stand some time will become sour. It may also be coagulated by the addition of vinegar or acetic acid. When combined with grape sugar, it is capable of generating some extraordinary organic substances. The artificial milk may be used with tea and coffee in the same way that cow's milk is used.

To make the milk, procure half a pound of sweet almonds—the Valencia, which is cheaper than the Jordan almond, will give just as good results. The skin of the almonds may be removed by scalding the nuts in boiling water, and peeling them with a sharp knife. The almonds should then be placed in a wooden chopping bowl and chopped as finely as possible. Take about two ounces of the chopped almonds, and place them in a mortar with a small quantity of distilled

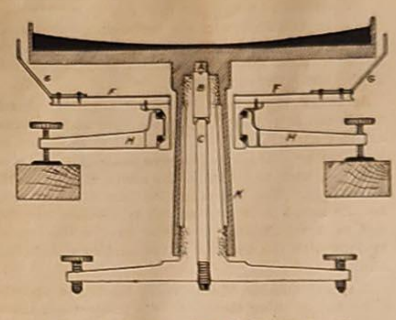


Fig. 1.—Construction of the instrument.

Rotating mercury mirror

the ceiling retreating to a great height, and the walls

Chopping the almonds.

Grinding the almonds in water.

Filtering the almond milk.

MAKING MILK ARTIFICIALLY

water. Then grind or levigate the chopped almonds, adding water occasionally, until about twelve ounces of water have been used. The longer the grinding is continued, the thicker and richer will the milk be. Now take a piece of cheese cloth about 12 inches wide by 24 inches long and rinse it in clean water, and after wringing it as dry as possible, fold it double over the top of a pitcher, and pour the contents of the mortar through the cloth into the pitcher. The milk

Development After Fixation. (*P. J. A.*)—The following is important in this connection, as it refers to a discovery made about twenty years ago by Professor F. E. Nipher, of Washington University, St. Louis, Mo. In 1901, he published in the Transactions of the St. Louis Academy of Sciences the results of experiments on very long overexposure. Giving, for instance, plates that required only a fraction of a second, several hours' exposure, necessarily to a fixed object, he found that not only was the picture reversed, a fact already known, in a general way, but the development could be made in full light; in fact, must be so made for if developed in darkness the plate will fog. Nipher's experiments were repeated a few months later by members of the Photographic Section of The Franklin Institute, Philadelphia, and the results were exactly as had been described. A rapid plate, which had been given four and one-half hours' exposure, was passed around a lighted room for the examination of those present, and then developed in front of a sixteen-candlepower electric light, while another plate similarly exposed, but which had been developed in the dark-room, was fogged. The plate developed in the light, on being fixed, came out as a perfectly clear positive.

The easiest way to get proper silvering solution is to go down to the mirror maker's with the flasks that need the coating. The solution can be purchased for a trifle. The following formula will do very well: A. Rochelle salt 10 grammes in 1 liter of water. B. Silver nitrate 5 grammes dissolved in a little water. Add 3 grammes of strong ammonia gradually, so that the precipitate at first formed is dissolved. Add water enough to make 1 liter. Mix equal parts of A and B. The glass ought to be perfectly clean and at a temperature of 25 deg. or 30 deg. C. In about half an hour the deposit is complete.

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Making Trees Preserve Themselves

NOWADAYS it is deemed of great importance that wood, especially for shipbuilding, the making of fine furniture and other purposes demanding the preservation of the integrity of the material, shall be rendered proof against decay. With this end in view, logs, destined to be cut into lumber for such uses, are commonly saturated with creosote, zinc chloride or other preservatives.

Such preservatives are fungus-killers. For the decay of wood is always caused by fungi of one kind or another—as, for example, the species which engender dry rot.

Recently, however, a method has been discovered whereby timber can be made rot-proof before it is cut down in the forest, and even while the trees are still alive. Very dilute solutions of zinc chloride or copper sulphate are introduced into holes bored to some depth in their trunks—the solution employed being contained in a tank elevated at a considerable height above the point of entrance, in order to give the requisite pressure.

The first experiments in this line were not at all successful. But it was found that they succeeded perfectly when the treatment was applied at the proper season of the year. In late summer the evaporation from the foliage of a tree is at a maximum, the result being that a partial vacuum exists in all the vessels of the great plant. If, at this period, a fungus-killing solution be introduced, it is automatically forced by atmospheric pressure into all parts of the tree, including even the roots, the highest twigs and the heart-wood itself.

By the ingenious means described the tree itself is compelled to carry, through its circulatory vessels, the preserving agent to all parts of its anatomical structure. Thus, when the tree, after such treatment, is cut down it is already fungus-proof, and the lumber cut from it (no matter what the use to which it is put) requires no further application of chemical preservatives in order to render it immune to attack by the organisms that cause decay.

(14049) F. K. J. asks: How many types of detectors are there in common use and

According to Concrete a separate unit type of reinforced concrete wall construction was used last year in building the power-house of a small hydro-electric plant at Newton Falls, Ohio. The pilasters are of monolithic concrete, while the walls between them are hollow and are built of inside and outside thin concrete slabs, which were set before the pilasters were poured, so as to be keyed into them. The slabs were reinforced with No. 28 gage expanded metal, and were made in sizes that could be handled conveniently. Their outer surfaces were corrugated by laying ⅝-inch round rods in parallel lines on the surface of the fresh concrete when the slabs were cast and pulling them out after the mixture had taken its initial set. These corrugations were designed to give a good bonding surface for the plaster coat which was applied to the walls after they had been erected. The slabs were allowed to cure and were then placed on edge in proper position. Vertical form boards were placed for the pilasters, extending beyond the surface for the monolithic work, so that the slabs rested against them. The inside faces of the pilasters were molded against form boards placed in the air space between the wall slabs, and were wired to the outside forms after the pilaster reinforcement had been placed. The inside boards also acted as spaces to keep the slabs the proper distance apart. This distance varied somewhat, but 8 inches was the minimum.

CONSTRUCTION OF A SELENIUM CELL.

BY J. CARLTON PAULMIER.

The materials required for the construction of a selenium cell are as follows: Twelve feet of spring brass ½ inch wide, 1/16 inch thick, two small machine screws, two 3-inch bolts and nuts, a piece of thin mica 6 x 12 inches, ¼ ounce of selenium, a small piece of thin board, some wood screws, and a piece of glass about 3 x 3 inches.

From the brass cut 40 pieces 3 inches long, and drill a hole to take the bolts, ⅛ inch from one end. Also make up 39 washers by cutting pieces ½ inch long and drilling holes in the center. From the mica cut 39 pieces 2¼ inches long by ⅝ inch wide. Take half the brass strips, place a washer between each, pass a bolt through the holes in the ends, and screw up the nut. Do the same with the rest of the strips, and you have two sections of the cell.

Now slide one section into the other, tighten up the nuts, and place in a vise. File down and polish the edges of the strips so as to form a perfectly smooth surface on one side.

Next separate the two sections again, place a piece of the mica between each strip, so as to insulate one section from the other, then assemble as before, being careful to get the top surface perfectly level and smooth.

Take another piece of the brass, 4½ inches long; ½ inch from each end drill and tap a hole to take the machine screws, and bend up ¾ inch of each end. Use this piece to clamp the two sections together in the center, being careful to insulate it from them. After making sure that the sections are properly insulated from each other, the selenium may be applied as follows: Hold the brass over a flame until the selenium melts freely, then rub the stick of selenium over the polished surface. If the brass is hot enough the selenium will adhere readily, but if too hot it will burn off. After applying the selenium, and while it is still soft, pass a knife blade lightly over the surface. This removes the surplus selenium, and leaves a thin smooth coating.

Now bake the cell in an oven for one hour, having the temperature just below the melting point of the selenium. Then take out and allow to cool in the open air.

Make a box with a glass cover, and wedge the cell in this with small pieces of wood. Fasten two binding posts in one end, and connect each binding post to one of the sections. The cell is now complete.

The advantages of this type of cell are that it is easy to get the top surface of the brass strips perfectly smooth; and as the insulation is of mica, there is no danger of burning it and thus spoiling the cell. It is not necessary to tin the edges of the brass strips, and it is better not to do so, as the solder used in tinning is apt to melt and run between the strips, short-circuiting the cell.

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Coming now to true synthetic rubber; a question often asked is whether there exists any probability of such an article being manufactured and displacing natural rubber, either wholly or to any large extent. Will rubber plantations go the way of madder fields and indigo cultivation? Well, the future is on the knees of the gods. In the face of the precedents just mentioned, to say nothing of others, he would be a bold man who would venture to say that even the best quality of rubber may not some day be made on a commercial scale from cheaper materials such as beet sugar and calcium carbide. But the day is not yet. There are beginnings; there are clear indications of the direction in which to proceed; there is distinct progress to note. But there is still some distance to go, and the end of the journey may not be even in sight.

India-rubber chemically is essentially a polymerized terpene. An article patented some time ago, and named "turpentine rubber," appears to foreshadow a synthesis of true rubber. Turpentine is a mixture of terpenes, and the article in question was to be obtained by passing turpentine through a hot tube, and treating the resulting vapors with hydrochloric acid. The result is a solid condensation-product; and the idea at the base of the process appears to be the production of polymerized terpenes having some of the elastic properties of rubber.

A more promising, because a more scientific way, is that outlined in Heinemann's patent No. 21,772 of 1907. Here a true synthesis is attempted. It is based upon the well-known fact that rubber is probably a polymer of the semi-terpene isoprene. The first step is the production of the unsaturated hydrocarbon divinyl, CH_2: CH.CH: CH_2. This is obtained by passing mixed acetylene and ethylene gases through a heated tube. With methyl chloride, divinyl yields isoprene [methyl divinyl, CH_2: $C(CH_3)$.CH: CH_2]; and the isoprene on treatment with strong hydrochloric acid is converted by a union of molecules into a substance closely resembling caoutchouc, if not identical with it. The raw materials, so to speak, are thus acetylene, ethylene, and methyl chloride, which are themselves obtained by any of the ordinary methods, e. g. from calcium carbide, alcohol, and beet sugar residues respectively.

The question is, can this or some other comparatively simple synthesis, theoretically quite possible as a laboratory operation, be translated into a practicable and profitable mode of manufacture on a large scale? One of the first doubts to arise is whether the synthesized caoutchouc will have the physical properties of natural rubber; or whether these, by any course of treatment, can be imparted to it. This doubt resolved, there comes the question of economical production in competition with the natural product. Much time and thought have been spent on the problem of synthetic rubber, and it is safe to conclude that there will yet be many a headache before it is solved. Judging by what is known to have been done rather than by the promises, rubber planters may for the present sleep peacefully in their beds.—Nature.

Alcohol briquettes are small tin boxes, filled with a yellowish combustible mass, that can be used like a spirit lamp. The flame is simply extinguished by replacing the lid; the contents can thus be preserved for any length of time, until exhausted. The dough-like substance that forms the filling of the boxes, is easily prepared and is made as follows: In a vessel of sufficient size, 1,000 parts of alcohol are heated in the water bath. As a rule, denatured alcohol is used. When the fluid has a temperature of 140 deg. F., 30 parts of grated and dried Venetian soap and 2 parts of gum lac are added. The fluid is then stirred until the substances added are completely dissolved and the mixture is then poured into the boxes, which are at once closed. On cooling the mixture solidifies.

Peroxids are sources of active oxygen. Oxone is a product which is formed by fusing certain peroxids, preferably the peroxid of sodium, which is then capable of generating oxygen gas in the presence of carbon dioxid and moisture. While sodium peroxid in the form of powder when dissolved in water, only gives forth the oxygen in its atomic state, the fused peroxid by heat of disassociation in the instant of solution drives out all available oxygen. It is for the purpose of preparing this fused peroxid of sodium, which I have named "oxone" that I have devised the process and apparatus herewith described and illustrated.

of electricity on its own account. After enough peroxid is melted to form a bath which will carry electricity in sufficient quantities to make oxone, the resistance 11 may be dispensed with, the peroxid simply being sifted in as it is needed. The current is kept on about half an hour and the peroxid is raised to a temperature of from 710 to 718 degrees.

Peroxid begins to melt at about 700 degrees F. and when the temperature is raised between 710 and 717 degrees the carbonic acid gas contained therein is thrown off. From 720 to 730 degrees the peroxid throws off its oxygen. It is for this reason that the temperature of the peroxid should be kept somewhere between 710 and 718 degrees and that it should never be raised to such a point that the peroxid boils. The exact heat required would depend upon the condition of the peroxid. If the peroxid is soft and floury, a higher degree of heat is necessary than if the peroxid is hard.

When the peroxid has reached the proper degree of heat and is uniformly melted so that it can flow easily, the melting pot is then tipped by depressing the lever 6 and the molten material passes out into the molds, as the latter are rotated. As the oxone is in contact with the upper face of the water jacketed table, it will in a short time solidify sufficiently so that the cake will drop through the opening 16 of the table.

Oxone, the product of the above described method and apparatus, is solid, easily transportable, and conveniently handled. One pound of oxone furnishes about 2.15 cubic feet of oxygen gas. "Oxone" has small volume and the oxygen gas given off thereby equals three hundred and twelve times the volume of the oxone itself. It may be used in medical practice, for regenerating the air in submarine vessels, or for any purpose for which oxygen itself may be used.

(14054) C. E. E. asks: If a body of water at a temperature of 40° were absolutely confined in an unbreakable vessel, and the temperature lowered indefinitely, would the pressure caused by the crowding of the molecules lower the freezing point sufficiently to keep the liquid from crystallizing? A. Water cannot freeze unless it can expand, and if ice is compressed to the volume which the water had before it froze it will turn back to water. Ice can be melted by pressure only at a temperature lower than 32 degrees Fahr. The experiment has been performed many times. This is expressed in the books by saying that the freezing point of water is lowered by pressure. This is true of very few materials. Most substances have their freezing points raised by pressure and melting is prevented by pressure.

TRADE NOTES AND FORMULÆ.

To Color White Enamel.—This may be effected with the following: Blue: 94 parts white enamel, 6 parts oxide of cobalt. Violet: 95 parts of white enamel, 5 parts manganese. Yellow: 91 parts white enamel, 5 parts Naples yellow. Green: 95 parts white enamel, 5 parts oxide of copper. Pistache green: 92 parts white enamel, 5 parts oxide of copper, 2 parts Naples yellow.

Leonhardi Ink Tablets.—42 parts Aleppo gall nuts and 3 parts of Dutch madder are extracted with a sufficient quantity of warm water; this fluid is then filtered. Dissolve in it 5½ parts of green vitriol and add 2 parts of pyrolignite of iron and 1¼ parts of indigo solution. The mixture is evaporated to dryness at moderate heat and made up into tablets of convenient size. One part by weight of these tablets, dissolved in 6 parts of hot water, gives an excellent writing and copying ink.

Beerit is a material discovered by Sculptor Beer in Paris for the production of castings of the smallest and also of the largest dimensions, the outlines and tracing displaying, in both cases, a sharpness never obtainable with plaster. The casting, in about three hours after being run into the mold, is perfectly hard and complete and but seldom requires working over. Beerit is said to be composed of 100 parts of marble dust, 10 to 25 parts of pulverized glass, and 5 to 10 parts of pulverized, screened lime, mixed with water glass.

A New Paint for Wooden Posts.—Take 50 parts of rosin, 40 parts of finely crushed chalk, 500 parts of fine white and sharp sand, 4 parts linseed oil, 1 part natural red oxide of copper, and 1 part of sulphuric acid. First heat the rosin, the chalk, the sand and the linseed oil in an iron kettle, then add the oxide and carefully introduce the sulphuric acid. Mix all very carefully and apply to the wood, while still hot, with the aid of a stiff brush. If the mixture does not appear to be thin enough, dilute it with some linseed oil. When this coat is cooled and dried it forms a covering as hard as stone, that no moisture will penetrate.

Belt Cement.—I. 5 parts of sulphide of carbon and half a part of oil of turpentine are mixed and therein gradually enough gutta percha dissolved to give the mass a paste-like appearance. The leather parts must then be freed from grease by placing a clean rag on the surface of the leather and standing a hot iron on it. Then both pieces are coated with the cement and exposed to pressure until it has dried. II. Dissolve 1,000 parts of good joiners' glue in 1,500 parts of water, concentrate to syrupy consistency and stir thoroughly into the hot mass 100 parts of Venice turpentine and 5 parts of carbolic acid. After cooling, we have a thick mass, which is cut into cakes ¼ of an inch thick and dried on tin saucers. In two days it is dry and can be placed on the market. The cement is applied to the beveled ends of the leather (belt) after it has been liquefied by the addition of a little vinegar, with the aid of a brush. Then the two ends are subjected to pressure for a quarter of an hour between two iron plates, heated to 87 deg. F. After this process the cemented leather holds securely and cannot be torn apart; it would sooner tear in a fresh place. III. Equal parts of good glue, made from skin trimmings and fish-glue, is softened for 10 hours in water and then boiled with pure tannin, until a uniform, adhesive mass is obtained. The surfaces to be cemented are combed and the cement applied hot. IV. 1 part of finely cut gutta percha is dissolved in the water bath in 10 parts of benzole, then 2 parts of linseed oil varnish stirred into it. V. 1.5 parts of fine cut caoutchouc is dissolved in 10 parts of sulphide of carbon, with application of heat, and 1 part of shellac and 1 part of turpentine added to the solution. The heating must be continued until all the shellac is melted.

A novel galvanic cell has recently been invented, which generates an alternating current. The electrodes of this cell are thin sheets of iron, and the electrolyte is a mixture of equal volumes of a two per cent sulphuric acid solution and a saturated bichromate solution. This cell deflects the needle of the voltmeter to each side of the zero position every five or ten seconds, the voltage indicated being plus 0.4 volt and minus 0.4 volt. This action is kept up for hours.

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SIMPLE LABORATORY THERMOSTAT.

BY GEORGE A. JAMES.

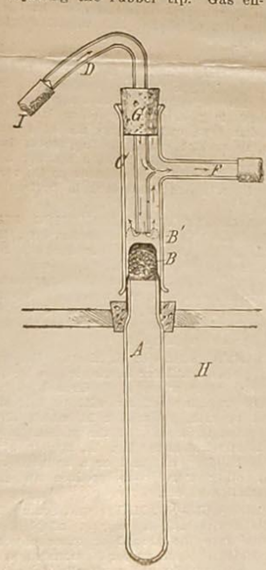
The accompanying drawing shows how a simple and yet accurate laboratory thermostat may be made at home. It comprises two tubes, *A* and *C*, which are formed out of test tubes twelve millimeters (½-inch) in diameter. The tube *A* is heated until, by melting, it contracts sufficiently to enter the other tube a distance of about two centimeters (¾ inch). It should fit this tube snugly when covered with a rubber finger-cot *B*. The value of the apparatus depends on this detail. The finger-cot is of the thinnest quality, such as is used by surgeons, and the smallest size obtainable should be selected, so that it will fit tightly over the end of the tube *A*. In order to insure a gas-tight joint, it will be well to wrap the cot *B* below the point where it enters the tube *C*. I find a thin rubber band stretched and doubled repeatedly over the part insures a tight fit. Before covering it is well to see that the tube is dry inside. I place mine in a desiccator before covering.

The glass blowing of part *C* is not beyond the ability of most chemists, and although it is best to make this part compact, the length has no particular importance. Three inches is about right.

The bent tube *D* is passed through cork *C* and must fit snugly, although not too tightly to prevent slipping up or down. It is then bent as in the drawing and the small teat (or by-pass) is blown on one side. This should have a minute opening (about the size of a small brass pin). The part *A* enters the space, or liquid, the temperature of which is to be controlled, through a cork of sufficient size to prevent the heat from injuring the rubber tip. Gas enters at *I*, passes through *D* and out at *F* to the burner used to heat apparatus *H*.

When heat of *H* reaches the desired degree, the tube D is pressed down on the nipple *B* until only gas passing through the by-pass *E* enters the burner. As the temperature of apparatus decreases, the air in *A* contracts and nipple *B* recedes from the end of tube *D*, increasing the supply of gas to burner, and restoring the desired temperature.

The object of the by-pass *E* is to prevent the total extinguishing of gas flame.



HOME-MADE THERMOSTAT.

There are four ...ays of control... g the thermostat. ...st, by the distance of tube from the rubber nipple. ...ond, by the distance the part *A* enters the heat. Third, by the gas cock regulating the supply ...as. Fourth, by the nearness of flame to the ap... is heated.

... apparatus, when made of glass, will control ...atures within two degrees in a comparatively ... volume of heated air or liquid, but if metal ...per, or silver) is substituted, or the tube *A* ... in the form of a box with larger volume, it ...bviously permit almost any degree of sensi...

GEO. A. JAMES.

A clear solution of shellac in alcohol, with an addition of picric acid and 1 per cent of boracic acid, makes a gold varnish that produces a fine hard surface and brilliant finish on metals.

24/1

Molten Iron Not Magnetic. (*Brass World*, viii, 4, 126.)—When red hot, iron is not magnetic, but becomes so when it falls to a black heat. Hence, iron can not be removed from molten metals by means of a magnet.

To Etch Names, Figures, etc., on Steel. E. (*Elektrochem. Zeit.*, xviii, 145.)—The surface is first covered with a carefully-prepared mixture of two parts of powdered asphalt, one part rosin, one and one-half parts wax, and a little tallow. Of this a very thin coating is put on the surface to be etched, and after inscribing the design the etching is done by nitric acid, acetic acid, or tartaric acid.

TRADE NOTES AND FORMULÆ.

Tectorium, a Substitute for Glass.—This material is prepared by applying a varnish to a finely-meshed iron-wire fabric. The varnish consists principally of good linseed oil, in which the vertically hanging wire fabric is repeatedly dipped up to as many as twelve times. After each dipping, the thin layer of oil is dried in warm air. The fabric thus obtained is exceedingly flexible, strong, impermeable, and very well adapted for skylights, greenhouses, etc.

Temperature Indicated by Paint.—According to Töllner, 100 parts each of iodide of mercury and iodide of copper are carefully rubbed down with sufficient distilled water to produce a spreadable paste. The color of this combination, at ordinary temperature, is red; at about 140 deg. F. it turns black but goes back to its red color on cooling. It is admirably adapted to show the heating of machine parts in inaccessible places.

Stamping Color for Linen.—10 parts each of pulverized dragon's blood gum and pulverized nitrate of silver are moistened through with a few drops of distilled water and the mixture increased by the addition of 10 parts of white dextrine and enough glycerine to give the mass the consistency of good printers' ink. The rubber stamps to be used should be rubbed off, before use, with a few drops of sweet almond oil. The color dries quickly and stands washing well. The color should be rubbed on pieces of velvet for transfering.

Terra cotta wood is made as follows: Mix, according to the degree of porosity it is desired to obtain, 1 to 2 parts of sawdust of highly resinous wood, with 1 part of washed kaolin and prepare from this, adding the necessary quantity of water, a plastic mass of spongy consistency, which is exposed, in metal cylinders, to heavy pressure by steel stamps. This produces cylindrical blocks of 8 to 12 inches diameter and 48 to 52 inches in length. They are first air-dried, then dried in a stove and finally placed in a kiln, where they are subjected to a white heat. The blocks, after cooling slowly, are said to be exceedingly durable and to be susceptible of sawing, cutting, planing, milling, and polishing. Their density is about one-half that of common brick. A special feature of the mass is its solidity. This wood is used with excellent results for building purposes.

To use this generator make a half round tray of thin sheet iron that will just fit inside of the retort, and fill it with a mixture composed of one part manganese dioxide and three parts potassium chlorate. Put the tray inside of the retort and bolt the end plates in place and light the burner. See that the scrubber 3 is filled with water

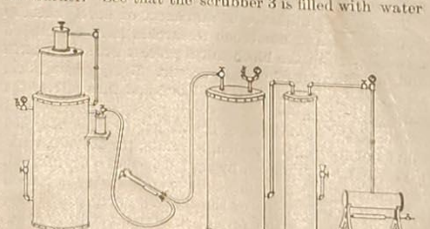
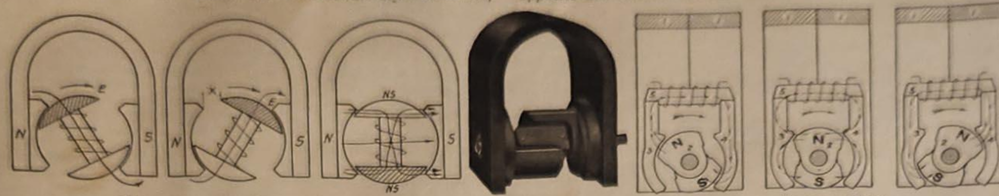


Fig. 4.—Complete apparatus.

Exterminating Rats

A REPORT from M. de Kruyff of the Dutch Agricultural Bureau at Buitenzorg, Java, points the way to real success in rat killing. He tried the modern method of giving a contagious disease to one rat in the hope that all would die. This proved useless. Finally, de Kruyff hit upon a novel use of carbon disulphide. All visible rat holes were first stopped with earth to ascertain which holes were inhabited, for the inhabited holes were found reopened on the following day. Half a teaspoonful of carbon disulphide was poured in each of these holes and, after waiting a few seconds to allow the liquid to evaporate, the mixture of vapor and air was ignited. The resulting small explosion filled the hole with poisonous gases and killed all the rats almost instantly.

ded detail ... to make ... nt function better. It ... be both north and south at once. Flux then flows across the ends of the armature, ... pieces in rotating. These lobes are opposite one another on the shaft, just ... while the latest wrinkle ... power by gearing down



Three stages in the working cycle of the armature magneto (left) and of the rotary-pole type (right); and the general arrangement of the latter (center)

'20's, who resigned be- ... and in both directions through its shank ... ture ends in the older type

(3) Its heat capacity should be small, so that as the resistance drops the increase in current, even though a very small one, passing through the thermoscope tends to heat it, and thus greatly increases the sensitiveness of the detector as the critical temperature is approached.

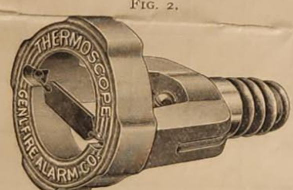
(4) Its characteristics should be permanent under all conditions to which it is apt to be exposed.

One of the best of the substances which have been found for this purpose, and to which Mr. Garretson applies the general name *thermitite*, is a preparation of silver sulphide.

ELECTRICAL PROPERTIES OF THERMITITE.

Before considering the properties of *thermitite* as investigated in this laboratory it will be well to describe the thermo-

FIG. 2.



Thermoscope.

scopes as made for use in practice, as most of the tests which will be described were made with these. In Fig. 2 we have a cut showing a thermoscope, actual size. The mount is made of glazed porcelain and carries a threaded brass shell which screws into a socket just as in the case of an ordinary incandescent lamp. The *thermitite* strip has copper wires fused to its ends, and these are soldered to the contacts.

If one of these thermoscopes is put in a circuit with a small volt tungsten lamp and three dry cells connected in series lamp will not light up; but if a lighted match is held under *thermitite* the lamp almost instantly begins to glow with full -power. If the match is removed and the piece of *ther-* cooled in any way the lamp is extinguished.

After 800 heatings and quenchings, the block of steel shown at the left had developed the shape at the right, passing through the central stage

Rings Bell if Water is Found in Gas

A DEVICE which gives an alarm if the presence of a minute trace of water vapor is detected in a gas, has been recently developed by the Gas Chemistry Section of the National Bureau of Standards. The apparatus depends upon the electrical conductivity of a film made of a substance highly sensitive in revealing the moisture in the atmosphere. For example, phosphoric acid was employed, which as long as it is wet has a high conductivity but as it dries it is deprived of its conductivity. The new water indicator operates under the principle of keeping this at a constant temperature, and the device is made part of a circuit to ring a bell or operate some other signal.

Magazine.

Removing Rust by Electricity

AN electrolytic process of deoxidation has been patented in the United States. The object to be treated is made the cathode in an electrolyte containing phosphoric acid. In addition to its normal function of carrying the current, this acid acts as a solvent upon rust without attacking the steel or iron body beneath. It is in this last detail that its chief availability lies, since nitric, sulphuric, or hydrochloric acids would not display such moderation. Finally, the phosphoric acid is beneficial in preventing subsequent further rusting. The electrolyte is made by adding 10 parts of phosphoric acid to 90 parts of water, or by adding 10 per cent of the acid to a 10 per cent solution of sodium phosphate. A temperature between 50° and 70° C., is recommended.

Aircraft Dope

FOR some time "dopes" made from cellulose acetate have had the preference for coating fabric used in aircraft production. It is more expensive than materials composed of cellulose nitrate since in their manufacture acetic acid and acetic anhydride are required and these raw materials are more expensive than those employed in the nitration of cellulose. However, the acetate is fire resistant or slow burning and that has given it a decided advantage. It has now been found that some five to eight per cent of ammonium magnesium sulfate when added to the nitrate makes it fire resistant, since when ignited a quantity of ammonia gas is given off extinguishing the flame.

Some Startling Electrical Phenomena with New Form of Vacuum Tube

(Continued from page 579)

nickel, there is an increase in resistance only when the nickel is made positive, but not when it is negative.

It is known that glass at or near its melting point becomes a good conductor. This property of becoming strongly conductive when heated to a semi-fluid state is probably shared by all other so-called dielectrics, but it is obvious that it would be absolutely impossible to operate a vacuum tube at such a temperature. The glass walls of the tube would collapse at about 425 degrees C. The glass will not, however, attain red heat until heated to about 600 degrees C. Electrolytic conduction of glass is observed at far lower temperatures than these. In actual operation the temperature of this electron tube never exceeds 140 degrees C.

A freezing-mixture of three parts of calcium chloride to two parts of snow will produce a temperature of 55 degrees below zero Centigrade, which is much below the freezing point of mercury.

Pinch-effect Steel Furnace. A. L. Queneau. (*Amer. Electrochem. Soc.*, xvii, 131.)—The pinch-effect is turned to useful account. The fused metal fills the bath of the furnace and two legs extending downward from it, slightly inclined outward. Electrodes are inserted at the bottom of these legs, and a large electrode is suspended above the bath. The metal in the legs is subjected to the hydrostatic pressure of the fused steel above it, and the current is so proportioned that a series of pulsations is set up leading to disruption and re-establishment of the continuity of the molten metal. The experimental furnace takes charges of 225 kg. C. A. Hansen considered any encouragement of the pinch-effect dangerous and thought the lining of the legs of magnesia and pitch would not last, as it became cheesy at steel-bath temperatures. Alundum too, was unsuitable for a lining.

A Good Waterproof Glue. (*Amer. Mach.*, xxxiii, 742.)—This is made as follows:

India rubber .... 1 part
Mineral naphtha or coal tar .... 12 parts

heat gently and mix and add

Powdered shellac .... 20 parts

Pour on a slab to cool; when used heat to 250° F.

A Laboratory Furnace for Very High Temperatures. D. F. Calhane. (*Met. and Chem. Eng.*, viii, 581.)—This convenient and inexpensive furnace, of the electrical resistance type, consists of a small, vertical fire-clay muffle, standing within an enclosure formed of four firebricks, the space between the muffle and the bricks is filled with a mixture of Portland cement, magnesium oxide and asbestos. At the bottom of the muffle there is an alundum block on which rests a graphite crucible 2 inches high. The space between the crucible and the muffle is filled with carbon powder, which forms the resistance. A ring of carbon fits flush at the bottom of the muffle and a second ring is provided just above the top of the crucible. The current enters at the bottom, where it is evenly distributed by the ring and leaves at the top ring. To concentrate the heat on the walls of the crucible, an alundum insulating ring is placed at some distance between the graphite rings, practically dividing the mass of resistance carbon into two portions, causing the current to flow along the sides of the crucible. The crucible is lined with alundum to prevent the metals or alloys being contaminated with carbon. The furnace has a capacity of one kilowatt, weighs about 25 lbs., and is capable of heating 60 or 70 Gm. of metal up to 2500° C. The total cost should not exceed $5.00.

A New Pyrophoric Alloy. Anon. (*Brass World*, viii, 5, 180.)—The usual pyrophoric alloy, used for self-igniting match boxes or gas lighters, consists of 70 per cent. cerium and 30 per cent. iron. A German inventor has found that alloys of manganese and antimony are also pyrophoric and are cheaper than the cerium alloys. For certain purposes it is an improvement to add 10 per cent. of chromium, and during the melting of the alloy it is an advantage to add a very small quantity of aluminum or magnesium to increase fluidity and soundness. The proportions found best are:—

Manganese .... 80 per cent.
Antimony .... 10 per cent.
Chromium .... 10 per cent.

Instead of giving a shower of sparks like the cerium alloys, it produces a long streak of flame, thus making the friction wheel unnecessary. The alloy is air proof and does not disintegrate like the cerium alloy.

Luminous Tubes of Neon. Geo. Claude. (*Mon. Scient.*, lxxiv, 135.)—The remarkable luminosity of neon can be utilized for lighting purposes. One of the difficulties of the problem is the ease with which neon is masked in luminous tubes by small quantities of certain other gases. It is not sufficient to introduce very pure neon into a tube with electrodes, under suitable pressure, in order to obtain an effective luminous tube, for the gases disengaged from the electrodes and from the walls by the current almost destroy its luminous power. This can be overcome by the use in a special way of Dewar's discovery of the absorbent properties of charcoal at low temperatures. In fact neon is not so easily liquified as the other gases introduced or set free by the passage of the current, and is therefore less easily absorbed than they are by charcoal at the temperature of liquid air. In this way neon is purified, and after prolonged treatment the beautiful orange luminescence appears and retains its brightness. This bright light is very rich in red rays and is just the corrective required for the light of vapor tubes; in many cases it could be used alone as for studios, halls and so forth.

A Method of Observing Stream-lines in Air. A. Lafay. (*Comptes Rendus*, clii, 318.)—This is done by using a thin stream of acetylene issuing from a nozzle 2 to 3 mm. in diameter, which when illuminated casts upon a screen a refraction shadow of one bright line between two dark ones; thus the path of the gas is rendered visible. The acetylene should flow from the nozzle at the same velocity as that of the air current in which it is immersed. By this method variations in the speed of the air can be detected by the discontinuity of the shadow. The acetylene will have the same density as the air if it is cooled to about 30° C. below the temperature of the air, or if it is mixed with CO_2 in the proportion of $8C_2H_2$ to $3CO_2$. If the smell of acetylene is too objectionable, substitute ·hylene.

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A "shot" of weak hydrochloric acid injected directly into the blood is the agent that has been found effective in recalling and restoring to sensibility patients who would otherwise sleep for hours, and in some cases would never awake.

Even 5,000,000 volts is a mere fraction of the potential of the actual electrical discharges from clouds. The voltage of the usual lightning flash is about 100,000,000 volts at 100,000 amperes. This represents a thousand billion horsepower and an energy of four thousand watt-hours. And the whole performance is complete in a few millionths of a second.

Military Science

WHAT WOULD BE THE CHA... OF A NEW WAR?—Eighteen authors—*Smith and Haas*, 420 p., $2.50. The English edition of this book was greeted by the *New Statesman and Nation* as "the most terrible book which has ever been written." In a way it merits the distinction. For the unemotional objectivity with which the group of distinguished authors, some of whom a few years ago were trying to kill each other, discuss shellfire and gas, bankruptcy and starvation and pestilence, leaves one more dazed with horror than any amount of impassioned pleading. Some of the men are professional soldiers; all of them have a first-hand knowledge of war and have made special studies of it and of its effects. They do not dogmatize, and where they do not know they say so; but the things they do know and state with calm confidence make the few ounces of this book weightier than tons of ordinary pacifist tracts.

Science News Letter, October 21, 1933

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Judge Parker also states that the determination of the relative importance of all industries and plants for both production and delivery by single agency, the War Industries Board, renders it possible to maintain a well-balanced program with respect to the several factors entering into production, which includes among other things, plant facilities, fuel supply or electrical energy, labor and transportation, without all of which production is impossible. In listing industries as such, or individual plants, while a number of factors are taken into account, the ultimate test is: "To what extent, if at all, will according preference contribute direct or indirectly toward winning the war, and, if at all, how urgent is the need?"

CLASSIFICATION OF INDUSTRIES IN NEW PRIORITIES LIST

Aircraft Plants	I	Navy and Army	I
Ammunition	I	Newspapers and Periodicals	IV
Army and Navy	I	Oil and Gas, Producing and Transporting	I
Arfs Plants	I	Oil and Gas, Manufacturing Equipment for	III
Bag Factories	IV	Paper and Pulp	IV
Blast Furnaces	I	Public Institutions and Buildings	III
Boots and Shoes	IV	Public Utilities	II
Brass and Copper	II	Pulp and Paper Plants	IV
Chain Plants	III	Railway (operated by U. S. Railroad Administration)	I
Chemical Plants	I	Railways	II
Coke and By-Product	I	Railways (street)	II
Cotton Compresses	IV	Rope Plants	IV
Cranes	II	Rope Wire Plants	II
Domestic Consumers	I	Ship Plants	I
Drugs and Surgical Supplies	IV	Soap Plants	IV
Electrical Equipment	III	Steel-making Furnaces	I
Explosive Plants	I	Steel-plate Mills	I
Farm-Implement Plants	IV	Steel-rail Mills	II
Feed or Livestock	I	Steel Plants	III
Ferro-Alloys	I	Surgical Supplies	IV
Fertilizer Plants	IV	Tanning	IV
Fire-Brick Plants	IV	Textile Plants	IV
Food Factories, Mills, and Storage Plants	I	Tin Plates	III
Food Container Plants	IV	Tobacco	IV
Gun Factories	I	Toluol Plants	I
Hospitals	I	Twine (binder and rope)	IV
Ice Factories	III	War and Navy Departments	II
Laundries	III	Wire Rope and Rope Wire Plants	II
Machine-Tool Plants	II	Woolen Textile Mills	IV
Mines, Coal	I		
Mines, Metal and Ferro-Alloy Minerals	II		
Mining Tools	III		

iberty Bonds * * *

E B Parker
Priorities Commissioner
War Industries Board

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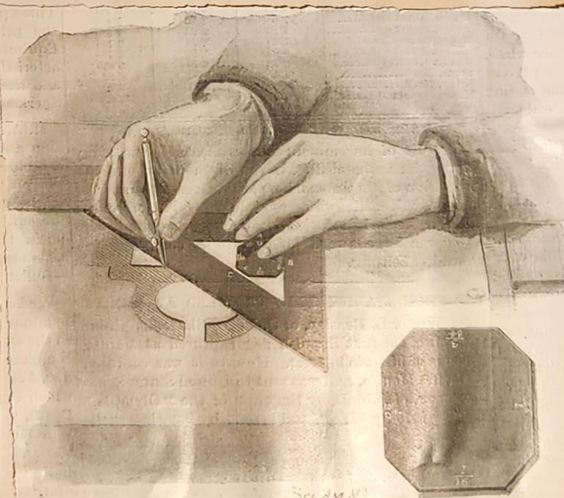
Invisible Light in Warfare. R. W. WOOD. (*Proceedings of the Physical Society of London*, vol. xxxi, p. 232, 1919.)—When a source of light is put at the principal focus of a converging lens the emergent beam consists of parallel rays and consequently does not change in cross-section as it proceeds. Often the narrowness of such a beam prevents its being observed. Greater accuracy was obtained by using a filter which permitted only the extreme red rays to issue. These would be invisible to an observer unless he protected his eyes from daylight by a similar screen. Through such a screen only the red light could penetrate and the eyes of the observer would be in a sensitive state owing to the exclusion of ordinary light. By such an arrangement secret signals can be transmitted. A variation of method was the use of a screen transmitting only ultra-violet light, which was received on a fluorescent screen. The range of signalling in both cases was about six miles.

The following arrangement proved of great value in maintaining communication between ships of the same convoy at night. In this case the light was sent out not as a parallel beam, but as a beam diverging in all directions. A Cooper-Hewitt mercury arc was the light source. It was surrounded by a glass chimney through which only ultra-violet light emerged. This caused parts of the eye and natural teeth to fluoresce, while false teeth were black. The receiving apparatus is a barium-platino-cyanide screen placed in the principal focus of a converging lens. The range was about four miles. G. F. S.

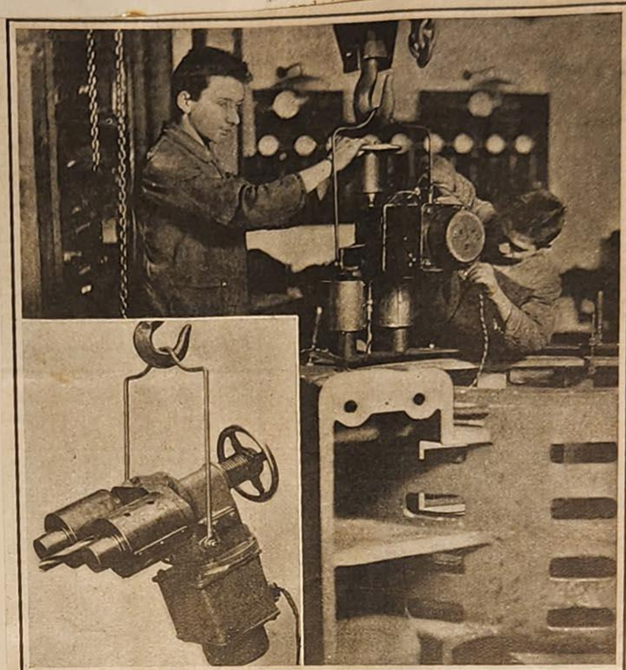


NEWTON'S SECTION LINER.

Sci Am Sup
Nov 5 98

…GRAPHY WITHOUT WIRES.

…ate herewith an apparatus, devised by M.



A NEW ELECTROMAGNETIC DRILL.

Decomposition of Water by Magnesium at Ordinary Temperature. A. W. Knapp. (*Chem. News*, cv, 253.)—When magnesium is mixed with water no reaction is observed at ordinary temperatures, although the formation of magnesium hydroxide and the liberation of hydrogen is an exothermic reaction. This is explained by saying that the film of hydroxide first formed covers the metal and retards further action. However, if magnesium powder be added to ten times its weight of water, and then palladious chloride equal to one-hundredth part of the weight of the magnesium, a brisk evolution of hydrogen occurs. The magnesium reduces the palladious chloride, forming metallic palladium, which acts catalytically. The small amount of magnesium chloride formed possibly accelerates the reaction by dissolving the hydroxide. The temperature rapidly rises until the water boils and white hydroxide is formed. The palladium, which has accelerated the decomposition of the water, now accelerates its formation, for it is warm, and some of it rising on the bubble-films, which separate the hydrogen from the air, causes the hydrogen to ignite spontaneously.

Transmitter

Prof. Zickler, of Brünn, has conducted an elaborate series of experiments, which show that a telegraphic instrument can be actuated at considerable distances by a beam of ultra-violet light. He employs a powerful arc lamp as his transmitter, using a screen of glass to produce intermittent flashes of the ultra-violet beam, which embody themselves as dot and dash signals on his receiver. The receiver is an air gap in a circuit containing an induction coil regulated to an electromotive force just below the sparking point at the air gap. As Hertz long ago has shown, a beam of ultra-violet light falling on the cathode of a strained air gap, near its breaking-down point, will immediately provoke a discharge. Zickler started by producing this effect over a distance of 2 meters. Then, by improving the shape and material of his electrodes and inclosing them in a chamber of compressed air, he was able to increase this distance to 200 meters, says The Electrical Review. This is a remarkable result, and it is extremely interesting to physicists to learn that the short and easily absorbed ultra-violet light can influence a spark discharge at so great a distance.

A Brazilian Indian Telephone.

Mr. José Bach, in a narrative of his travels among the Indians of the regions of the Amazon, describes in L'Illustration an instrument by means of which these people communicate with each other at a distance.

These natives live in groups of from one hundred to two hundred persons, and in dwellings called "malocas," which are usually situated at a distance of half a mile or a mile apart.

In each malocca there is an instrument called a "cambarisa," which consists essentially of a sort of wooden drum that is buried for half of its height in sand mixed with fragments of wood, bone, and mica, and is closed with a triple diaphragm of leather, wood, and India rubber.

When this drum is struck with a wooden mallet, the sound is transmitted to a long distance, and is distinctly heard in the other drums situated in the neighboring maloccas. It is certain that the transmission of the sound takes place through the earth, since the blows struck are scarcely audible outside of the houses in which the instruments are placed.

After the attention of the neighboring maloccas has been attracted by a call blow, a conversation may be carried on between the cambarisas designated.

According to Mr. Bach, the communication is facilitated by the nature of the ground, the drums doubtless resting upon one and the same stratum of rock, since transmission through ordinary alluvial earth could not be depended upon.

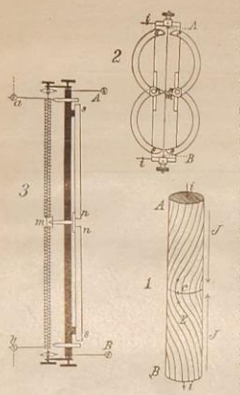
We have here an ingenious improvement upon the process employed by Indians for perceiving distant noises (such as the gallop of a horse), and which consists, as well known, in applying the ear to the earth. This method was formerly much used by the people under consideration during the course of wars of one tribe with another.

…within the security of the coil may be provided for.

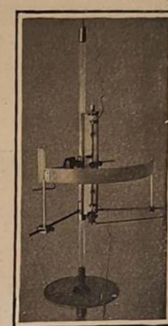
AN INGENIOUS TORSIONAL WAVE DETECTOR

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN

Prof. A. G. Rossi, of the Royal Polytechnic Institute of Turin, has devised a new form of detector for use in wireless telegraphy, which is of special interest because of the novel principle it employs. He uses the property known as "magneto-striction" found in iron or nickel wires. A fine iron wire stretched in a magnetic field is found to lengthen at first, and then shorten, according to the strength of the field, the value effect being about 1-400,000th of the length of the wire. The inventor sought to increase this effect and to apply it to a detector for waves. The principle of the apparatus is shown in Fig. 1. A fine iron wire is stretched in a vertical position between two fixed points *A B*. Two constant magnetic fields formed by two equal bar magnets, magnetize the wire in two halves in the opposite sense with the intensity *J J* and longitudinally, as shown by the arrows. At the same time a current is sent through the wire from *i* to *i*, and this gives a circular magnetization to the wire, with an intensity *c*. The result of the combined magnetic fields will be a magnetization of helical form, *E*. Owing to the effect of magneto-striction, the wire will have a torsion represented at *C* in the direction of the arrow, this being what is known as the Wiedemann torsion effect. Leaving the longitudinal field as it is, if we reverse the current in the wire the torsion effect will be also reversed. When we send an alternating current through the wire we have a strong effect of vibration, as the torsion is also alternating in its sense. A mirror placed at the middle of the wire is made to reflect a beam of light on a screen, and the spread of the beam shows the amplitude of the vibration. The effect is much stronger when the period of the alternating current is of the same value as the normal vibration rate of the wire, and we have a much longer line of light on the screen. The wire is of about 0.02 millimeter diameter, and is held under tension between two light springs mounted on an insulating plate. Fig. 3 shows the arrangement, and the springs are coupled to the binding posts *A B*. Near the ends and at the middle of the wire project three iron points, which come from the bar magnets *n s*, *n s*, so as to guide the magnetic flux into the wire. This latter is stretched inside a glass tube of small diameter, leaving a gap at the center for the mirror *m*. A spiral of insulated copper wire is wrapped about the glass tubes with the two halves coiled inversely and the current comes from *a* and *b* into the wire. The copper spiral is designed to receive the waves from the antenna, and it acts to modify the effect which we have seen above to be given by the combination of the alternating current and the bar magnets in the wire. When no waves are received, we have a constant torsion effect in the wire, that is a constant rate of vibration. When on the contrary the wave effect occurs in the copper spiral, the rate of the vibration is modified, and the line of light on the screen is changed. The terminals *a b* are connected to a pair of vertical antenna wires which are insulated from ground. All the rest of the apparatus is held insulated on a glass tube support 5 feet from the floor. Light for the beam is given by a Nernst lamp, and the same alternating current circuit is used for exciting the wire, using the proper means to secure a very small current through the wire. The copper spiral is joined at the top to the antenna and at the bottom to ground. With such an arrangement, the instrument shows the effect of waves received from a distant station, and we notice variations in the beam of light due to this cause. It is designed especially to be used for receiving signals formed by a succession of waves, such waves to follow each other in series so as to form periods of low frequency. The frequency is first adjusted so as to be the same as that of the vibrating wire. Besides the tuning of the high frequency waves, this allows us to use a second or local tuning of the low period waves. It should be remarked that Prof. Rossi's instrument transforms directly an electric vibration of low frequency into a mechanical vibration, and contrary to other detectors, there is no transformation of energy between the effect of the name and the registered optical indication. It is thus extremely sensitive. To have a permanent record of the signals, the author proposes the use of a photographic band descending in front of the beam, and as the variations of the latter are sidewise, we would have a set of wave-like signals printed on the band. By using a selenium cell, which is lighted by the beam, we could work a Morse register with the instrument, provided a strong enough light is reflected by the mirror on the cell. Owing to the sensitiveness of the instrument, there is no doubt that it can be used with a much less expenditure of power at the sending station. On the other hand it simplifies the apparatus which is needed at the receiving station. An alternating current generator is not required in this case, but a simple vibrator will give the needed impulses for exciting the stretched wire.



How the torsional effect is produced.

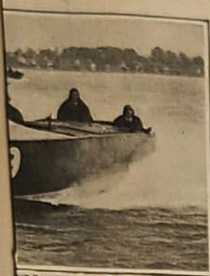

A detector which transforms electrical wave trains into mechanical vibrations.

A New Telescope

A SWISS inventor named Rosing is reported to have constructed a "light-electric" cell for telescopic purposes, which responds to variations of light much more rapidly than any selenium cell thus far invented and which possesses the great advantage of not being subject to "fatigue."

This cell which is already in use for practical purposes in Rosing's telescope, consists of a hollow ball filled with rarefied hydrogen or helium. Upon one side it is covered with sodium amalgam or potassium amalgam, while upon the opposite side it is provided with a platinum electrode. When the amalgam surface receives a negative electric charge and is afterward illuminated an immediate discharge takes place; the electric current connecting the two electrodes can pass from the platinum electrode to the amalgam. Hence as a result of the illumination it is able to overcome the resistance with which it was formerly unable to cope.

According to the experiments made by Rhigi and Stroletow the strength of the photoelectric current which is here operative corresponds precisely to the intensity of the light. Indeed, it follows the variations of intensity in the illumination so exactly that the most peculiar effects can be obtained; for example, by the use of an intermittent light. The inventor calls this instrument an "elektroskop." This new apparatus is now being tested by Marconi in his wireless telephony experiments.



"Maple Leaf VII"

...a II";

My bleaching solution is made with one ounce each of potassium ferricyanide and chromic acid in one gallon of water, at which strength it acts very quickly and produces a transparent yellow image. Transfer to running water should be made immediately when the image is completely bleached, to avoid over-hardening of the gelatine by the chromic acid. Long washing is necessary to clear out the free chromic acid, but it discharges rapidly in water containing a little soda bicarbonate, and the image also dyes up quicker and clears more rapidly after dyeing if the soda bicarbonate is used. I always use it, but too long immersion whitens the image, reduces its transparency and produces a weaker, though still strong and brilliant dye image.

The Variation of Thermal Conductivity during the fusion of metals is discussed in a recent issue of the *Philosophical Magazine*. The results of a long investigation are summarized as follows: (1) The thermal conductivity of tin, lead, zinc, and aluminum decrease with the rise of temperature up to their melting point. (2) For these metals thermal conductivity decreases abruptly during melting. (3) The thermal conductivity of bismuth and antimony slightly decreases at first and then increases a little. (4) During melting the conductivity of bismuth considerably increases, and that of antimony seems to increase only slightly. (5) The thermal conductivity of all liquid metals here investigated decreases but slightly with the rise of temperature. (6) The above changes of thermal conductivity are similar to those of electric conductivity for the same metals.

...CT OF HEAT UPON VARIOUS BODIES.

	Deg. F.
...	145
...	140
...) freezes	—46
...	1166
...	365
...	151
...	520
...at	98
...ezes	25
...	—7
...	1900
...	610
...	800
...	325
...ial	—166
...l	—56
...	790
...	1929
...	2377
...	1913
...	145
...	1500
...l)	1141
...	1860
...	1077
...	2900
...gypt	117
...	32
...	4172
...	2786
...	2980
...	752
...	884
...	94
...	618
...	2237
...	662
...	680
...	—39

	Deg. F.
Milk freezes	+30
Naphtha boils	186
Nickel melts	2646
Nitric acid, spec. gravity 1,424 freezes	—45
Nitrous oxide freezes	—150
Olive oil freezes	—36
Petroleum boils	306
Phosphorus melts	108
Phosphorus boils	560
Pitch melts	91
Platinum melts	3191
Potassium melts	135
Proof spirit freezes	—7
Saltpetre melts	610
Sea water freezes	—28
Silver (fine) melts	1733
Snow and salt, equal parts	0
Spermaceti melts	112
Spirits of turpentine freezes	14
Steel melts	2532
Steel, polished blue	580
Steel, polished straw color	460
Strong wines freeze	—20
Sulphur melts	235
Sulphur acid, spec. gravity 1,641 freezes	—45
Sulphur ether freezes	—46
Sulphur ether boils	98
Tallow melts	97
Tantalum melts	5162
Tin melts	446
Tungsten melts	5432
Vanadium melts	3182
Vinegar freezes	—28
Vinous fermentation	60 to 77
Water, *in vacuo* boils	9[illegible]
Zinc melts	77[illegible]

60

USEFUL INFORMATION.

Shrinkage of Metal Castings.

Pure Aluminum (13-64 inch)	.2031 inch to the foot
Iron, small cylinders	.0625 " " " "
Thin Brass Castings	.1875 " " " "
Thick Brass Castings	.150 " " " "
Zinc	.3165 " " " "
Lead	.3125 " " " "
Copper	.1875 " " " "

Melting Points of Metals.

	Deg. Cent.	Deg. Fahr.
Tin	230.0	446
Lead	325.6	618
Zinc	415.0	779
Aluminum	625.0	1157
Bronze	922.2	1692
Silver	945.0	1733
Gold	1045.0	1913
Copper	1053.9	1929
Cast Iron	1530.0	2786
Steel	1377.8	2532
Wrought Iron	1600.0	2912

Tempering of Steel.

After hardening, the following colors may be made use of in drawing temper on steel cutting tools:

	Corresponding Temperature F.
Lancets	Pale Yellow.. 430 deg.
Razors	Straw Yellow 450 "
All kinds of Woodcutting Tools.	Darker Straw Yellow.... 470 "
Screw Taps	Yellow......490 "
	Brown Yellow 500 "
Chipping Chisels	Brown, slightly tinged Purple.... 520 "
Hatchets and Saws	Light Purple. 530 "
All kinds of Percussive Tools	Dark Purple. 550 "
	Dark Blue... 570 "
	Pale Blue... 610 "
	Blue Tinged with Green 630 "

48

. . . should appoint a commiss- . . . any other system, and give the that one which proves itself to be universally and conveniently adapted to the needs of mechanical science and trade.

San Jose, Cal. Geo. H. Cooper.

Preserving Books in the Tropics

To the Editor of the Scientific American:

We are readers of your excellent publication and notice the letter of Mr. Rosenheim in your issue of July 26th last. We can tell him that to get rid not only of bookworms but of everything else that will eat and damage books including mildew he will find the following efficacious. Put the books inside an airtight box of metal or wood. On top of them place a saucer or a shallow tin can filled with cotton. Once a day for three days saturate this cotton with carbon bisulfide, closing the box tightly. Do this every six months or so, putting the books back in the box again, and you are absolutely protected. This is the way we preserve our valuable books here, with complete success.

San Pedro Sula, Honduras. Sula Ice Co.

Eight Hours in Exchange for Sixteen

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Welz used selenium or a compound of selenium and cadmium sulphide for the production of rose, red, and orange colored glass (*Eng. Min. Journal*, December 18th, 1897, page 731, and Scientific American Supplement, January 1st, 1898, page 18,345); on investigation it was found that Welz's formula was not satisfactory. The formula was soon corrected, and is made as follows:

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The result of the above batch is a beautiful coral-red corresponding to Kaiser-red glass.

Similarly, for a transparent yellow-red glass:

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Selenium	200-300 grammes
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Glass decolorized by means of selenium possesses an unusual clearness and brilliancy. The use of selenium as a decolorizing agent (sodium selenate is generally used) is claimed in German patents, Nos. 63,558, 75,565, and 88,615. Selenium manganese is now being marketed in the United States as a glass decolorizer.

. . . The proportions . . . the paper for which . . . paraffin paper of . . . is used, heating . . . a flame or a hot-plate: Dextrine 30 parts, rich starch 30 parts, acetate lacquer 20 parts, beeswax 20 parts. The mixture, well stirred, produces an extremely viscous, yet transparent, mass with good weather-resisting qualities.

AN EASILY-MADE HIGH-FREQUENCY APPARATUS.*

By A. FREDERICK COLLINS.

A GENERAL impression seems to prevail among those who have not taken the trouble to scratch the surface of the subject that currents of high frequency and high potential can only be obtained with apparatus of large and special construction, an impression probably resulting from the spectacular experiments per-

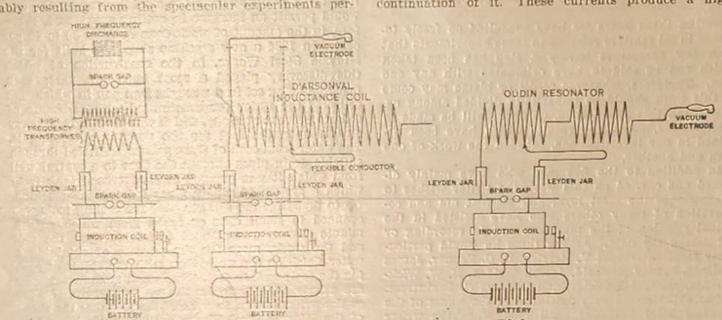

FIG. 1 TESLA HIGH FREQUENCY APPARATUS
FIG. 2 D'ARSONVAL HIGH FREQUENCY APPARATUS
FIG. 3 OUDIN HIGH FREQUENCY APPARATUS

ARRANGEMENT OF HIGH-FREQUENCY APPARATUS.

formed by Tesla a dozen years ago when the art was yet young.

As a matter of fact, high-frequency and high-potential phenomena are present in the discharge of the smallest induction coil, and a coil giving a spark of two inches will suffice to produce very interesting results, while coils from this size up to the largest made will exhibit all the striking effects in electrical resonance and the action of inductance and capacity of a circuit on oscillating currents with the exception of long disruptive discharges.

At the outset it should be understood that there is only one fundamental method known by which it is possible to set up high-frequency currents, namely, by the equalization of high potentials through the medium of the discharge spark, but there are, however, several forms of devices by which such currents can be manifested and utilized.

The best known of these is the Tesla transformer, formed of a few turns of heavy wire whose ends lead to the outside coatings of a pair of Leyden jars, the inside coatings being connected with the opposite arms of a spark gap which in turn are joined to the terminals of the secondary of an induction coil. Around the primary of the transformer, but exceedingly well

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This result is due to the fact that the oscillations are not confined to the turns of wire that are included in the closed circuit, but surge with equal intensity in the other and outer turns of the coil which is a continuation of it. These currents produce a high potential in virtue of their exalting action on each other due to the inductance of the circuit.

The high-frequency apparatus shown in Fig. 4 can be used to obtain either D'Arsonval or Oudin currents. The apparatus comprises a plunge battery of six cells, an induction coil giving a two-inch spark, a pair of one-pint Leyden jars, and the inductance coil. The jars may be made by coating the inside and outside surfaces of two preserve or other bottles having wide necks with tin-foil to within one-third of the top; this may be done by shellacking them and then laying on the foil before it is dry, while the exposed parts are given two or three coats of varnish. A thin hardwood stopper, also shellacked and supporting a brass rod fitted with a ball at its upper end and two or three inches of brass chain on its lower end to make contact with the inner foil, is provided for each jar.

The inductance coil can be made by winding twenty turns of bare copper or brass wire, No. 16 or 18, spirally around a tall bottle of uniform diameter. These turns may be spaced approximately one-fourth of an inch apart; the exact distance is not material, though the nearer these are together the greater will be the inductance of the circuit, but it is not advisable to wind them closer than three-sixteenths of an inch

gram Fig. 2 and the one terminal used when a D'Arsonval current is desired, or the other terminal when an Oudin current is required.

With this simple resonator many experiments may be performed, such as lighting a small incandescent lamp attached to the turns of the inductance coil, impedance and resonance phenomena shown, physiological effects, etc. Of the latter, the lighting of a lamp held in the hands so that the oscillating currents must pass through the body first is a striking example and proves conclusively that when the frequency is sufficiently high, i.e., in the neighborhood of a million reversals per second, the electrical energy will pass through the body without sensation of any kind. High-frequency currents are being widely used at the present time as a therapeutic agent in the treatment of various diseases.

THE ART OF CUTTING METALS.*

By FRED W. TAYLOR, Philadelphia, President American Society Mechanical Engineers.

THE experiments described in this paper were undertaken to obtain a part of the information necessary to establish in a machine shop our system of management, the central idea of which is: (A) to give each workman each day in advance a definite task, with detailed written instructions, and an exact time allowance for each element of the work. (B) To pay extraordinarily high wages to those who perform their tasks in the allotted time, and ordinary wages to those who take more than their time allowance. There are three questions which must be answered each day in every machine shop by every machinist who is running a metal cutting machine, such as a lathe, planer, drill press, milling machine, etc., namely:

a. What tool shall I use?
b. What cutting speed shall I use?
c. What feed shall I use?

Our investigations, which were started 26 years ago with the definite purpose of finding the true answers to these questions under all the varying conditions of machine shop practice, have been carried on up to the present time with this as the main object still in view.

ROUGHING WORK EXCLUSIVELY CONSIDERED.

The writer will confine himself almost exclusively to an attempted solution of this problem as it affects "roughing work;" i. e., the preparation of the forgings or casting for the final finishing cut, which is taken only in those cases where great accuracy or high finish is called for. Fine finishing cuts will not be dealt with. Our principal object will be to describe the fundamental laws and principles which will enable us to do "roughing work" in the shortest time, whether the work is rigid or elastic, and whether the machine tools are light and of small driving power, or heavy and rigid with ample driving power. In other words, our problem is to take the work and machines as we find them in a machine shop and by properly changing the countershaft speeds, equipping the shop with tools of the best quality and shapes and then mak-

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To the Editor of the SCIENTIFIC AMERICAN:

We are readers of your excellent publication and notice the letter of Mr. Rosenheim in your issue of July 26th last. We can tell him that to get rid not only of bookworms but of everything else that will eat and damage books including mildew he will find the following efficacious. Put the books inside an airtight box of metal or wood. On top of them place a saucer or a shallow tin can filled with cotton. Once a day for three days saturate this cotton with carbon bisulfide, closing the box tightly. Do this every six months or so, putting the books back in the box again, and you are absolutely protected. This is the way we preserve our valuable books here, with complete success.

San Pedro Sula, Honduras. SULA ICE CO.

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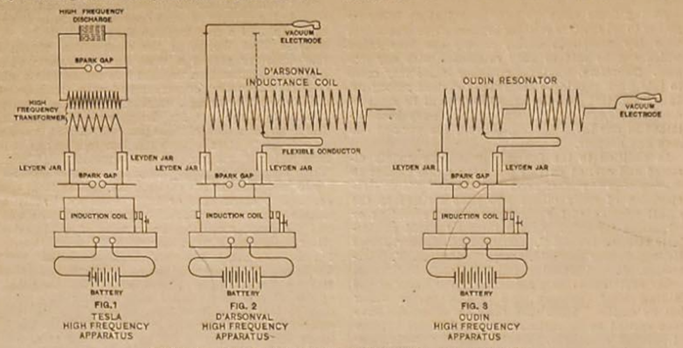

ARRANGEMENT OF HIGH-FREQUENCY APPARATUS.

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The best known of these is the Tesla transformer, formed of a few turns of heavy wire whose ends lead to the outside coatings of a pair of Leyden jars, the inside coatings being connected with the opposite arms of a spark gap which in turn are joined to the terminals of the secondary of an induction coil. Around the primary of the transformer, but exceedingly well insulated from it, is wound the secondary coil, consisting of a single layer of much finer wire whose terminals are connected, as illustrated in the diagram Fig. 1, to a second spark gap. Thus the potential of the current is not only stepped up, but the frequency is enormously increased as well.

An apparatus devised by D'Arsonval for the production of high-frequency currents is much simpler in construction, though it is not as efficient as the Tesla transformer, but it has the advantage of being more easily constructed, while by merely changing a connection it can be converted into an Oudin resonator. These arrangements are called resonators from their analogous action to acoustic resonators which directly reinforces a simple sound vibration, as may be demonstrated by whistling at a low pitch across the open mouth of a bottle and then raising the pitch until a corresponding frequency of vibration equal to that of the natural period of the bottle is reached, when the latter will emit a similar sound and reinforce the note in strength and quality.

D'Arsonval's resonator consists of a simple coil of bare wire wound on a cylinder of some insulating material. One terminal of the coil is connected with the inner coating of one of the Leyden jars, the outer coating of the jar being attached to one of the terminals of the secondary of the induction coil. The opposite terminal of the secondary coil leads to the outer coating of the other jar, while the inner coating is connected with a flexible terminal the end of which carries a spring clip or other means of contact. This clip or contact can be attached to any portion of any of the turns of the resonator, and by varying its position a value of inductance can be found where it cancels the value of capacity, when the effects of the oscillating currents in it will be a maximum. Fig. 2 shows the D'Arsonval resonator diagrammatically.

When this resonator is in action the induction coil charges the two oppositely-disposed Leyden jars which discharge across the spark gap, the balls of which should be only slightly separated to lessen the resistance to a minimum. When the spark takes place the energy stored up in the jars is released and becomes electric currents which oscillate through the circuit of which the resonator coil is a part.

From the above diagrams it is apparent that the Tesla apparatus is bi-polar; that is, there are two terminals which may be used. In D'Arsonval's resonator either one or two poles may be employed, the second pole or terminals being indicated by the dotted line. Oudin's resonator is similar to that of D'Arsonval, but instead of tapping the coil at the points indicated in Fig. 2 he used the single terminal at the end of the supplementary induction coil as shown in Fig. 3, and obtained an accentuated discharge.

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The high-frequency apparatus shown in Fig. 4 can be used to obtain either D'Arsonval or Oudin currents. The apparatus comprises a plunge battery of six cells, an induction coil giving a two-inch spark, a pair of one-pint Leyden jars, and the inductance coil. The jars may be made by coating the inside and outside surfaces of two preserve or other bottles having wide necks with tin-foil to within one-third of the top; this may be done by shellacking them and then laying on the foil before it is dry, while the exposed parts are given two or three coats of varnish. A thin hardwood stopper, also shellacked and supporting a brass rod fitted with a ball at its upper end and two or three inches of brass chain on its lower end to make contact with the inner foil, is provided for each jar.

The inductance coil can be made by winding twenty turns of bare copper or brass wire, No. 16 or 18, spirally around a tall bottle of uniform diameter. These turns may be spaced approximately one-fourth of an inch apart; the exact distance is not material, though the nearer these are together the greater will be the inductance of the circuit, but it is not advisable to wind them closer than three-sixteenths of an inch. In inductance coils to be used in resonators energized with large induction coils, the distance may be as great as one-half inch, the diameter of the turns 12 inches, and the number of turns about forty.

In making a bottle inductor the turns of wire may easily be kept in place and insulated from each other by applying a compound made by melting equal parts of resin and beeswax in a melted state as the wire is wound on the glass surface and holding it until it has cooled. The flexible conductor may be soldered to a small spring clip or to the end of a wire, say No. 14, and the free end flattened and bent up ⅛ inch, so that it can be slipped between a turn of the coil and the bottle, a little scheme that will serve admirably for the adjustable connection. The different parts are then ready to be connected up as shown in the diagram Fig. 2 and the one terminal used when a D'Arsonval current is desired, or the other terminal when an Oudin current is required.

With this simple resonator many experiments may be performed, such as lighting a small incandescent lamp attached to the turns of the inductance coil, impedance and resonance phenomena shown, physiological effects, etc. Of the latter, the lighting of a lamp held in the hands so that the oscillating currents must pass through the body first is a striking example and proves conclusively that when the frequency is sufficiently high, i.e., in the neighborhood of a million reversals per second, the electrical energy will pass through the body without sensation of any kind. High-frequency currents are being widely used at the present time as a therapeutic agent in the treatment of various diseases.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

FIG. 4.—THE HIGH-FREQUENCY APPARATUS IN USE.

THE ART OF CUTTING METALS.*

By FRED W. TAYLOR, Philadelphia, President American Society Mechanical Engineers.

THE experiments described in this paper were undertaken to obtain a part of the information necessary to establish in a machine shop our system of management, the central idea of which is: (A) to give each workman each day in advance a definite task, with detailed written instructions, and an exact time allowance for each element of the work. (B) To pay extraordinarily high wages to those who perform their tasks in the allotted time, and ordinary wages to those who take more than their time allowance. There are three questions which must be answered each day in every machine shop by every machinist who is running a metal cutting machine, such as a lathe, planer, drill press, milling machine, etc., namely:

a. What tool shall I use?
b. What cutting speed shall I use?
c. What feed shall I use?

Our investigations, which were started 26 years ago with the definite purpose of finding the true answers to these questions under all the varying conditions of machine shop practice, have been carried on up to the present time with this as the main object still in view.

ROUGHING WORK EXCLUSIVELY CONSIDERED.

The writer will confine himself almost exclusively to an attempted solution of this problem as it affects "roughing work;" i. e., the preparation of the forgings or casting for the final finishing cut, which is taken only in those cases where great accuracy or high finish is called for. Fine finishing cuts will not be dealt with. Our principal object will be to describe the fundamental laws and principles which will enable us to do "roughing work" in the shortest time, whether the work is rigid or elastic, and whether the machine tools are light and of small driving power, or heavy and rigid with ample driving power. In other words, our problem is to take the work and machines as we find them in a machine shop and by properly changing the countershaft speeds, equipping the shop with tools of the best quality and shapes and then making a slide rule for each machine to enable an intelligent mechanic with the aid of these slide rules to tell each workman how to do each piece of work in the quickest time.

It may seem strange to say that a slide rule enables a good mechanic to double the output of a machine which has been run, for example, for ten years by a first-class machinst having exceptional knowledge of and experience with his machine, and who has been using his best judgment. Yet our observation shows that, on the average, this understates the fact. To make the reason for this more clear it should be understood that the man with the aid of his slide rule is called upon to determine the effect which each of

* Extracts from Part I. of the President's annual address at the New York meeting (December, 1906) of the American Society of Mechanical Engineers.

the 12 elements or variables given below has upon the choice of cutting speed and feed; and it will be evident that the mechanic, expert or mathematician does not live who, without the aid of a slide rule or its equivalent, can hold in his head these 12 variables and measure their joint effect upon the problem. These twelve elements or variables are as follows:

a. The quality of the metal which is to be cut.

b. The diameter of the work.

c. The depth of the cut.

d. The thickness of the shaving.

e. The elasticity of the work and of the tool.

f. The shape or contour of the cutting edge of the tool, together with its clearance and lip angles.

g. The chemical composition of the steel from which the tool is made, and the heat treatment of the tool.

h. Whether a copious stream of water, or other cooling medium, is used on the tool.

j. The duration of the cut—i. e., the time which a tool must last under pressure of the shaving without being reground.

k. The pressure of the chip or shaving upon the tool.

l. The changes of speed and feed possible in the lathe.

m. The pulling and feeding power of the lathe.

Broadly speaking, the problem of studying the effect of each of the above variables upon the cutting speed and of making this study practically useful may be divided into four sections, as follows:

(A) The determination by a series of experiments of the important facts or laws connected with the art of cutting metals.

(B) The finding of mathematical expressions for these laws which are so simple as to be suited to daily use.

(C) The investigation of the limitations and possibilities of metal cutting machines.

(D) The development of an instrument (a slide rule) which embodies, on the one hand, the laws of cutting metals, and on the other the possibilities and limitations of the particular lathe or planer, etc., to which it applies, and which can be used by a machinist without mathematical training to quickly indicate in each case the speed and feed which will do the work quickest and best.

THE EXPERIMENTS BEGUN IN 1880.

In the fall of 1880 the machinists in the small machine shop of the Midvale Steel Company, Philadelphia, most of whom were working on piecework in machining locomotive tires, car axles, and miscellaneous forgings, had combined to do only a certain number of pieces per day on each type of work. The writer, who was the newly appointed foreman of the shop, realized that it was possible for the men to do in all cases much more work per day than they were accomplishing. He found, however, that his efforts to get the men to increase the output were blocked by the fact that his knowledge of just what combination of depth of cut, feed and cutting speed would in each case do the work in the shortest time was much less accurate than that of the machinists who were combined against him. His conviction that the men were not doing half as much as they should do, however, was so strong that he obtained the permission of the management to make a series of experiments to investigate the laws of cutting metals, with a view to obtaining a knowledge at least equal to that of the combined machinists who were under him. He expected that these experiments would last not longer than six months. With the exception of a few comparatively short periods, however, these experiments have continued until the present time, through a term of about twenty-six years.

The writer wishes to call attention to the fact that in these first experiments he was far more fortunate than almost all of the experimenters who have investigated the subject since then, in having at his disposal a comparatively large mass of uniform metal to work upon, and a comparatively large and powerful machine to work with, a 66-inch diameter boring mill and large locomotive tires made of hard tire steel of uniform quality having been used. He was also especially fortunate in having over him as president of the company William Sellers, who, as is well known, was one of the most patient and broad minded experimenters of his day. Mr. Sellers, in spite of the protests which were made against the continuation of this work, allowed the experiments to proceed, even, at first, at a very considerable inconvenience and loss to the shop.

The extent of this inconvenience will be appreciated when it is understood that we were using a 66-inch diameter vertical boring mill, belt driven by the usual cone pulleys, and that in order to regulate the exact cutting speed of the tool it was necessary to slow down the speed of the engine that drove all of the shafting in the shop, a special adjustable engine governor having been bought for this purpose. For over two years the whole shop was inconvenienced in this way, by having the speed of its main line of shafting greatly varied, not only from day to day but from hour to hour. Before the two years had elapsed, however, the writer had obtained such valuable and unexpected results from the experiments as to much more than justify all of the annoyance and expenditure, and soon after that he readily obtained permission to employ a young technical graduate to devote his whole time to the continuation of this work.

ACKNOWLEDGMENTS TO THOSE WHO ASSISTED IN THE WORK.

G. M. Sinclair, a graduate of Stevens Institute of Technology, devoted his entire time to this work from 1884 to 1887, when he left the employ of the company. H. L. Gantt, also a graduate of Stevens Institute, succeeded Mr. Sinclair in July, 1887, and has been interested with us in carrying on these experiments throughout their whole period. In 1898 Maunsel White, of Bethlehem, another graduate of Stevens Institute, joined us and has been actively interested in our work up to this time. Carl G. Barth, a graduate of the Technical School of Horten, Norway, joined us in 1899, and is still actively working on our investigations.

During these years we have consulted so freely together in all matters relating to these experiments that with few exceptions hardly a step has been taken which can be said to have originated with any one man. Therefore, whatever credit or blame may come to this work should be impartially divided among us. In writing this paper, then, no effort will be made to discriminate, as to the results which have been obtained in our investigations, between the work of one man and another.

In addition to the five men who have mainly directed and carried on this work the writer wishes to acknowledge the most loyal and efficient aid and co-operation of many others who have assisted in the actual running of the machines and in recording or tabulating the data. Among these he would particularly mention Dwight V. Merrick, D. C. Fenner, James Kellogg, Sidney Newbold, Joseph Welden, N. W. Wickersham, Edward Kneisley, and Leonard G. Backstrom.

Our experiments were continued in the works of the Midvale Steel Company until 1889, when the writer left its employ. Since then these investigations have been carried on in various shops and at the expense of different companies. Among these we would especially acknowledge our indebtedness to the Cramp's Shipbuilding Company, Wm. Sellers & Co., the Link-Belt Engineering Company, Dodge & Day, and, more than all, to the Bethlehem Steel Company.

In carrying on this work more than ten machines have been fitted up at various times with special driving apparatus and the other needed appliances, all machines used since 1894 having been equipped with electric drives, so as to obtain any desired cutting speed. The thoroughness with which the work has been done may perhaps be better appreciated when it is understood that we have made between 30,000 and 50,000 recorded experiments, and many others of which no record was kept. In studying these laws we have cut up into chips with our experimental tools more than 800,000 pounds of steel and iron. More than 16,000 experiments were recorded in the Bethlehem Steel Company. We estimate that up to date between $150,000 and $200,000 have been spent upon this work, and it is a very great satisfaction to feel that those whose generosity has enabled us to carry on the experiments have received ample return for their money through the increased output and the economy in running their shops which have resulted from our experiments.

SECRETS GUARDED TWENTY-SIX YEARS NOW REVEALED.

Throughout the whole twenty-six years we have succeeded in keeping almost all of these laws secret, and in fact since 1889 this has been our means of obtaining the money needed to carry on the work. We have never sold any information connected with this art for cash, but we have given to one company after another all of the data and conclusions arrived at through our experiments in consideration for the opportunity of still further continuing our work. In one shop after another machines have been fitted up for our use, workmen furnished us to run them, and specially prepared tools, forgings, and castings supplied in exchange for the data which we had obtained to date; and we have the best indication that they received full value for the money spent from the fact that the same company fitted up for us at intervals of several years three sets of apparatus, the additional knowledge obtained each time evidently warranting them in making the added outlay.

During this period all of the companies who were given this information, and all of the men who worked upon the experiments, were bound by promises to the writer not to give any of this information away nor to allow it to be published. Most of these promises were verbal; and in this day, when there is so much talk about dishonesty and graft in connection with some of our corporations and prominent business men, it is a notable fact that through a period of twenty-six years it has not come to our knowledge that any one of the many men or companies connected with this work has broken a promise. The writer has his doubts whether any other country can produce a parallel record of such widespread good faith among its engineers and mechanics.

It seems to us that the time has now come for the engineering fraternity to have the results of our work, in spite of the fact that this will cut off our former means of financing the experiments. However, we are in hopes that the money required to complete this work may be obtained from some other source.

The writer has no doubt that many of the discoveries and conclusions which mark the progress of this work have been and are well known to other engineers, and we do not record them with any certainty that we were the first to discover or formulate them, but merely to indicate some of the landmarks in the development of our own experiments, which to us were new and of value. The following is a record of some of our more important steps:

CHRONOLOGY OF DISCOVERIES.

A. In 1881, the discovery that a round nosed tool could be run under given conditions at a much higher cutting speed and therefore turn out much more work than the old-fashioned diamond pointed tool.

B. In 1881, the demonstration that, broadly speaking, the use of coarse feeds accompanied by their necessarily slow cutting speeds would do more work than fine feeds with their accompanying high speeds.

C. In 1883, the discovery that a heavy stream of water poured directly upon the chip at the point where it is being removed from the steel forging by the tool, would permit an increase in cutting speed, and, therefore, in the amount of work done of from 30 to 40 per cent. In 1884 a new machine shop was built for the Midvale Steel Works, in the construction of which this discovery played a most important part; each machine being set in a wrought iron pan in which was collected the water (supersaturated with carbonate of soda to prevent rusting), which was thrown in a heavy stream upon the tool for the purpose of cooling it. The water from each of these pans was carried through suitable drain pipes beneath the floor to a central well from which it was pumped to an overhead tank from which a system of supply pipes led to each machine. Up to that time the use of water for cooling tools was confined to small cans or tanks from which only a minute stream was allowed to trickle upon the tool and the work, more for the purpose of obtaining a water finish on the work than with the object of cooling the tool; and, in fact, these small streams of water are utterly inadequate for the latter purpose. So far as the writer knows, in spite of the fact that the shops of the Midvale Steel Works until recently have been open to the public since 1884, no other shop in this country was similarly fitted up until that of the Bethlehem Steel Company in 1899, with the one exception of a small steel works which was an offshoot in personnel from the Midvale Steel Company.

D. In 1883, the completion of a set of experiments with round nosed tools; first, with varying thicknesses of feed when the depth of the cut was maintained constant; and, second, with varying depths of cut while the feed remained constant, to determine the effect of these two elements on the cutting speed.

E. In 1883, the demonstration of the fact that the longer a tool is called upon to work continuously under pressure of a shaving, the slower must be the cutting speed, and the exact determination of the effect of the duration of the cut upon the cutting speed.

F. In 1883, the development of formulæ which gave mathematical expression to the two broad laws above referred to. Fortunately these formulæ were of the type capable of logarithmic expression and therefore suited to the gradual mathematical development extending through a long period of years, which resulted in making our slide rule which solved the whole problem in 1901.

G. In 1883, the [illegible]mental determination of the pressure upon the tool required on steel tires to remove cuts of varying depths and thickness of shaving.

H. In 1883, the starting of a set of experiments on belting described in a paper published in Transactions, Vol. 15 (1894).

J. In 1883, the measurement of the power required to feed a round nosed tool with varying depths of cut and thickness of shaving when cutting a steel tire. This experiment showed that a very dull tool required as much pressure to feed it as to drive the cut. This was one of the most important discoveries made by us, and as a result all steel cutting machines purchased since that time by the Midvale Steel Company have been supplied with feeding power equal to their driving power, and very greatly in excess of that used on standard machine tools.

K. In 1884, the design of an automatic grinder for grinding tools in lots and the construction of a tool-room for storing and issuing tools ready ground to the men.

L. From 1885 to 1889, the making of a series of practical tables for a number of machines in the shops of the Midvale Steel Company, by the aid of which it was possible to give definite tasks each day to the machinists who were running machines, and which resulted in a great increase in their output.

M. In 1886, the demonstration that the thickness of the chip or layer of metal removed by the tool has a much greater effect upon the cutting speed than any other element, and the practical use of this knowledge in making and putting into everyday use in our shops a series of broad nosed cutting tools which enabled us to run with a coarse feed at as high a speed as has been before attained with round nosed tools when using a fine feed, thus substituting, for a considerable portion of the work, coarse feeds and high speeds for our old maxim of coarse feeds and slow speeds.

N. In 1894 and 1895, the discovery that a greater proportional gain could be made in cutting soft metals through the use of tools made from self-hardening steels than in cutting hard metals, the gain made by the use of self-hardening tools over tempered tools in cutting soft cast iron being almost 90 per cent, whereas the gain in cutting hard steels or hard cast iron was only about 45 per cent. Up to this time the use of Mushet and other self-hardening tools had been almost exclusively confined to cutting hard metals, a few tools made of Mushet steel being kept on hand in every shop for special use on hard castings or forgings which could not be cut by the tempered tools. This experiment resulted in substituting self-hardening tools for tempered tools for all "roughing work" throughout the machine shop.

P. In 1894 and 1895, the discovery that in cutting wrought iron or steel a heavy stream of water thrown upon the shaving at the nose of the tool produced a describes the so-called "ozoidal system," which is claimed to produce gears that run long and smoothly. *Ore Unloading on the Great Lakes* is a most interesting story, telling how the immense increase in the shipments of ore on our inland seas compelled the invention and development of ingenious machinery for the rapid handling of great quantities of material. A large number of photographs illustrate these wonderful machines that are equalled nowhere else in the world.

A matter of importance is *Trade-Marks in the American Republics*, which is a plea for the ratification of the Buenos Aires Convention of 1910.

The Open Hearth versus the Electric Furnace in the Manufacture of Commercial Steel gives facts and figures of considerable value. An *Anemometric Paradox* describes a curious windmill that always turns the same way no matter how the wind blows, and it is illustrated by an explanatory diagram and photographs. *A High Efficiency Incandescent Lamp* describes the principles of operation, and the steps by which the lamp was developed. The valuable article on *The Structure of the Atom* is concluded. There is also an interesting variety of shorter articles.

Mixed Fuels Better Than Gasoline

COMPELLED by the exigencies of war to look around for substitutes for gasoline, in the operation of its huge fleet of army motor vehicles, Germany has reached at present a state of perfection in the adaptation of alcohol-benzol mixtures, which a year ago seemed impossible. It has been known for several years that pure benzol, pure denatured alcohol or pure kerosene would not work well in internal combustion motors for automobiles, but the exact requirements in connection with the use of these fuels were not known, because none seemed impressed with the necessity for drastic action. When the war started and the importation of gasoline stopped, steps were being taken by the army authorities which promise to revolutionize automobiling in Germany.

It is openly declared now that even after the war the majority of German motorists will continue to use certain alcohol-benzol mixtures recommended after severe tests by the government. During these tests many new facts were discovered in relation to the use of highly volatile and less volatile fuels, as were also the causes of former failures with alcohol mixtures, benzol, kerosene and mixtures of these with gasoline. The engineering department of the Imperial German transportation department has tabulated a series of experiments with various mixtures of the fuels mentioned, their effective horse-power when compared with pure gasoline and the distances traveled with them, under the identical road and driving conditions accompanying the tests with gasoline.

While, of course, many of the tests and the tabulated results are of merely theoretical value in the United States, and probably would not have created much interest even in Germany, had it not been for the extraordinary demand for motor fuels caused by the extensive use of motor vehicles in the army service—they are none the less interesting to Americans, because they show conclusively that gasoline is not by any means the best and most effective motor fuel for automobiles. When compared with the work of certain mixtures of benzol and alcohol, gasoline must be considered both wasteful and expensive. Pure gasoline of low volatility gives greater horse-power than is needed by the car; therefore it is wasteful and a gallon of it will not carry the car as far as a gallon of the alcohol-benzol mixture.

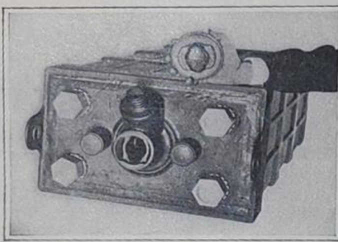
In the course of the experiments the tester used a medium-powered Mercedes touring car, of the 1914 type, the carbureter of which was set for ordinary gasoline and not adjusted in any way during the series of tests. The highest speed obtained, and the distances covered on 1 litre of fuel are given in the following table:

Fuel used.	Speed attained, km. hr.	Dist. traveled on one litre.
1 part benzol with 1 part alcohol....	68 km. hr.	7.5 km.
1 part benzol with 2 parts alcohol...	66 km. hr.	7.2 km.
1 part benzol with 3 parts alcohol...	63 km. hr.	7.0 km.
1 part benzol with 4 parts alcohol...	62 km. hr.	6.6 km.
1 part benzol with 5 parts alcohol...	58 km. hr.	6.0 km.
Pure benzol........................	67 km. hr.	7.1 km.
Pure gasoline......................	70 km. hr.	*5.8 km.

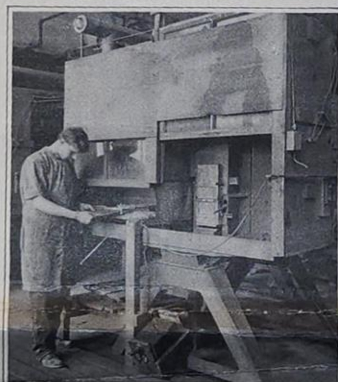
* Distance traveled on pure gasoline is 25% *less* than on the best benzol-alcohol mixture, 1:1.

When the cost of the fuel is taken into account, leaving aside all "war considerations" and counting only the prices of the fuels as they stood in Germany just previous to the outbreak of the war, the balance shows greatly in favor of the alcohol-benzol mixtures. Gasoline cost about 38 cents a gallon; benzol 37.5 cents and alcohol 34 cents. Taking these prices into account, as a basis for determining the cost of motoring the investigator discovered that he could travel 62 km. for $1, if he used gasoline; 76 km. if he used pure benzol, and 84 km. if he used the 1:1 mixture of alcohol and benzol. Strange to say, if the motorist had used pure denatured alcohol, without benzol, his expense would have been exactly the same as with pure gasoline, namely, 62 km. for $1.

Such performances, not so long ago, would only have caused the motorist to point to the many supposed drawbacks attending the use of less volatile fuels; but the automobile motor of to-day has been improved so greatly that carburetion troubles are minimized. Furthermore, it was chiefly due to attempts to use *one* substitute (either benzol *or* alcohol) that carburetion troubles arose. Benzol, if used alone, requires considerably more air for complete combustion than gasoline; and gasoline carbureters refused to work properly when called upon to handle benzol or alcohol. On the other hand, alcohol can be compressed far more, requires less air and can stand greater heat without pre-ignition than gasoline. Mixtures of alcohol and benzol, calculated so as to equalize the excess of air required by benzol with the excess of fuel required by alcohol, can be used in the ordinary gasoline carbureter without any adjustment whatsoever, as far as the air inlet is concerned. Such mixtures will not form any carbon deposits, not even in the oldest type of motors.



The cap and valve that seals the cell



Machine for filling the tubes of the positive plate with active material

Machine for making the fine horizontal saw cuts in the tubes of the positive plate

The greatest drawback to the use of benzol-alcohol mixtures in automobile motors still remains the low volatility of the fuel and the necessity for pre-heating it, or for heating the motor itself. It is very difficult to start a motor on the benzol-alcohol mixture, and in the dangerous work which the motor cars are called upon to perform in the war, this starting difficulty at first was a serious drawback. The German army authorities realized this drawback, and every car was ordered fitted with a small auxiliary fuel tank, in protected position, in which fuels of high explosive force and low volatility are carried; chiefly ether, gasoline and benzene. A three-way cock connects this auxiliary tank with the carbureter. When starting the motor, the auxiliary tank is connected, but as soon as the motor has turned over a few hundred times, the gasoline or ether supply is shut off and the regular fuel tank is connected.

The installation of the auxiliary tank, strange to say, was about the most successful innovation introduced by the German army authorities. It is reported to have saved a large number of motor vehicles from capture by the enemy. Nearly all gasoline tanks (that is to say, the regular tanks) on German automobiles are fitted with pressure feed, and the moment a rifle bullet or shell fragment pierces the tank in its exposed position, the fuel supply is shut off automatically and the car has to stop. But with an auxiliary tank the car may still be operated, by simply turning the three-way cock. The driver is enabled to cover 10 or 15 miles without any difficulty, bringing his car to safety; so that the installation of the "starting" tank has really worked out to even better advantage in providing also a reserve fuel supply for emergency cases.

The general use of benzol-alcohol mixtures by thousands of professional chauffeurs, drafted into army service, is certain to be felt in the field of motoring after the war is over. Motor trucks, even before the war, have been operated to no small extent on benzol-alcohol in Germany, and a strong propaganda is now being waged by the chauffeurs, the Imperial Automobile Club and the military authorities, to extend further the use of such mixtures, with gasoline starting tanks. There is a strong probability that gasoline will be used to a less degree by motorists in Germany, than it was before the war. Popular prejudices, based chiefly on limited knowledge and mis-information, have been conquered, and the strong incentive of "patronizing the home industries" apparently makes it easy to stick to home-made fuel, instead of returning to imported gasoline.

Insects as Spore Carriers

AMONG the numerous diseases of various plants caused by parasitic fungi, none are better known or have received more attention from scientists and the general public than the chestnut tree bark disease which has been recorded from all states in which the chestnut tree grows naturally. The fungus causing this disease is called *Endothica parasitica*, which is killing millions of chestnut trees annually. No efforts on the part of the state and federal authorities are spared in the way of preventing the spread of this disease wherever the presence of the fungus is detected. It was supposed originally that the most frequent and rapid mode of spore dissemination was by wind wafting the spores from tree to tree, and that a good method of combating the disease was by cutting and removing not only the diseased trees, but also those that stood close to them, especially those in the direction of the prevailing winds.

Although the amount of success depended very largely upon the thoroughness, combined with an intelligent method of carrying out the work, it was soon learned that there must be means of spore dissemination other than by wind. Plant pathologists observed during recent years that insects are directly responsible for the spread of certain plant diseases, and the Pennsylvania Chestnut Tree Blight Commission in coöperation with the Office of Forest Pathology, U. S. Bureau of Plant Industry, undertook to demonstrate experimentally whether insects carry spores of the blight fungus. The result of the work conducted on this project by Mr. R. A. Studhalter, formerly of the U. S. Bureau of Plant Industry, and Mr. A. G. Ruggles, of the Pennsylvania Blight Commission, are published in Bulletin 12 of the Pennsylvania Department of Forestry.

A careful study of the findings of the recent investigations dealing with the subject of insects as carriers of the spores of *Endothica parasitica* affords convincing evidence of a real connection between insects and this disease. The only point in doubt now is to what extent the insects are responsible for the rapid spread of the disease. Granted, at any rate, that insects are responsible for a large share in the dissemination of the chestnut tree bark disease, it must be allowed that the study carried on by the Commission is of the greatest importance. It gives strong support to the theory that the spread of other plant diseases are directly traceable to the action of insects.

Feeling Through the Fog by Wireless

A New Means of Locating Vessels at Sea

By Robert G. Skerrett

POSSIBLY it may not be quite exact to say that fog is as much of a menace to the navigator as ever; but it is undoubtedly true that a formidable peril lurks in these visually impenetrable banks of mist. Therefore, both the seafarer and the water-borne passenger have every reason to be interested in the invention of Otto Fricke, an engineer and a former mariner.

The cunning displayed in this new mechanism is two-fold. It is a clever combination first of existing facilities of established value, and then this union of forces, so to speak, is made effective through mechanisms that provide a visible guide for the groping navigator. The seafarer is accustomed to depend upon charts, especially when piloting his craft in the neighborhood of the land. Topographical features are permanent, but a nearing ship, hidden by the fog, while just as much of a danger as a submerged ledge or a jutting headland is, however, on the move. Therefore, the thing most desired is that the man on the bridge may know just where this particular menace is and the speed and the direction in which it is advancing. In brief, what is wanted is a chart that changes at short intervals and carries a trace of the unseen vessel's course.

To this end, certain data are necessary. First, the distance off of the invisible craft that is underway, and next some check on her position at chosen intervals of time, this information serving to show both her path and the speed with which she moves onward. Mr. Fricke obtains this information by means of wireless telegraphy and the lagging travel of sound signals, the interval between the arrival of the two messages serving to establish the factor of distance with a reasonably accurate approximation. We say approximation, because it is a well-known fact that intervening strata of different temperatures affect somewhat the speed of transmission of sound waves through the air. But this is not a serious handicap in the case of the field of usefulness of the present apparatus, because absolute exactness at the start is not necessary in measuring the interval between vessels several miles apart.

The velocity with which wireless waves travel is such that their departure and arrival across a gap of 10 miles, let us say, is for all practical purposes instantaneous. While sound waves sent simultaneously with the wireless ones come along afterward seconds later. By measuring the difference in time between the receipt of the wireless and the sound signals thus dispatched from a far-off ship it is possible to come pretty close to determining the remoteness of the sending craft. The invention in question constitutes an apparatus which, in time of thick weather, is continually on the alert, and automatically responds to impulses of the character described and makes a graphic record or series of records, by means of which the navigator is both warned of the approach of another ship and shown just what he must do in order to steer a course that will carry him safely away from or past the other steaming vessel.

Basicly, the registering mechanism is operated by clockwork, which is brought into play by wireless. This machinery causes a series of radial belts—directed toward as many different parts of the entire horizon—to move uniformly outward from a common center. That center represents the ship carrying the apparatus, and each of these belts bears two tinting points placed equidistant, but only one of which is operable during its travel from the center to the rim. Above these belts, which are disposed like the spokes of a wheel, is a translucent disk upon which is marked a series of concentric circles, and each zone typifies a mile. The disk is of paper and removable, so that it can be filed away for record. The method of functioning is as follows:

Upon the arrival of the wireless "dash" from the far-off craft the clock-work is released and all the belts start moving outward from the center taking with them their passive tinting points—passive because they leave no marks. Seconds later comes the sound signal. This is received by a telephone transmitter which, in its turn, closes a circuit which operates a relay. The relay, in its turn, energizes a magnet located within the travel of the belt that happens to point in the particular direction of the source of sound. This magnet acts upon a bit of iron on one end of each of the tinting points carried by that belt; attracts these lower ends; and, in the case of the one on top, brings its coloring tip up sharply against the under side of the translucent paper disk. Just where the mark is then made shows the direction as well as the distance off of the unseen craft that dispatched the operative signals. The mechanism comes to a halt when the upper pen has reached the outermost limit of the belt, and, at the same time, the second tinting point is ready for action at the central starting point.

Again, a few minutes later, the remote ship repeats the sending of her dual signals—wireless and sound, and once more the clock-work functions, starting the belts rimward with their markers; and when the sound impulse arrives later the record is made—only that tinting point responding, as before, which at that instant points toward the fog-hidden vessel. Thus it goes on from time to time, and upon the paper disk are dotted the successive positions of the distant craft in relation to the vessel warned. First the tell-tale dot is in the neighborhood of the outer zones, and gradually the succeeding dots come closer and closer as the two steamers draw nearer to each other. It is understood, of course, that the idea is that all liners should be equipped with an outfit of this sort; and once two vessels have established the fact of their proximity in this way, they would alternate in sending signals and thus give each other a graphic story of their respective courses, distances, and speeds.

The direction-determining part of the apparatus hinges upon the placing of the sound detectors at points around the ship's deck corresponding to the radial positions of the several pen-carrying belts; and the telephone transmitter or detector in any one of these positions controls only the tinting point of its associate belt. To prevent operative confusion, each sound detector is blanketed by flanking walls so that it can receive sound impulses coming only from a limited sector of the horizon. But should three of these mechanical ears pick up the signal—each making a mark on the disk, the true direction would normally be the mean position; and the same would be the case should two of the detectors respond to the sound waves.

Primarily, the apparatus is designed for service on the open sea or upon fairly expansive waterways where the signals would be exchanged over distances of some miles. However, should a number of vessels be concerned they would alternate in sending their signals, and this can be just as easily arranged in the case of the combined wireless and sound impulses as it is now commonly practiced in sending either of these signals. Of course it is understood that the first purpose of the instrument is to pick up sounds that would not readily be detected by the ear, and in this manner to discover and to place a far-off ship, thus giving an ampler period of warning—in effect a wider margin of safety.

This same sound-recording apparatus is equally capable of serving to detect icebergs or any other sound-reflecting body. For this purpose the ship's whistle is blown *before* the wireless "dash" is dispatched, or the clock-work can be released by hand immediately after the siren blast. As the sound has to travel to the reflecting surface of the hidden menace and then back to the telephone detectors the clock-work is arranged then to run at half speed. In this way the true distance of the iceberg or other menacing mass can be determined by means of the echo.

The New York Motorboat Show

THOSE who had an opportunity to visit the Motorboat Show, which was held at the Palace last week, certainly had occasion to congratulate themselves, for it undoubtedly presented the best collection of real boats, both in numbers and in variety of styles and models, that has ever been gathered together at one of these popular exhibitions. Almost every description of boat, from tiny rowing tender to lordly cruiser, which, with its silky black sides towered in the halls of the Palace like an ocean liner, was to be found, something to match every taste and every requirement. One class, however, which has been prominently represented at most of the previous shows, was missing, and this was the racer, for the racing machine of to-day has become such an expensive and formidable combination, three parts engine and one part boat, that there are not very many craft in existence that can rightfully claim title to a place in the championship class, and there is little inducement to the builder of such a boat to exhibit his creations for the benefit of trade rivals.

The most diminutive boat in the show was an atom of a hydroplane that was about the size and shape of a shingle, but powered with a "V" type aeroplane engine it boasted of a speed of thirty-five miles an hour. Needles to say, it was a decidedly smooth-water affair. A novel feature of this craft was the mounting of the rudder on a skeleton outrigger that extended several feet behind the wheel.

Among the pleasure boats the smallest specimen shown was the homely little "jitney," a flat-bottomed skiff model, with the wheel located in a rectangular stern tunnel, and a little motor stowed away in a sort of vest-pocket compartment amidship. Starting from this lower extreme the line extended upward through a delightful series of graceful runabouts in mahogany and teak to the lordly 60-foot cruiser above mentioned, which was finished in elaborate detail and luxury and powerful enough to sail on any sea. Two splendid lifeboats were also shown, impressive on account of their sturdy construction and powerful models, one of which was fitted with a motor located within a water-tight housing amidship.

Cruisers having complete living accommodations are growing in popularity, and the competitions instituted by various associations, first as tests of reliability and seagoing qualities, have developed into speed contests as well, and one of the large boats shown has achieved quite a reputation in this direction. This craft is of the now popular "V" bottom type, a method of construction that is being widely adopted, and there were several handsome specimens of this type shown; but the older round bottom, or displacement model, still holds its own, as is evidenced by the number of handsome and speedy runabouts seen in the exhibition, and these formed attractive pictures with their immaculately polished hulls, gleaming metal work and luxurious passenger accommodations.

While the finished boats were the most prominent features of the show, the exhibition of engines was equally important and interesting, and a striking feature of the exhibits was the almost universal practice of inclosing all working parts. This method of design makes the motor so cleanly that the owner-operator is not now compelled to don overalls when going out for an afternoon run, and the smooth, enameled casings add greatly to the tidiness and attractiveness of any craft. In every direction there was evidence of unusual attention having been given to refinement in both design and workmanship, and the comparison between the engines of to-day and those of five years ago is most striking. This refinement is the most prominent feature of the motors shown, but there are a few notable novelties, one in particular being a new "express" model, specially designed for use in the fast cruiser, which is becoming so popular, or in the speedy runabout. In such craft high power in a compact form is required, and the engine must necessarily run at high speeds for considerable periods of time. In the past such engines were difficult to operate because of the liability of the bearings to heat, and the watchful attention of an expert was necessary to avoid a breakdown. In the engine in question, in addition to bearings of a liberal size, a forced feed system of lubrication is introduced which insures that all bearings are constantly flooded with oil. The surplus oil, together with that which has flowed over the bearings, passes to the base and is utilized to lubricate the wrist pin and pistons by the splash; but the notable feature is the water-jacketing of the lower part of the base, which thoroughly cools the oil before it returns to the pump to be circulated again. This not only maintains the oil in better condition, but insures a double cooling of the fast moving shafts and pins. Another novelty was a two-cycle motor which was provided with pumps that drew the mixture from the carbureter and forced it into the cylinder, thus insuring more perfect scavenging and a fuller charge than is attained by the ordinary system of base compression.

There was one Diesel type engine, suitable for yacht work, and several oil engines of the hot bulb type, especially designed for heavy duty in commercial vessels; and these were well worthy of careful study, as the use of internal combustion motors in working boats, in place of steam, is rapidly becoming of greater importance. Indeed, if the price of gasoline continues to increase, we may expect another year to see motors of this type offered for use in pleasure craft. It is certainly a question that has so far received too little attention from builders generally.

An attractive assortment of accessories was shown, to me every requirement of the motorboatman; but the star feature of this department was the gyro ship stabilizer, which was shown in actual operation, attached to a model section of a boat which, by an ingenious mechanism, was caused to roll in a very natural and suggestive manner. The attachment here shown, which would be suitable for a craft of about three tons displacement, was very compact, and its control over the movements of the boat is one of the marvels of modern science.

Spaces were occupied by the New York Naval Reserve, the Junior Naval Reserve and the New York Nautical College, where displays of an educational character added variety to a notable exhibition.

Another System of Generating Electricity

One of the latest propositions for producing electricity commercially is the application of thermo-electric couples placed around a heated flue. These couples are composed of an element made of a special secret alloy and a copper-nickel element. These elements are separated by a layer of mica insulation and are joined together at their hot ends by a band of electrolytically deposited copper. Five of these elements are connected together in series to form a unit, and a suitable number of these units, which are wedge shaped, are formed into a ring that surrounds the heated flue, from which it is insulated by an interposed layer of mica to prevent short circuiting the units. The unheated ends of the elements are kept cool by circulating cold air around them. It is said that the cost of installing such a sytem, as compared with steam, gas and oil operated engines, is as 13 compared to 26, 30 and 38, respectively, while the cost of producing electricity by this arrangement compares with the above sources as 5.6 to 24, 16.5 and 19.3, respectively, not taking into consideration the cost of depreciation or attendance of the steam, gas and oil plants.

New German Freezing Apparatus.

Reporting from Hanover, Consul Robert J. Thompson says that what promises to effect a considerable economic result in the future physical comfort and health of man is a newly invented freezing and refrigerating apparatus, a model of which has recently been privately exhibited in that German city, and the operation of which he describes:

The device is an extremely simple and inexpensive affair, costing perhaps not more than $1 to manufacture. It consists of a double-wall tin vessel with a capacity of 5 gallons or more. There is a hollow space between the two walls, or inner and outer vessels. This space completely surrounds the inner compartment and is about an inch in width. By the graduated admission of carbonic acid to this surrounding chamber at the bottom of the vessel, and from this surrounding chamber into the vessel proper at the top through a cross-armed tube, the contents of the vessel are frozen quickly and completely. Water is changed into ice in the space of sixty seconds. Meats, fruits, bottled beverages, such as beer, champagnes, wines, etc., may be chilled or frozen in a few seconds. This effect is produced by the sudden great reduction of temperature caused by the rapid expansion of the carbonic acid, which is admitted from an ordinary carbonic acid reservoir. The invention is at present designed for hotels, restaurants, hospitals (particularly field hospitals), and the ordinary household.

There is some difficulty in making paint adhere to cement, but if the cement is first washed with 1 per cent sulphuric acid (one part concentrated acid to one hundred of water), rinsed and allowed to dry thoroughly, the paint will find the surface suitably prepared for adhesion. Or the cement may be covered with three coats of water glass (silicate of soda), one part to four of water, and then painted. A first coat of linseed oil varnish followed by the usual paint is effective.

flash. A suitable flashing charge for the bullets, which gives a brilliant flash and leaves a white deposit, comprises a mixture of powdered aluminium or magnesium or an alloy thereof and a nitrate or chlorate, for instance nitrate or chlorate of baryta. The composition found most suitable is:—Nitrate of baryta 8¾ parts, fine coal ¼ part, aluminium 5 parts, and this produces a white flash and leaves a white deposit.

SELECTED FORMULÆ.

Bottle-Sealing Materials.—What is commonly known [as] bottle wax is made by melting together ordinary [ro]sin and beeswax, a little Venetian red being usually [a]dded to color it. The proportions of rosin and wax [a]re about 15 to 2; some variation is required for [c]limate. Burgundy pitch may be added to give a [to]ugher wax, the proportions then being rosin 12, wax [1], and pitch 2.

When prepared to be sold to the general public the [w]ax is usually molded into square "sticks." The [m]olds may be open pans of tinned iron, which should [b]e "chilled" by surrounding with ice cold water just [b]efore pouring the wax. The pouring should be done [w]hen the mixture has been allowed to cool nearly to [t]he "setting" point and it should be well stirred as [i]t nears this point and until pouring to prevent sep[a]ration of the ingredients.

A finer kind of sealing wax may be made by the following formula:

Shellac	25 parts
Rosin	45 parts
Venice turpentine	15 parts

Color by the addition of Venetian red or ultramarine, etc.

A transparent red coating for cork tops and for sealing bottles is made as follows:

Select a clear sample of gelatin; to 3 parts of it add 9 parts of water, let soak until the gelatin is softened, liquefy by gently heating, and add 2 parts of glycerin, and enough cochineal coloring, N. F., to impart the desired tint.

The liquid must be kept warm for use, as it solidifies on cooling.

It may be necessary to slightly vary the proportions given to secure the exact result which is wanted.

Any coloring matter desired can, of course, be used; by soluble colors like cochineal coloring a transparent coating will be had, and insoluble ones, of course, give an opaque coating.

While the glycerin has a certain preservative power, it may be best not to prepare the solution in greater quantity than is required for early use.

Care must be taken to have the surface to be coated entirely free from grease.

The cap may be stamped while still soft with a slightly oiled die.—Drug. Circ. and Chem. Gaz.

(13046) C. L. V. asks: Will you kindly tell me what preparation or chemical solution I can use to make wood burn with a blue or other colored flame for use in a fireplace? A. Artificial drift wood, which burns with a greenish or blue flame like the wood from an old wreck, may be made by soaking pieces of soft wood, white pine or white wood, in a strong solution of copper chloride in water and drying the wood. A pound of copper chloride will serve to prepare a large quantity of wood. The best way to proceed is to set the pieces of wood, split as for kindling, end wise in a wooden, or better, an agate pail. The solution will soak into the wood better if the upper ends of the sticks are out of the water and dry. Do not use an iron pail because it will be ruined by corrosion from the solution. The addition of an ounce of lithium or strontium chloride will give red flashes in the flame.

A CARBON ELECTROLYTIC INTERRUPTER.

The loss of platinum in a Wehnelt interrupter by wearing away of the point in dilute sulphuric acid when large currents are used suggested the employment of a cheaper material. Fair results are obtained for a time with an anode of copper wire, well insulated except for one to one and one-half millimeters at the tip, with a lead plate as cathode, but the working is not satisfactory. Other metals and solutions have been tried with indifferent success. The critical voltage below which an interrupter fails to work properly seems to vary with different metals. Although for carbon this point is rather high, it appears to give by far the best results. A new apparatus is described, having as anode a carbon rod 3 millimeters in diameter, immersed in 20 per cent potash solution in a lead jar 27 millimeters in diameter and 80 millimeters high, which forms the cathode and is cooled by water. Heating is also prevented by copper-plating the anode to within 1.5 millimeters of the tip. The rod is inclosed in a tube with a stirrup at the bottom, and as it wears away it slides down the tube and so always exposes the same length. It is adapted for a 6-inch spark coil on a 100 to 110-volt direct or alternating circuit [illegible] use of a resistance in series. By adjusting [illegible] stirrup or the size of the rod any other spark length within the security of the coil may be provided for. [illegible]

AN IMPROVED LIQUID INTERRUPTER FOR INDUCTION COILS.

The following is a description of an improved form ... Caldwell interrupter for induction coils, ... in conjunction with Mr. J. C. M. ...

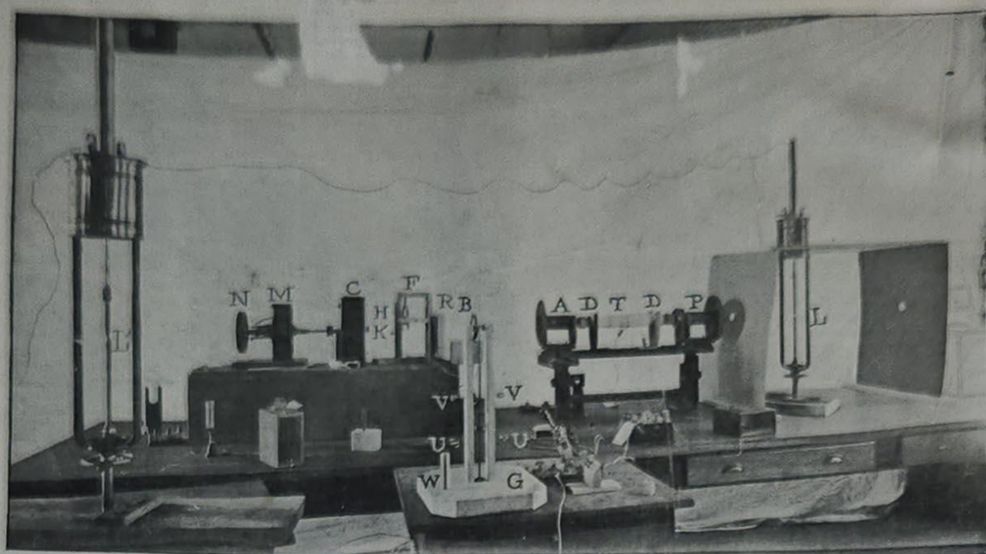


FIG. 1.—ARRANGEMENT OF LABORATORY APPARATUS.

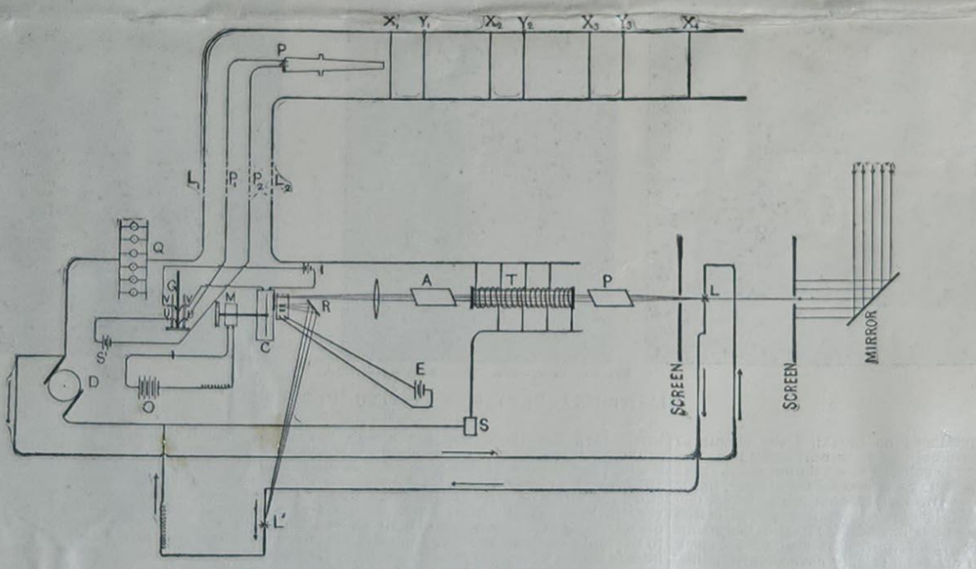


FIG. 2.—COMPLETE ARRANGEMENT OF ELECTRICAL CIRCUITS.

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* An abstract from an interesting paper by Dr. Albert C. Crehore, Assistant Professor of Physics at Dartmouth College, and Dr. George O. Squier, First Lieutenant, Instructor United States Artillery School. For a full account of these experiments see Journal of the United States Artillery, July, 1895.—Fortress Monroe Press.

THE POLARIZING PHOTO-CHRONOGRAPH APPLIED TO THE MEASUREMENT THE VELOCITY OF PROJECTILES.*

THIS new instrument for the reliable measurement of very minute intervals of time was developed in some preliminary experiments at the United States Artillery School, Fortress Monroe, Va., in measuring the velocity of projectiles from the new 3·2 inch B. L. field rifle adopted by the army.

In the course of these experiments, which were necessarily limited to two weeks' time, observations were taken at intervals as small as 5 feet, and as many as ten consecutive observations at 5 foot intervals, beginning at the muzzle of the gun and extending to 45 feet distance, were easily obtained from a single shot. This instrument being admirably adapted for recording the passage of the projectile at a number of points of its trajectory, it was made an object to study the law of variation of the velocity of a projectile near the muzzle of a gun. From measurements on the negatives it is clearly evident from each that the velocity

actually increases after leaving the gun, a fact which has long been suspected, but which, so far as we know, has not previously been demonstrated experimentally.

The particular form of transmitter used in these experiments depends for its action upon the use of polarized light. A sensitive photographic plate is made to rotate at a known speed in a light-tight box, and light is admitted to the plate through a narrow slit by means of a "massless" shutter, as the inventor terms it. Any material shutter would possess a certain amount of inertia, and would not admit of a practical result. By the use of a polarizer the light is admitted or shut off without the movement of any material thing.

As is well known, the most efficient polariscope consists of a pair of Nicol prisms. When the prisms are "crossed," the light is totally extinguished, as though the beam had been interrupted by an opaque body. By turning the analyzer ever so little from the "crossed" position, light will pass through it, and its intensity increases until the planes of the prisms are parallel, when it again diminishes, and if one of the prisms is rotated, there will be darkness twice every revolution.

To accomplish the end that is obtained by rotating the analyzer without actually doing so, a transparent medium which can rotate the plane of polarization is placed between the polarizer and analyzer, and made subject to the control of an electric current. The medium used in these experiments was liquid carbon bisulphide, contained in a glass tube with plane glass ends. This was selected because it is very clear and colorless and possesses the necessary rotary property to a considerable extent when situated in a magnetic field of force, the rotary power being in proportion to the intensity of the magnetic fie'd.

To produce a magnetic field in the carbon bisulphide a coil of wire is wound around tne glass tube, and an

electric current passes through the coil. The prisms being crossed, so that no light emerges from the analyzer, a current is sent through the coil on the tube, causing the rotation of the plane of polarization.

This is equivalent to rotating the polarizer; hence a light now emerges from the analyzer. When the current is broken the medium loses its rotary power and there is again complete darkness. This arrangement makes an effectual shutter for the beam without moving any mass of matter.

A view of the laboratory apparatus is shown in Fig. 1. Fig. 2 shows diagrammatically a complete arrangement of the electrical circuits and apparatus, and Fig. 3 shows the apparatus on the proving ground. Corresponding letters represent like parts in the figures.

The arc lamps, L and L', are used as sources of light. P is the polarizer; T, the transmitter tube containing carbon bisulphide and wound with magnet wire; A is the analyzer, in front of which is a lens to condense a beam of light upon the camera, C. The motor, M, revolves the sensitive plate in the camera.

The speed of the plate is obtained at the moment of firing by the shadow of one prong of a tuning fork cast by a beam from the lamp, L', reflected from a mirror, R, upon the sensitive plate, the tuning fork being run electrically by the cells, E. At X', X², X³, etc., placed at regular intervals from the gun, are wire screens which are cut one after the other by the projectile.

At Y', Y², Y³, etc., are placed devices for mechanically restoring the current. Before firing, the current passes only through the screen, X', because of an insulating plug placed between the jaws of the device which interrupts the connections between X', X², X³, etc. When the projectile strikes a wire attached to this insulating plug, the plug is pulled out and the jaws spring together, thus establishing the circuit through X².

The receiver is a photographic means of recording

the intermittent beam of light through the analyzer, and consists of a camera containing a sensitized plate, which is shown in position ready for use at C (Fig. 1). Detailed views of the camera are shown in Figs. 4 and 5. It is made of wood, in the shape of a rectangular box, the interior dimensions being 10 inches high by 10 inches wide by 2·5 inches deep. Fig. 4 represents the front view of the camera box, A, with the cover, B, removed, showing the small auxiliary dark chamber, C, which contains the electromagnetic device, D, with armature, E, attached to the brass spring, F, for releasing the camera slide, G. This slide is shown in the photograph, withdrawn from the grooves in which it normally slides by passing it through the opening at the top after removing the cover, H. The na... horizontal slit through which light is admitted ... photographic plate is shown at I.

When the camera slide is in position, the na...

rests upon the top of the brass spring, F, and the upper edge, L, of the lower screen of the slide covers the slit, I. When the current passes through the electromagnets by the binding posts, M, the armature is drawn and the slide released. The slit is exposed only while the opening in the camera slide is passing by.

When the camera slide comes to rest, the upper screen, G, covers the slit and it remains so covered. The upper screen, G, is capable of adjustment along the brass rods of the slide, and the opening between the upper and lower screen of the camera slide is thus adjustable, and the time of exposure of the slit under control.

The wires shown at O are for the purpose of producing on the plate reference circles by casting their shadows. The entire back of the camera is removable, and its outside face is shown at P. Through the cen-

Heat absorbent cell

Solutions of alum have long been employed for intercepting the calorific rays of light. The use of alum for this purpose was an article of faith until an experimenter discovered that pure water possesses quite as much absorbent power as a solution of alum. Houston and Logie have been seeking a still more powerful absorbent of thermal rays, which is required in many cases, and have found it in a solution of ammoniacal sulphate of iron. A stratum of this solution, 1.2 inches in thickness, transmits 75 per cent of the luminous rays, but only 5.1 per cent of the total radiation of a carbon filament electric lamp. It should be added that the luminous rays constitute only about 5 per cent of the total radiation, in this case.

elop

Making Mirrors by Electricity

A RAPID and admirable method for depositing suitable metals on the surface of glass so as to produce mirrors consists of decomposing the metal by means of a high potential electric current. It is thus described in the *Physikalischer Zeitschrift* by G. Rumelin.

A metal plate is placed in juxtaposition with the glass plate which is to receive the coating. The two plates are then placed flat on a table beneath the receiver of an air-pump suitable for producing a high degree of vacuum, such, for example, as the rotary pump of Gaede. A small quantity of an inert gas, such as hydrogen, is introduced into the vacuum and a high potential current is then turned on by means of the negative pole of a suitable source of electricity, this pole being attached to the metal plate. Thirty seconds duration of this cathodic flow is sufficient to obtain a properly silvered mirror. Besides silver the metals gold, copper, platinum, nickel, iron, palladium, and iridium may be employed.

(12885) L. C. asks: 1. What is the greatest known depth of the ocean, and where? A. In charting the ocean floor any area below 3,000 fathoms is called a deep. The Aldrich Deep in the South Pacific is one of these, in which three soundings of 5,022, 5,147 and 5,155 fathoms were made by the British ship "Penguin" in 1895. This is exceeded in depth only by the Challenger Deep, which lies between Guam and the Pellew Islands, where in 1899 the United States ship "Nero" sounded to a depth of 5,269 fathoms. This is the greatest depth reached by the sounding wire. 2. Are there any parts of the ocean so deep that, up to the present time, soundings have not established the correct depth? If so, where? A. There are no places known whose depth has not been determined by sounding. The popular notion that there are places whose depth cannot be sounded is entirely without foundation. The writer was shown a small basin a few hundred feet across in Penobscot Bay last summer, and was told that it had no bottom. He looked at it with interest, and wondered how intelligent people could believe such a story. 3. Are there any parts whose depths have not been charted for any other reasons? If so, where? A. All parts of the ocean bottom have not been charted, but surveys have been made over most of it. There may be in the neighborhood of volcanic islands, especially in the South Pacific Ocean and along the Asiatic coast of the Pacific, deeps as yet undiscovered. Sir John Murray's recen work, "The Depths of the Ocean," which we send for $7.50, covers the knowledge we have on this most interesting topic. It describes the methods and apparatus for sounding and the results obtained. One desirous of a knowledge of what has been accomplished should consult this valuable work.

(12886) E. F. O'K. asks: If one square inch of air is compressed one half, what is the pressure? A. If air is compressed to one half its volume the pressure is doubled. The atmospheric pressure is 14.7 pounds per square inch, as against a vacuum. This pressure does not affect a pressure gage when air is on both sides of the gage. For this reason the gage pressure will be 14.7 pounds when the air has been compressed into half its volume, since the gage reads zero before the air is compressed. The pressure as against a vacuum will be 29.4 pounds when the air has been compressed to half its volume. It is customary to call the atmospheric pressure 15 pounds per square inch, in round numbers, and at half volume the doubled pressure will be 30 pounds per square inch, as against a vacuum.

(12887) L. G. B. asks: If two bodies (say like planets) approach one another within the range of appreciable gravitation, what determines whether they will become permanently locked in orbital revolution, or whether they will be only somewhat deflected, and then pass on out of the range of gravitation? A. The problem which you propose is one of celestial mechanics. It is treated in a simple way in Young's "Manual of Astronomy," Chapter XI. We send the book for $2.50 by mail. It may be that this will suffice for your purpose. The general answer to all your questions is that the velocity and masses of the ...

... and the balloon would drop to the earth.

(12884) H. V. asks: Would you kindly tell me if aluminium can be electro-nickel plated the same as iron, brass and copper, and is it done the same way? A. The method for coating aluminium with other metals, as given in Watt's "Electro-Plating" (which we send for $4.50) is first to remove the film of oxide of aluminium with which all aluminium is covered as soon as it is exposed to the air, by first immersing it in a solution of sodium carbonate—washing soda—till gas comes off freely, and then rinse in hot dilute hydrochloric acid, one part acid in 20 parts water, and finally immerse in a dilute solution of copper sulphate. A film of copper is formed upon the surface of the aluminium which adheres firmly and forms a base upon which other metals can be deposited in the usual way. There has been great difficulty in covering aluminium with other metals so that the coating will last.

Working Capacity of a Single Gallon of Gasoline.—According to the *Wall Street Journal*, a single gallon of gasoline will do wonders almost anywhere, but nowhere has it been applied to better purpose than on the farm. It will milk 300 cows, bale 4 tons of hay, mix 35 cubic yards of cement, move a ton truck 14 miles, plow three fifths of an acre of land or generate sufficient electricity to illuminate the farm house for 30 hours.

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The Home Laboratory

[The Editor of the Home Laboratory will be glad to receive any suggestions for this department and will pay for them, promptly, if available.]

Some Optical Experiments With Liquids

By Prof. Gustave Michaud, Costa Rica State College

AMONG the few liquids which we commonly see or even among the numerous liquids which are commonly used by the chemist there is none which has so high a refractive and dispersive index as carbon disulphide. This fact may be used in the class room or in the home laboratory for the production of some pretty optical effects, the only needed apparatus being a small spherical glass flask and a larger vessel, square-shaped with parallel, plane sides, as shown on the accompanying figure. A preserve jar, of such shape, selected among those which have the planer and most transparent sides, will do. Half of it is filled with carbon disulphide (carbon disulphide is very combustible and its vapor, when mixed with air, is explosive; it is a dangerous substance which should be handled with the utmost care), and the production of rainbows, which testify to the high dispersive power of the liquid, is immediately noticed. The little round flask is then entirely filled with water, its exterior surface is wiped dry, and it is submerged in the carbon disulphide. Its appearance has now completely changed. In the air it was a globe made of thin glass and filled with water. In carbon disulphide it is a submerged globe made of thick glass and entirely empty. The cause of the illusion is obvious. So far as the path of light is concerned, a globe filled with water and submerged in carbon disulphide is comparable to a globe filled with air and submerged in water. In both cases the spherical, less refringent medium occupies the center of the large, parallelopipedic vessel and is surrounded by the more refringent medium. The rays are in both cases refracted in similar directions and give similar impressions.

The carbon disulphide is now poured out of the jar and common kerosene is poured in instead. A solid piece of clean, white, polished glass is submerged in it and the vessel is placed between the eye and a vertical sheet of white paper. Carbon disulphide is now added little by little to the kerosene, and after every such addition the liquids are thoroughly mixed and the glass is examined. It seems to fade away gradually until comes a moment in which it is hard to perceive it. The next addition of carbon disulphide will then bring it back to sight, but this time with a changed, hollow appearance.

Kerosene has a smaller refractive index than that of crown glass, while that of carbon disulphide is much higher. The moment in which the glass is the least perceptible coincides with a refractive index of the mixture which closely approximates that of glass. Light passes

Silver ball appearance of empty flask in carbon disulphide.

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then from the liquid to the glass about as if the latter were not there.

For the prettiest optical experiment which can be made with carbon disulphide the empty and dry spherical flask is simply submerged again into carbon disulphide contained in the jar. At first sight the appearance of the little sphere is such as to lead every one to believe that it is but one of the silvered globes that are hung on Christmas trees. The fact is that the greater part of the spherical surface actually reflects light even better than silver does. Only such rays as make a small angle with the perpendicular to the surface of the globe are allowed to pass; the others are incident at an angle greater than the critical angle and undergo total reflection. In the center of the broad silver ring a small but deep hole seems to have been carved, and deep into this hole a small miniature reproduction of outside objects showing a strong stereoscopic relief is perceived, just as appears on a photographic finder when this is a concave lens. This effect is actually produced by the combined action of the two plano concave highly refringent carbon disulphide lenses.

Methyl iodide has a higher refractive index (1.74) than carbon disulphide (1.64) but its price (89 cents an ounce) is almost prohibitive. Carbon disulphide costs but 20 cents a pound.

Warning: Never allow any fire nor any heated object to be brought in the vicinity of a vessel containing carbon disulphide.

Trade Notes and Formulæ

Dead Black Paint for Iron and Steel.—Chloride of bismuth, 1 part; chloride of mercury, 2 parts; chloride of copper, 1 part; concentrated hydrochloric acid, 5 parts; water, 50 parts; alcohol, 5 parts. To insure success, the article to be blackened must above all be perfectly clean and free from grease, the object is then dipped in the fluid, or it is applied by a brush. After it is dry, it is placed for a quarter of an hour in boiling water. If the color is not as dark as desired, the operation is repeated.—*Neueste Erfindungen und Erfahrungen.*

Cleaning Copper Plate Engravings.—Wash the sheet on the front and back sides by means of a soft sponge or brush, with water, to every 1,000 parts of which 40 parts of carbonate of ammonia have been added, and rinse the sheet off with water. Then moisten it with water, to which a little wine-vinegar has been added, rinse again with water, in which a little chloride of lime has been dissolved, and dry in the air, preferably in the sun. The sheet will be perfectly clear, without injury to the print.—*Neueste Erfindungen und Erfahrungen.*

Incandescent Lamp Varnish.—The dipping varnish, used for incandescent lamps, according to the *Werkmeister Zeitung*, consists either of solutions of resin in amyl acetate or of alcoholic solutions of collodion. There is nothing to prevent individual preparation of such varnishes. Some preparations are certainly patented, but the patents mostly relate to the employment of certain solvents, for instance, dichlorhydrin and epichlorhydrin. The principal thing in making such a varnish is the employment of as volatile a solvent as possible, so as to insure quick drying. The color is produced by the addition of coloring substances, especially aniline colors. The solution of a resin is as a rule effected by forcing a flannel bag into the neck of a bottle containing the solvent selected, it is then filled with pieces of resin and the bottle well closed. By this means the solution is effected with fair rapidity, and in many instances filtration avoided. Some resins, however, do not dissolve clear and these are subjected to filtration through a fine meshed sieve, provided at the bottom with a flannel or linen covering. On this is placed a layer of fine, well-washed white sand, then two or three sheets of filter paper, another layer of sand, and again filter paper and sand. After filtration the filter can be washed with pure solvent. Where collodion or celluloid is used as the starting material, it is best to proceed by dissolving 5 parts of celluloid in 50 parts of alcohol, finally adding 5 parts of camphor; or 5 parts of celluloid are dissolved in 50 parts of amyl acetate, or 25 parts of amyl acetate and 25 parts of acetone. As regards the concentration of these varnishes, they must not be too thick, but must rather be fairly thin. The varnish can readily be brought, by the addition of solvent, to the desired concentration, as determined by experiment.

Paper thread?

Artificial Sponges of Paper

WHEN paper pulp is treated with zinc chloride there results a viscous mass. Sodium chloride (or ordinary table salt) is added to this; the mass is then thoroughly rinsed with alcohol, and is finally submitted to the action of a press whose platform bristles with a number of fine metallic points or projections. These penetrate the mass, forming tubes like those in an ordinary marine sponge known as "*canalicules*."

The block thus obtained is of a spongy consistency and is both insoluble and unalterable in water. It is smooth and pleasant to the touch, and is not susceptible of putrefaction. It is a very ingenious employment of the cellulose to which we owe so much.

How to Bleach Ivory.—To bleach ivory ornaments or piano keys the following method works well. The ornaments are first washed or "soaked" if possible in a bath of unslaked lime, which has in it a few ounces of bran and water. This should make a pasty solution if properly mixed, and will bleach the ivory which is discolored or stained. It should be rubbed off with a cloth and the ivory dried in magnesia powder. After a few minutes a few strokes with a cloth gives the ivory a brilliant polish.

(14052) W. F. V. asks: 1. How many cubic feet of hydrogen and oxygen gas can be obtained from one cubic foot of water by the electrolytic method; also what amperage and voltage is required to produce this amount of hydrogen and oxygen in a given length of time? 2. Is there any chemical that can be mixed with the water that will hasten decomposition, or aid the electric current to tear apart the elements that compose water? 3. What is the largest amount of hydrogen and oxygen that can be produced in a given length of time by any method now known? 4. Is there any books that deal with this subject exclusively and where can they be had? A. 1. One cubic foot of water contains about 1,230 cu. ft. of hydrogen gas and half as many cu. ft. of oxygen gas. For the commercial production of these gases by the electrolytic method an e. m. f. of about 3 volts is employed. To separate a cubic foot of water into oxygen and hydrogen about 244 kilowatt-hours are required. 2. If iron electrodes are used, the water should have about 15 per cent of sodic hydrate dissolved in it. If lead electrodes are used, sulphuric acid is added to the water. These substances are not used up in the process but serve to render the water a conductor of the electric current. Pure water only is added from time to time as it is decomposed into its gases. 3. The quantity of gases produced in a given time is limited by the size of the apparatus. If you wish a large quantity you must have a large outfit. 4. We can furnish you with Engelhardt's Electrolysis of Water, translated by Richards, for $——.

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The Laboratory

Some Suggestions for Home Experime

polish. They should be remounted in the original cell, separated by a thick ring of cardboard. The definition will be greatly improved. The magnification of the eyepiece will be increased by removing the front lens.

A Thermo Magnetic Motor and Generator

By E. R. Stockle

THE device described below is an interesting application of a well-known phenomenon of ferro-magnetism, viz., the loss of the magnetic quality of iron at red heat. It will be well before proceeding with a

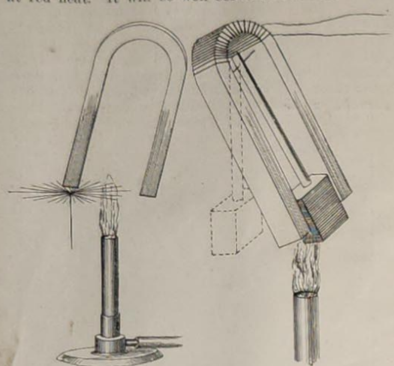

Fig. 1.—The rotating spider. Fig. 2.—An oscillating generator.

description to set forth briefly the manner in which this phenomenon can be employed to furnish mechanical energy, as in a motor, and electrical energy, as in a generator.

Consider the energy expended by a magnet in attracting an iron armature from a distance x to its poles. This energy will be equal to the product of the average force, f, and the distance x. To remove again the armature to its original position before the poles of the magnet, it is necessary to do an amount of work equal to that given up by the magnetic system when the iron was attracted, viz., $f \times x$. Now the energy for this work can be furnished in two ways. Mechanical energy can be furnished the system by exerting a force, f, and withdrawing the iron to its original position, x. Again, heat energy may be given to the system by heating the armature to red heat, whereupon it loses its magnetic quality, and may be withdrawn the distance x without overcoming any attractive force due to the magnet, that is, without doing any work. Upon the cooling of the armature, however, the heat energy again takes the form of potential energy, because of the restoration of the attractive force between the armature and the magnet. This energy is therefore again available as mechanical energy.

To apply this principle to the operation of the thermo magnetic motor in its simplest form, the following apparatus is assembled:

Several equal lengths of iron wire (about No. 30) are fastened to a needle by a turn or two about its center. These wires are then arranged to radiate symmetrically from the needle, thus completing the "spider" or rotating element of Fig. 1. The needle is then suspended from one pole of the magnet by its point as shown, the ends of the radiating wires just clearing the opposite pole. When a Bunsen burner is placed to heat the wires just to one side of this pole, the cool wires on the other side are attracted toward the pole and into the flame, where they in turn become heated, and give place to other cool wires from the other side of the pole. Thus the rotor may be caused to turn at about 200 revolutions per minute.

The Negro a...

A New Industrial Process for Manufacturing Oxygen

By Our Berlin Correspondent

DR. G. KASSNER, professor at Münster University, has designed a new process for the manufacture of oxygen which is based on the Tessié du Motays process but, thanks to the absence of any antagonistic effects, lends itself to a far better industrial application than any chemical method so far suggested. Kassner adds to the alkali manganates used in the Tessié du Motays process an alkali salt of metaplumbic acid, thus increasing enormously the efficiency and constance of the mass. The process comprises two phases characterized by the action of currents of steam and air, respectively. During the first phase the alkali given off by dissociation is immediately absorbed by the alkali metaplumbate, thus forming orthoplumbate. Inversely, during the second phase, which is that of regeneration, the alkali absorbed by the metaplumbate is given back to the residual manganese oxide, thus forming alkali manganate. This is how the formation and decomposition of the manganate due to the addition of metaplumbate (which eliminates any disturbing antagonistic effects) takes place in continuous succession, without any appreciable alteration in the composition of the mass.

In opposition to physical processes which only utilize indirectly the heat units given off by the fuel, this chemical process works without any appreciable heat losses. It is carried out in the following manner:

After being introduced into a suitable apparatus refractory to heat and insuring a constant temperature, the active mass is, by means of a special fire-place, raised to and kept at the relatively low temperature of reaction of about 400 deg. Cent. A mechanically controlled valve causes separate currents of steam (exhaust steam, etc.) and air to enter this mass, at short intervals of equal duration. By inserting a very short discharging phase between the air and steam phases, any nitrogen left after regeneration in the pores of the mass is eliminated. The oxygen produced during the steam phase is led automatically into a gasometer set apart for this purpose. Moreover, a recovering apparatus serves to transmit any heat units escaping with the nitrogen, to the currents of air and steam entering the apparatus, thus preventing as far as possible any loss of heat. Finally, the process is so designed that the charge can be exchanged readily and easily, without any interruption in service worth speaking of, should it after some considerable time's working show any decline in its output which, however, will only happen exceptionally. As, in fact, the active mass remains constant in quality as well as quantity, it will at most require (after protracted working) a mechanical regeneration, restoring it to its previous porosity.

In view of the relative insensitiveness of the mass to the moisture of hot air, the new process would seem to lend itself for metallurgical applications.

The Making of Copper Stencils.—To make copper stencils for marking laundry, etc., stencil sheet copper is used (the thinnest that is made) and dipped in a tin dish containing melted bees' wax so that both sides will be evenly covered with a thin coat of the wax. The monogram, device or figure is then drawn on ordinary white paper, the reverse side of the paper is blackened with graphite, and it is laid on the center of the stencil plate and by means of a blunt needle the design is lightly traced. The design will now be visible on the thin wax coating. With the same blunt needle or point trace the monogram, but not completely, the lines being interrupted at regular intervals, to form "holders," so that after etching the monogram cannot fall out. Then the stencils are laid in a dish, fresh nitric acid poured over it, and the air bubbles removed with a goose feather. In barely half a minute the monogram will be eaten through. This may be observed by holding the stencil up to the light. It is then rinsed off with water and the wax coating removed by heating and wiping it off with a cloth. Any wax remaining can readily be removed with the aid of benzine or petroleum.

"Jungle Foot"
½ lb Rosin
1 liter Castor oil

Removing Iodine Stains

TO remove iodine stains from bacteriological instruments or the hands a strong solution of hypo sulphite of soda is good and effective. The solution should be quite strong, and after its application the solution should be rinsed off with warm water, and the stained article dried well.

Sci Am Sup. July 26/02

FIRE PROOFING

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dition that it would remain permanently fixed in the fiber, a number of pieces of flannelette were soaked in sodium stannate and, after thoroughly drying, separately passed through various solutions containing sodium or ammonium salts at the ordinary temperature and at temperatures up to the boiling point. Although, as was to be expected, the results were not uniformly good, a certain degree of permanent fireproofing was always achieved and consequently the matter was systematically followed up with the result that a process was gradually evolved which yielded material possessing quite remarkable properties. The process is briefly this:

The flannelette (or other material) is run through a solution of sodium stannate of approximately 45 deg. Tw. in such a manner that it becomes thoroughly impregnated. It is then squeezed to remove the excess of the solution, passed over heated copper drums in order to thoroughly dry it, after which it is run through a solution of ammonium sulphate of about 15 deg. Tw. and again squeezed and dried.

Apart from the precipitated stannic oxide, the material now contains sodium sulphate and this is removed by passage through water; the material is then dried and subjected to the ordinary processes of finishing. A long series of trials, carried out under the most stringent conditions, have conclusively proved that material, subjected to this process is permanently fireproofed. No amount of washing with hot soap and water will remove the fireproofing agent, or in other words, the property of resisting flame lasts so long as the material itself lasts. I will demonstrate this by exhibiting four different specimens: (*i*) material as it leaves the process and before washing, (*ii*) material which has been washed 10 times by hand, (*iii*) material washed 20 times in a machine in a laundry, and (*iv*) a portion of a garment which has been in actual use for 2 years, washed every week and is, as you see, in rags. This extraordinary property of resisting soap and water seems to me to indicate that the oxide of tin is not present merely as an insoluble precipitate in the cloth, but must have entered into some actual combination with the fiber, yielding a compound which is not broken down by the action of the weak alkali of the soap. But a matter of hardly less importance from the practical point of view is that the material is not only permanently fireproofed by the process I have just described, it also retains and acquires properties which make it as perfect a material in all other respects as could be desired. In the first place the treatment has no effect on the delicate colors which are now so generally employed in connection with the manufacture of flannelette and other cotton goods, and very careful experiments have demonstrated the fact that the insoluble tin compound in the fiber has not the slightest deleterious action on the most delicate skin. In addition, the presence of the tin compound in the pores gives the cloth a softer and fuller feel than that of the original flannelette, and what perhaps is the most unexpected result is the fact that the material is considerably strengthened by the process.

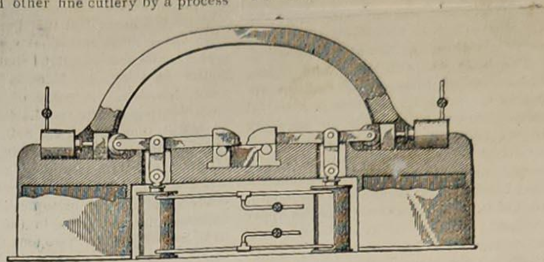
A series of tests made by the Manchester Chamber of Commerce proved that the tensile strength of flannelette is increased nearly 20 per cent as the result of the introduction of the tin compound into the fiber.

Telephoning from the Body

Prof. D'Arsonval lately presented to the Académie de Médecine an interesting series of researches made by Dr. J. Glover upon a new method of telephoning in which the microphone transmitter is placed against the human body. He had the habit of making an auscultation of patients by using a telephone transmitter placed upon the body, while the observer listens in the receiver, and found that when the person spoke, his voice was heard in the receiver much more distinctly than in the usual way of speaking before the microphone. In fact, the sounds are transmitted better by the body than through the air, and all outside noises are eliminated such as often cause disturbances. Thus it is an easy matter to telephone with face and hands free and with the transmitter applied say on the chest or back. In this case the voice is heard in the receiver with remarkable clearness, and this precision is also shown by the oscillograph curves which he made. Such a method of telephoning might possibly be put to practical use.

POLISHED BLADES FORGED ELECTRICALLY.

"The way to make excellent cutlery is, without a blacksmith, without a grinder, and without a polisher." Such is the startling declaration of an inventor who is preparing to manufacture blades for razors and other fine cutlery by a process



ELECTRIC FORGING FURNACE.

which is indeed revolutionary. Under the only methods of manufacturing cutlery now in use anywhere in the world, the blacksmith, the grinder and the polisher are each most important factors. It is difficult enough to imagine how any one of these is to be eliminated from the process but that they are all three to go, truly makes one marvel.

Apparently the only skilled workman left, under this process, is the temperer. Electricity is to be the wonder-worker, aided by vacuum pumps, refrigerating machines and clever power forgers. The new process is the invention of Joseph Misko, M. E., of Pittsburg, Pa.

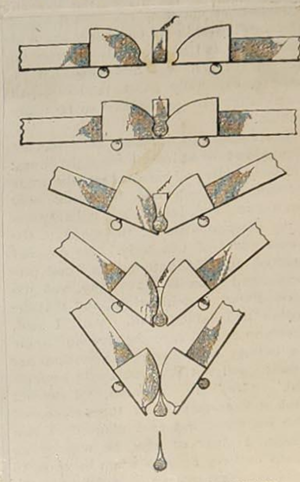
In the Misko system the usual process of manufacture is reversed. The grinding and polishing are done before the forging is begun. A rod of steel ten feet long or of any other convenient length, is taken for this initial process. The rod is ground on all sides and polished. In this state it contains just enough material for the forming of the blades into which it is to be converted. It is now ready for the forging.

The forging machine is a tunnel of steel a little longer than the steel rod. Lying along the middle of this tunnel and with their ends separated enough to receive the prepared rod and yet not touch it, is a double row of dies reaching almost to the full length of the rod.

Each pair of these dies is ready to form a blade, each die forming one side of it. The upper part of the tunnel is an arch of steel which trusses the dies together and serves also as a guide to them in their forging operation. At each end of the dies are hydraulic presses and there are more of these below the dies on either side.

The operator thrusts the rod of cold polished steel into the tunnel and between the die heads. He closes the door and touches a button. Powerful pumps quickly exhaust the air out of the machine. As the door closes and seals itself, electrical connections are made on either end of the polished steel rod. As the air disappears from the inside of the chamber the electric current is turned on. In a few seconds the rod is at a cherry-red forging heat. Another touch by the operator and the dies close together, forming with their ends the backs of the blades into which the rod is to be transformed. Another touch and the far ends of the dies begin to travel up the arched sides of the tunnel. As they move the inner ends close more and more with a revolving motion, squeezing down the steel between them until at the last it is forced into a very thin edge.

The operator returns the dies to their places, cuts off the current and opens the machine. The steel rod has been transformed into a series of shining polished blades. There are nicks between the blades, marking where they are to be broken apart later. As there was no air in the forging chamber the blades have lost none of the brightness of the polished rod of steel.



HOW A RAZOR BLADE IS FORMED.

The next operation is the hardening. Again the rod of blades is placed in a tunnel and the air is exhausted. This time instead of dies there are on either side of the rod heads of metal indented to fit the blades and inside each head runs a stream of refrigerating brine, cooled to below the zero of the thermometer. The current is again applied to heat the rod of blades and when they are glowing the refrigerated heads close together, chilling the thin steel, but doing it so evenly that it is claimed that there is no tendency to produce warping or cracking.

Still the blades are bright and polished when they come from the hardening machine. To put the finishing touch to the blades, Mr. Misko has devised a refrigerated grinding and polishing wheel on which the cutlery would be kept from losing its temper though it were ground dry as is the custom. These wheels are of hollow iron with the abrasive substances cemented to their outer edges and the whole kept cool by a stream of freezing brine run through the inside of the wheel. A factory to make use of this process will soon be erected at Newcastle, Pa.—Elect. Re.

Rights of Joint Owners of Patents

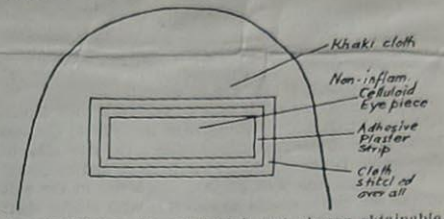
JOINT patentees, or joint owners of a patent, no matter what the relative proportions of the interests may be, can each and all of them exercise all the rights secured under the patent entirely independent of each other and without the necessity of accounting to their co-owners. They can do everything separately and on their own account except to sue infringers, in which proceeding it is necessary that all the owners combine as parties plaintiff. In case one of the owners should decline to join in a suit to restrain infringement the suit may be instituted by the other co-owners naming as one of the defendants the one who refuses to join as a party plaintiff. Each of the co-owners may manufacture, use and sell the invention on his own account and for his sole benefit, and may freely license anyone else to do the same, and may keep for himself all the profits, and this is true even though he owns but a relatively small interest in the patent. There is no legal right in the others to demand an accounting, or any part of the profits.

Should the co-owners be bound by an agreement that neither of them will part with his interest or any part thereof, nor grant any licenses without the consent in writing of the others, he can still sell and give a good title to his purchaser and can still grant licenses to others, and the co-owners would have no cause of action against the purchaser, or licensee, but could proceed against the co-owner, who had violated his agreement for damages and possibly for a share of the proceeds. The purchaser or licensee would remain in undisturbed possession of the interest which they acquired.

Therefore, it is always best that a patent should be owned entirely by one person, or a firm, or a corporation. If two or more persons not partners in business, and not stockholders in a corporation, desire to participate in the profits arising from a patent, they should assign their interests in the patent to one or more persons in trust and by a suitable trust agreement define the powers of the trustee and specify under what conditions he may work or dispose of the patent and the interest of each of the parties in the proceeds. In this way and this way only can the interest of joint owners of patents be protected, and each of them participate in the profits, when they are not co-partners in business and not stockholders in a corporation.

...ti-chlor. Respirators

...ators used by British soldiers who have ... going into atmosphere poisoned by Germans ... chlorine are saturated with a solution of sodium hyposulphite and sodium carbonate. The following is a diagrammatic sketch of a hood which is being much used:



As non-inflammable celluloid is not always obtainable, transparent, insoluble and non-inflammable gelatin is also used. The hoods, with the insertion for the eyes, are saturated with the following solution by means of a powerful spray; they are then packed in waterproof tissue to retain their moisture as long as possible, though the War Office says that it is not essential if water is at hand; *it must be moist to be efficient, the nose and mouth being covered.* The eyepiece is first stitched in, then adhesive plaster placed over it.

Sodium hyposulphite	15 oz.
Sodium carbonate	5 oz.
Glycerin (by weight)	2 oz.
Water	10 oz.

Mix the glycerin and water, and dissolve the salts in the mixture, straining if necessary.

A little eucalyptus essence may be added to the solution as a refresher. About 6 fluid drams of the solution is used for each respirator.

The main reaction is represented in the following equation:

$$4Cl_2 + Na_2S_2O_3 5H_2O + 5Na_2CO_3$$
$$= 2Na_2SO_4 + 8NaCl + 5H_2O + 5CO_2$$

There are secondary reactions, but it will be seen that the chlorine is fixed as sodium chloride.—*The Chemist and Druggist, London.*

Cheap Subsitute for Horn

As a cheap substitute for horn the following composition is being employed. It is prepared from wheat flour and silicate of soda. The compound consists of mixing ten parts of silicate of soda with a little water, and then making an addition of fine wheat flour to the resultant liquid until a thick paste is formed with consistent stirring. This composition can be colored to imitate almost any kind of horn substance by mixing with the former ingredients different organic dyes to effect the object aimed at. The paste when mixed to the proper consistency is allowed to rest for some time to enable it to become hard, during which time the chemical reaction the mass undergoes causes the production of a horn-like substance so hard and strong that it may be turned and machined like brass or other metal. When the composition is first made it may be molded without pressure into any desired form, and thus in many ways it may be employed to replace real horn. —*The American Jeweler.*

Working the Chickens Overtime.

A RESIDENT of Chicago is reported to have devised a way to keep his chickens up to their work during the winter season, when the short days have an undesirable effect on the production of eggs. His plan is to provide his chickens with artificial light to work by, and he has installed a series of electric lights in his hen house. This is the way he works his scheme, according to the *Electrical Review:*

"At six in the morning I turn on the switch, and the fowls get up, thinking it is daylight. The lights are turned off at daylight, when the neighbors' fowls are just arising. At four the lights are turned on again, and they are kept going until nine at night, when I turn out all except the 2 candle-power lamps. These give just sufficient light to give the appearance of dusk, and the fowls begin going to roost. I leave the small lamps lit all night, so that if any of the fowls want to get up at night to eat they can do so. Eleven days after the lights were installed the daily n... from twenty-six eggs to eighty-three. ... moulting season under the old custom, ... the food was going to feathers instead ... only eleven eggs a day. Now I get fifty-t... ing the moulting season. By my meth... chickens thinking they are getting the s... daylight all the year round, and I am ... thinking all the time."

Tribo-luminescence. W. S. ANDREWS. (*Trans. Amer. Electrochem. Soc.*, xviii, 279.)—A tribo-luminescent product, that is, one that emits light when rubbed or scratched, is prepared by mixing together 70 parts of powdered zinc carbonate and 30 parts flowers of sulphur to a thick cream with distilled water containing a small particle of manganese sulphate. After thorough trituration the mass is dried at a gentle heat, finely powdered, then packed tightly into a porcelain or plumbago crucible with a tight cover and heated to bright redness for 20 minutes. The product emits sparks of a yellowish light when scratched with a knife; the sparks will not ignite inflammable vapor.

Fire-proofing Stage Scenery

As far back as 1820 the eminent French chemist, Gay-Lussac, endeavored to find a practicable fire-proofing for the canvas scenery used in stage settings. But his efforts and subsequent ones have been so far from satisfactory that infringements of the law requiring incombustible scenery have been only too common in Paris, says *La Nature* (Paris). The great difficulty with the various methods proposed has been that in the course of time they caused an alteration in the materials used and modified the colors of the decorative painting.

Very recently, however, the Director of the Municipal Laboratory in Paris, who has been making extensive investigations and experiments on the subject, announced a complete success in discovering a method of fire-proofing not only free from the objections stated above, but having the merits of cheapness and ease of application. In his report upon the subject, recently presented to the Commission on Theatres of the Prefecture of Police, he states that the cost of his new process, whose merits are acknowledged and attested by a number of well-known theatrical scene-painters, is only five centimes (one cent) per square meter of canvas, including the required labor. The fire-proofing solution may be applied to the canvas like paint, or the fabric may be impregnated with it by means of soaking.

The solution consists of 50 grammes of boric acid plus 60 grammes of borax dissolved in one litre of water. When the cloth is soaked it is taken out of the bath after being thoroughly impregnated, is allowed to drip till excess of solution is removed, and is then dried either by evaporation in the air, or by being ironed with hot irons.

It is advisable, however, that the protective substance be applied like paint to canvas meant to be covered with decorative paintings. This method has the advantage that the painter may fire-proof his canvas at the same time that he prepares its surface in the usual way to receive the paint. To this end he merely dissolves in the sizing of Spanish white commonly employed, about 200 grammes per litre of the mixture of boric acid and borax above described. To obtain perfect incombustibility about one-half litre per square meter of the protective mixture must be "fixt" on the canvas.

Mr. Kling states that after very numerous experiments with all sorts of reagents, he was convinced that the fire-proofing action of the mixture is not due, as has been supposed, to the formation of an inert gas, but that the efficacious substances are principally composed of salts or saline mixtures capable of melting at low temperatures. When acted on by heat, these substances form a layer or "glaze" which protects the fabric from coming in contact with the air.

Fitting Motor Truck Rims

An ingenious method of heating motor truck wheel rims is employed by one of the large manufacturers. The tires, which have to be heated before being pressed on to the wooden wheels, are heated electrically by being laid in a steel tub around a transformer coil. The tire thus forms the secondary and is heated in a similar manner to the metal in an induction furnace. In three minutes a tire about ½ inch thick, 10 inches wide and 36 inches in diameter can be heated to the required temperature, which is just about sufficient to make the ash wheel smoke. The advantages are that there is no danger of fire in the wood-working shop and that the tires are heated quickly and uniformly without being sooted or oxidized.

Steam to Clear the Soil.—A new piece of agricultural apparatus has been developed for the purpose of combating the destructive bugs and undesirable vegetable growths by an application of steam to the soil penetrating some distance below the surface. The machine carries a steam generating plant and moves over the surface on a large drum, the periphery of which is staggered with protruding steam outlets in the shape of blades or spines. As the apparatus is drawn over the ground the spines imbed themselves in the soil and while in this position the steam is released and penetrates the soil for some distance around the outlet, killing the worms, larvæ and bugs and the undesirable crop of weeds which seed themselves from one season to another.

ings, piping, etc.

Copper Oxide Electrically Sensitive to Light.—At the June meeting of the New York Electrical Society a paper was read by Theodore W. Case, describing experiments on the action of light on oxidized copper. If two copper wires or plates are oxidized and immersed in an electrolyte, a galvanometer connected between them will be deflected when light falls upon one wire or plate. The voltage observed was about 0.1 volt. The current obtainable depends upon the area of the plates and approximated 0.2 ampere. Many variations of the experiment were described in the paper.

Insulating Aluminum Wire

Aluminum trioxide, or rust as it might be called, is a poor conductor of electricity. A firm, coherent coating of this may be deposited on an aluminum wire by passing it as cathode through a bath of borax or water glass and then through a second bath in which it is made the anode. Two wires covered with the oxide and twisted together have stood a pressure of 200 to 500 volts before short circuiting through the film. In making the film a high current dens[illegible] is used and the voltage brought up quickly.

Effect of Static Charge Upon Rubber

Fontana showed that the inside volume of a Leyden jar increased during an electric charge. If the jar contains water which serves as one of the coatings, the level of the liquid is seen to lower when the jar is charged, on account of the jar's increase in volume. Later on, Korteweg and Julius showed that in the case of rubber as dielectric, the deformations vary roughly as the square of the dielectric field. The French scientist, L. Bouchet, now makes a series of careful researches as to the effect of the electric charge upon rubber, and uses a rubber sleeve which undergoes the action of the charge on both sides so as to produce an analogous effect to the Leyden jar experiment. Water contained inside the sleeve communicates with a capillary tube so that any small change in volume is readily seen in the height of the liquid in the tube, and the water level is observed by a microscope. He used a high tension dynamo furnishing 550, 1260, 1800 and 2520 volts, and the water level was noted at regular intervals during 2 minutes after the action of the electric charge, in each case. During that period, the level first lowers quickly, then more slowly and finally reaches a fixed point. The author already noted that under the action of constant mechanical pressure of about the same order of strength as here used, the same rubber piece required about 20 seconds to reach the limit of deformation. This limit is now greater in time for the electric action, and he concludes that up to the 20th second there is a combined electrical and mechanical effect, while after this point the elec- proper is the only one which enters in.

Rapid Production of Working Drawings

An ingenious method of getting out a set of blue prints quickly has recently been proposed, which appears decidedly useful where the scale of the drawings is large enough and where too much detail is not required. A sheet of carbon paper is laid face up on the drawing table, and over it is placed a sheet of tough tissue paper, upon which the drawing is made in pencil. It will be seen that the carbon backing of the drawing makes it strong enough to enable a blue print to be made at once, without the delay of having to trace the drawing over with ink. Even when the carbon paper cannot be applied when the original drawing is made, it can be used subsequently with advantage, if the drawing is made on the tissue paper, as it requires less time to go over the lines with a pencil than with ink.

Heat Screen for Lenses

Means for preventing the overheating of condenser lenses for projection apparatus such as used in moving picture work, are provided in a recent patent. Formerly there was employed an absorbing trough near the lens, which contained a solution of a ferric salt. It was also found that a plate of glass containing iron salts could be used to advantage to absorb heat rays. The lens itself, however, must not be made of such glass, as the thick part would have a pronounced coloration which would absorb the light. Again, when a glass plate is used, it reflects light from its surface and thus causes a loss. The new method consists in building up a glass disk against the flat side of the condenser lens, so as to avoid reflection of light. It is not required to cement the plate to the lens, but the two can be well pressed together in a suitable mounting.

ns

so thin and flexible as to make small aluminum wire as economical of space in coils as copper, has been developed by C. E. Skinner and L. W. Chubb of the Westinghouse Electric and Manufacturing Company, of Pittsburgh, and was described in a recent paper presented before the American Electrochemical Society. By different processes two types of films are produced. One is smooth and iridescent and the other white and abrasive. The latter is the better, being from 0.0001 to 0.0004 inch thick and standing from 200 to 500 volts. Two wires can be pressed together so as to indent without breaking the film; but if there is relative motion the abrasiveness of the film will expose the metal for a short circuit. The material is fireproof and has mechanical strength to support the wire in small coils above the melting point. The film is made by passing the wire through electrolytic baths (solutions of borax, ammonium borate or sodium silicate), the wire being the anode.

A New Type of Electric Furnace.—*Abstract.* At the recent meeting of the American Electrochemical Society in New York, Mr. Carl Hering described a new electromagnetic phenomenon which he has named the "squirt phenomenon" and which he is using as the basis of a new type of electric furnace, for which he claims it is particularly well adapted.

This new phenomenon is as follows: If an electric current is passed lengthwise through a liquid conductor, like a molten metal which is confined in a tube or hole closed at the bottom by the electrode, and opening at the top into a bath of the molten material—then the liquid in the hole will be squirted out axially quite forcibly through the contral part of the open end, and other liquid will be forcibly sucked down into the hole around its periphery, provided the relation of the current to the cross section of the liquid conductor is sufficiently great. It may be said to be a valveless pump circulating the liquid rapidly throughout the hole.

If this hole is located in the bottom of a crucible or hearth and is so proportioned that the current will produce the necessary heat in the material in it, by virtue of its electrical resistance, the device will constitute a new kind of furnace, in which the liquid in the hole constitutes the resistor; it may be said to be a furnace with a "flowing resistor." The cooler liquid material flows down into this hole near the circumference, becomes heated by the current and is then at once expelled with considerable force to the top of the bath, where, in the case of the refining of steel, it comes into direct and intimate contact with the blanket of slag which takes up the impurities mechanically and chemically. In the furnace there are, of course, two such flowing resistors, one for each electrode.

The chief claims made for furnaces based on this principle are: greater heat economy, as the heat is all generated directly where it is wanted, without waste; much greater rapidity of refining, when the furnace is intended for steel refining, on account of the enormous and continually changing surface exposed to slag action; hence greater furnace capacity per day and greater heat economy, due to the shorter time of treatment; great homogeneity of the product due to the very rapid circulation; cheapness of construction, as the furnace consists merely of two holes in the bottom of a hearth, plugged with the two electrodes; no unnecessarily high temperatures with their attending heat losses; no consumption of electrodes with its attending costs; ease and nicety of regulation; no machinery for regulating an arc; applicability also to zinc and arsenic ores, glass, etc.; adaptability to being added to existing open-hearth furnaces or pots; possibility of adding fuel heat at the top of the lower temperatures; an arc may be added if desired; etc.

The force which produces this squirting action is caused by the so-called "pinch effect," described by the author some years ago, which is a radial force tending to contract the cross section of a conductor as though it were being pinched or squeezed; in the squirting phenomenon this radial force is made use of to produce

1680 grains rock candy
or white sugar
80 grains nitric acid
6½ ozs alcohol
Distilled water to make 50 oz
in stoppered bottle

500 grains nitrate silver
250 grains potassa
(pured by alcohol)

Silvering Solution

On the Electrical Conductivity of Copper Fused with Mica. SUB-LIEUT. A. L. WILLIAMS. (*Phil. Mag.*, September, 1920.)—To prepare the material an electric arc was struck between an iron or copper plate serving as an anode and a carbon rod as cathode. The arc was shifted over to the mixture of copper and mica lying on the plate and fusion followed. "In making up the samples studied, about equal proportions of copper and mica were used." The resulting material seems to be uniform throughout, about as hard as glass and more brittle than copper. It is malleable at 2000° C. The outstanding characteristic is the great reduction in its electrical resistance caused by an increase of temperature. A specimen whose resistance was 91,010 ohms at 99° C. was found to have only 11,370 ohms at 228° C. For another specimen the data are 16,000 ohms at 27° C. and .5 ohm at 850° C. For mixtures of iron and mica similar results were obtained.

The author makes the suggestion that the copper-mica mixtures may prove of use in signalling and in sound-ranging "as the changes of resistance, due to changes of temperature, are quite considerable, being some thousands of ohms per degree centigrade with some samples."

Prof. J. C. McLennan of the University of Toronto has caused the experiments to be repeated and extended in his laboratory by Miss Mackey and Miss Giles. Some of the results above quoted are from their data.

G. F. S.

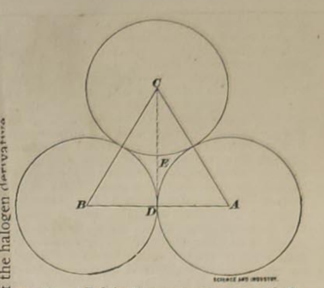
Thermometer
stuff for new lab

A Galvanic Cell Which Reverses its Polarity when Illuminated. A. A. C. SWINTON. (*The Physical Society of London*, vol. xxvii, part iii.)—If two plates—one of zinc and the other of tinned copper coated on one surface with selenium and varnished with enamel over the remainder of its surface—are immersed in tap-water, the electric current through a galvanometer connected to the plates shows that in the dark the zinc is electro-positive to the selenium, while the result of light falling on the selenium is to increase the effect. If, however, instead of zinc, carbon or copper is employed for the non-coated plate, the interesting result is obtained that, while the selenium proves to be electro-positive to the carbon or copper in the dark, it immediately becomes electro-negative to carbon or copper the moment it is illuminated, this being easily shown by the deflections of the galvanometer in contrary directions as the light is turned on or off.

(14143) E. P. du P. writes: I notice an inquiry as to boring holes in glass in your issue of June 24th, 1916, the inquiry number being 14111. Permit me to tell of a method I have used which is free from certain objections and limitations which govern that given by your paper. My method, which I got from some source now forgotten, permits of making any sized hole and of eliminating all danger of breaking when "coming through." Take a brass tube of the size of the desired hole and have the end turned true, smooth and square. Arrange it in wooden bearings in a vertical position so that the end rests upon the glass. Place on the tube a small wooden pulley, say 3 inches diameter for a ⅝-inch hole and drive it from some source of light continuous power such as a small water motor. A string belt if given considerable length, works well. The speed should be from 150 to 300 R. P. M. for the size given above. This is allowed to run, resting with its own weight (the size above being about 12 inches long of medium weight tubing) and the interior of the tube is kept filled with No. 100 emery or carborundum powder mixed with machine oil so that it will flow freely. This will gradually work out over the glass and maintain a cutting action. The drilling progresses very slowly, 24 hours being required to drill a ¼-inch plate, but the resulting hole is smooth and round and entirely free from chipping on either side. The process requires attention only at long interevals as the emery and oil works out very slowly. Any sized hole can be drilled in this manner, but the hole will be found to be just a little "full" of the size of the tubing used. I think E. A. V. will find the method very satisfactory.

(14144) N. B. writes: In the July 1st issue of the SCIENTIFIC AMERICAN, C. E. asks in query No. 14128 for an explanation of the fact that differently colored letters projected upon a screen at the same time appear to lie in different planes. I believe that the following explanation accounts for the phenomenon: difference of the focal planes for red and [illegible] rays in the eye amounts to 0.5 mm. Consequently, if a red and violet letter are shown simultaneously on a screen, more effort is required on the part of the ciliary muscle of the eyeball to bring the red letter in focus upon the retina than is required to bring the violet letter in focus. Since we judge the distance of objects to a great extent by effort required to bring them in focus, it is evident that in the above illustration that the red letter will appear to be closer to the observer than the violet letter. Any two differently colored images projected simultaneously and situated closely together upon a screen will give this illusion. The degree of the illusion will depend upon the differences of the focal planes of the colors. A careful reading of the chapter on "The Dioptric Mechanisms of the Eyeball" in Starling's "Human Physiology," Ed. of 1912 will make the above explanation more clear. The first paragraph on [illegible] 58 deals with the answer to C. E.'s [illegible].

Chemiluminescence. S. MOELLER. (*Archiv. Pharm. Chem.*, xxi, 440.)—The appearance of light has been noted in several chemical reactions, notably in that of Grignard, when an ether solution of an alkyl halide reacts with magnesium dust. A red light is developed on mixing 35 c.c. of each of the following solutions: A 1 : 2 potassium carbonate solution, a 1 : 10 pyrogallol solution, and a 35 : 100 formaldehyde solution; then adding 50 c.c. of 30 : 100 hydrogen peroxide solution. Also phenylmagnesium bromide, in ether solution, develops an intense green light on contact with moist air. The effect is not, however, due to the moisture, but to oxidation. The luminescence is stronger in an atmosphere of pure oxygen than in other gases. Ether which has stood months over calcium chloride reacts well; some, but not all, specimens of official ether do so also. Chemiluminescence is observed with most organic magnesium compounds, and its intensity is directly proportional to the molecular weight of the halogen derivative.



[illegible] triangle ABC is 2 [illegible]

Hence the rule: [illegible] area of the figure intercepted between the points of tangency of three equal circles is given, the diameter of the equal circles is equal to 4.982 times the square root of the area of the intercepted figure.

Problem was to find diam. of circles ~~with~~ when E = 1 foot area

A New Primary Electric Cell. (*La Nature*, September 18, 1920.) —During the war the French army needed a great number of cells of the Leclanché type. France had no manganese dioxide and it was difficult to obtain it from the outside world. Féry succeeded in devising a cell which does not polarize in spite of its lack of the dioxide. At the bottom of the solution is a flat horizontal plate of zinc, to which is soldered a wire forming one terminal of the cell. A cylindrical, porous carbon rests on a thin piece of insulating material which is supported by the zinc. The carbon carries a terminal post. As soon as the current flows hydrogen forms on the part of the carbon close to the zinc. The superficial layers of the liquid have absorbed oxygen from the air. The upper part of the carbon is therefore in a liquid rich in oxygen while the lower part is coated with hydrogen. A gas cell results, the upper part of the carbon being positive and the lower part negative. In consequence of this oxygen is liberated at the lower part and combines with the hydrogen, causing polarization. Hydrogen is set free at the upper end of the carbon and combines with the dissolved oxygen. The operation of the cell therefore depends on the action of oxygen dissolved from the air.

The salt of ammonia is regenerated within the cell, there are no creeping salts and the zinc is not attacked on open circuit. A reduction in cost results from the elimination of the manganese dioxide.

G. F. S.

New Use for a Rare Element

NEW uses for rare metals or elements seem to be appearing constantly. The metal selenium is not a familiar one but is a by-product in the electrolytic refining of copper. Demand for it has been very light and its chief use has been in the glass industry, in photographic chemistry and in medicine. It has also been used to a limited extent in electrical work, because it possesses the peculiar property of varying conductivity according to the intensity of the light. Under the influence of light its conductivity may be 500 times greater than in the dark. As the result of research work carried out at the University of Wisconsin by Prof. Victor Lenher, a new property has been discovered which should open up a big field for the application of selenium and incidentally make it worth while for copper refiners to pay more attention to its recovery. In the form of selenium oxychloride it acts as a powerful solvent on certain organic substances. The unsaturated hydrocarbons, such as acetylene, benzene, and toluene, dissolve readily, while the paraffin hydrocarbons, such as gasoline, vaseline, and paraffin wax, are unaffected. Pure rubber, vulcanized rubber, asphalt, bitumen, and the casein glue used in airplane construction dissolve easily in selenium oxychloride, and it can be used in coal analysis to extract the bituminous material in soft coals.

Sealing Metals. P. E. SHAW. (*Phys. Soc. Proc.*, xxiv, 95.)—Threlfall used Margot's solder (92 per cent. tin, 8 per cent. zinc) to fasten glass, aluminum or quartz surfaces to any other. Other solders are found efficient, viz., tin, zinc, various alloys of tin and zinc, tinman's solder, and aluminum. Besides these, there are many materials with melting points between 180° and 660° C. For these and similar materials which act like sealing-wax, the name "sealing-metals" is suggested. They have the advantage over wax in high melting-point and the non-emission of vapor at high temperatures.

MILKS MADE TO ORDER—Pig's, Sheep's or Dog's, You May Make Them All from Cow's Milk.

DEALERS in what is known as "modified" milk use in their business only one kind of raw material—that is to say, cow's milk. But, on order, they will deliver goat's milk, sheep's milk, asses' milk, pig's milk or dog's milk. All of these are prepared from the same original fluid, in accordance with prescribed formulæ.

Not infrequently it happens that valuable young animals, which, by reason of their breed, may be worth hundreds of dollars apiece, lose their mothers in infancy. Under such circumstances they have to be fed artificially, of course, and the makers of modified milk are called upon to supply the appropriate lacteal diet. Counterfeit mare's milk, furnished in this way, has saved the life of many a thoroughbred colt.

Milks differ very much in composition. That of the sheep is extraordinarily rich in butter-fat, while that of the ass is in this item strikingly deficient. Dog's milk contains three times as much "proteids" (the stuff that goes to make muscle and blood) as cow's milk, and eight times as much as pig's milk. Asses' milk is extra rich in sugar. Accordingly, in imitating one kind of milk or another, the manufacturer, starting with the product of the cow, is obliged to change the proportions of the ingredients radically.

For example, to make sheep's milk, he adds fat by putting in an extra quantity of cream. What could be more simple? To reduce the sugar content (sheep's milk has less sugar than cow's milk), he adds water. And, to increase the proportion of "proteids" (in which sheep's milk is rich), he contributes white of egg. For asses' milk he would add milk-sugar to the cow's milk.

In this manner, indeed, every kind of milk may be successfully imitated—except, perhaps, the milk of human kindness, the formula for which has not yet been definitely ascertained.

PHOTOGRAPHING THE INVISIBLE.

The following is a curious and interesting experiment, based upon the peculiar property possessed by fluorescent substances of altering the refrangibility of the chemical light rays. Take a colorless solution of bisulphate of quinine, and write or draw with it on a piece of white paper. When dry the writing or design will be invisible, but a photograph made of it will show them very nearly black.

MAKING DIRECT POSITIVES IN THE CAMERA.

Prepare a saturated solution in water of the crystals of thiosinamine, and add from two to eight minims of it to an ordinary pyro or eikonogen developer. Expose rather less than usual. The effect of this addition to the developing agent is an entire reversal of the image, a positive instead of a negative being obtained. Ammonia will assist the reversal. Colonel Waterhouse, the discoverer of this process, recommends in some cases the plates being s[illegible]ected to a bath of 5 per cent. nitrate acid and 3 per cent. p[illegible]assium bichromate before exposure, followed by a thorough washing.

FIRELESS STOVES.

LATEST GERMAN IMPROVED SELF-COOKERS.

In reply to a Kansas City correspondent Deputy Consul-General John W. Dye, of Berlin, furnishes the following information concerning the newest form of fireless stoves in Germany:

Fireless stove, or self-cookers, as they are variously known, have been in use in Germany for a number of years, so that they may now be classified as successful. The earlier types were merely boxes constructed with double walls; or by secret processes built so as to retain heat when sealed. These cookers, which are still on the market, are used as follows: After a thorough heating, food to be cooked (stewed or boiled) is placed inside the box, sealed, and left for a sufficient time, when it is opened, and the food, cooked by the retained heat, is ready to serve.

Recently a company here has improved upon the apparatus and produced a fireless stove that not only cooks, but fries and roasts. Profiting by past failures and successes the company has perfected a cooker that, although on the market but a year, has already proved very popular. Frying and roasting are accomplished in the new cooker by the use of a heated stone. The stone is thoroughly heated in an oven, over gas or any fire, and placed in the cooker with the steak or roast. The box is sealed up and left for an hour or so, as required, then opened, and the food is fully prepared and hot. In the double boxes all three processes may proceed at one time without care or difficulty.

The owners of the patents on this latest apparatus claim that the sales in the coming year will exceed 50,000 cookers in Germany and Switzerland.

[A copy of the cookbook issued by the fireless stove company, which accompanied Deputy Consul-General Dye's report, is on file in the Bureau of Manufactures, where it may be consulted by parties interested.]

The Indictment.

Soon after the opening of court tomorrow morning the defendant will be called upon to plead to the indictment that has been reported against her as follows:

"The grand jurors of the United States of America, in and for the District of Columbia aforesaid, upon their oath do present:

"That Lola Ida Bonine, late of the District aforesaid, on the 15th day of May, in the year of our Lord 1901, and at the District aforesaid, in and upon one James Seymour Ayres, in the peace of God and of the United States then and there being, feloniously, willfully and of her malice aforethought, did make an assault, and that she, the said Lola Ida Bonine, a certain pistol then and there charged with gunpowder and a leaden bullet, which said pistol she, the said Lola Ida Bonine, in her right hand then and there had and held, then and there feloniously, willfully and of her malice aforethought did discharge and shoot off to, against and upon the body of him, the said James Seymour Ayres; and that she, the said Lola Ida Bonine, with the leaden bullet aforesaid, by the said Lola Ida Bonine, discharged and shot off, as aforesaid, then and there feloniously, willfully and of her malice aforethought did strike, penetrate and wound the said James Seymour Ayres in and upon the left side of the breast of him, the said James Seymour Ayres, giving to him, the said James Seymour Ayres, then and there with the leaden bullet aforesaid, so as aforesaid discharged and shot out of the pistol aforesaid by her, the said Lola Ida Bonine, in and upon the left side of the breast of him, the said James Seymour Ayres, one mortal wound of a depth of six inches and of the breadth of half an inch; and of which said mortal wound the said James Seymour Ayres then and there instantly died.

"And so the grand jurors aforesaid, upon their oath aforesaid, do say that the said Lola Ida Bonine him, said James Seymour Ayres, in the manner and by the means aforesaid, then and there feloniously, willfully and of her malice aforethought, did kill and murder; against the form of the statute in such case made and provided and against the peace and government of the said United States."

Helioplastic Engraving.

See The Crayon, V.4p 93 (1857)
in Print Dept.Library of Congress.

Memo. for C.Francis Jenkins.

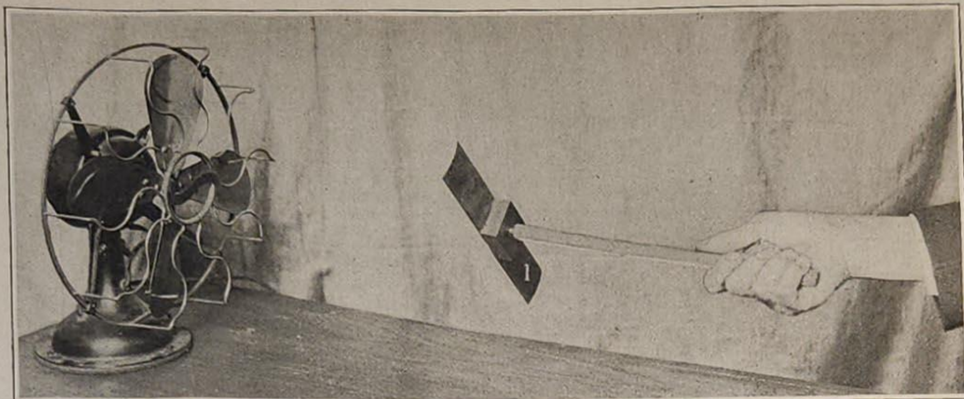


FIG. 1. WHEEL WITHOUT TWIST OR WEATHER ANGLE WHICH WILL TURN IN THE BLAST OF AN ELECTRIC FAN

Paradoxical Windwheels and Soaring Birds

Rotary Thrust Produced Without Weather Angle

By Thomas O. Perry

THOSE who are familiar with windwheels know, or think they know, that the weather angle of the wings, or their inclination with the plane of motion, is a necessary feature for propulsion by the wind, and that the wheel must turn only in one direction according to the angle of weather.

In Fig. 2 are shown photographic prints of five small windwheels which, when held facing the breeze from an electric fan, were wind driven clockwise or anti-clockwise without any alteration either in construction, position or other conditions. Three of these wheels apparently turned one way as rapidly as in the reverse direction, the slight difference evidently being due to some rotation of the blast from the fan in the direction of fan revolution. This difference was eliminated when the blast was directed through a tunnel with thin longitudinal partitions. Our illustrations omit the tunnel which was used, but is not necessary except for refinement in exact tests.

Those who are skeptically inclined are advised to first try forms No. 1 and No. 2, as these two forms are very easily made and as easily managed. We have shown No. 1 with a wooden hub joining opposite wings separately attached, but the wings can as well be made of one piece of thin metal of uniform section from end to end without twist or weather angle throughout its length. Any kind of hub will do, and the exact curvature of the wings is not important. We made the camber about 1 in 14, width of wing 1¾ inches and length 10½ inches. The electric fan used was 12 inches in diameter, had a speed of 1,800 r.p.m. and was placed from 15 to 20 inches away from the windwheel. The average speed of the windwheel in either direction was about 1,390 r.p.m. This wheel had to be started by giving it an initiatory whirl with the fingers, though it would turn slowly of its own accord in a *direction contrary to the fan's motion*, in which respect this particular wheel was peculiar.

Wheel No. 2 was made of white pine and received the blast squarely against its flat face. The back was rounded from 3/16 inches thick along its center line to thin edges about 1/32 inch thick along the sides. To make this wheel it is only necessary to take a straight piece of wood 10½ inches long, 1¾ inches wide, 3/16 inch thick and round over one side from end to end. Any kind of hub will do, or no hub. This wheel is started very easily with the fingers and runs in either direction at about 1,650 r.p.m. On account of its lightness, the acceleration after starting is very rapid.

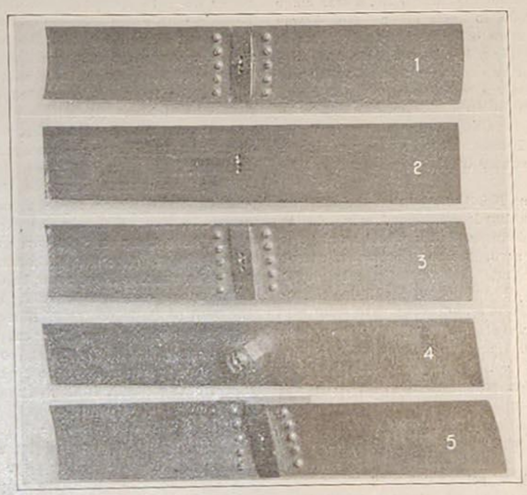


FIG. 2. WINDWHEELS USED IN THE TESTS

Wheels No. 1 and No. 2 responded so vigorously to the impulse of the wind after being started in either direction, that we were tempted to try another wheel made precisely like No. 1, except that the two wings were given a small weather angle of about 3 degrees after the manner of ordinary windwheels. This wheel, No.

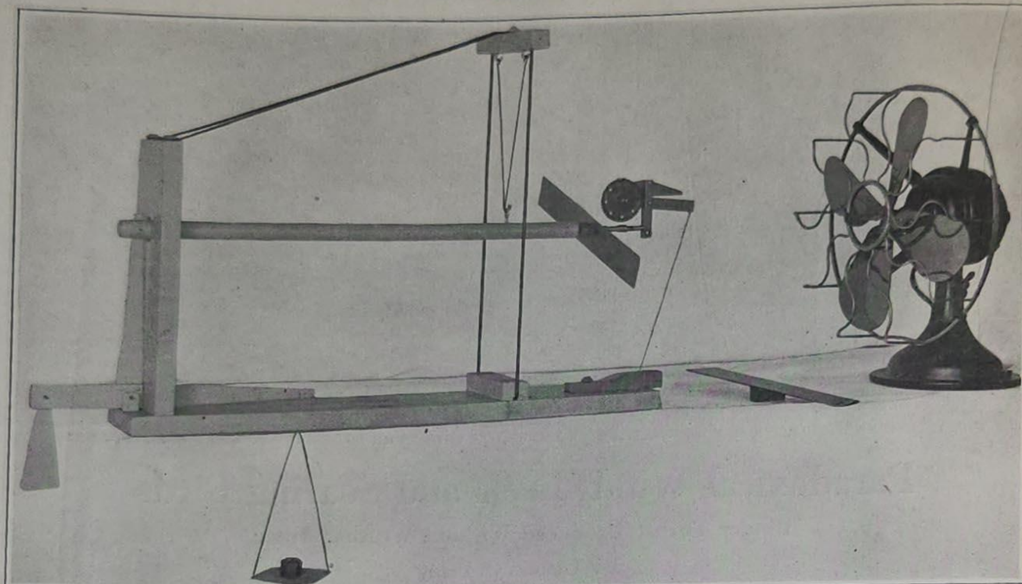


FIG. 3. APPARATUS FOR WEIGHING THE PRESSURE OF THE WIND IN AXIAL DIRECTION

3, would readily start itself and run in one direction just as any one would expect, making about 1,560 r.p.m. But, if given a vigorous push to start it in the opposite direction, it would run and maintain about 960 r.p.m. *against natural inclination.*

The fact that wheel No. 3 with considerable weather angle could be made to run backward against inclination, as well as the fact that wheels No. 1 and No. 2 ran equally well in either direction they were started, was at first supposed to be due entirely to the fact that these three wheels had at least one side made with transverse curvature. It was with the expectation of confirming this supposition that wheel No. 4 was made with both face planes parallel to each other. No. 4 was nothing more than a plain strip of hard and smooth sheet brass about 1/16 of an inch thick, 1½ inches wide and 10½ inches long fitted with a small hub at the center. Contrary to expectation, this wheel, too, maintained a speed of 1,030 r.p.m. after receiving a good start in either direction. It had to be started at much higher speed than any of the others by winding a string around the hub. It also had to be nicely balanced. Slightly rounding the sharp corners of the edges improved its performance.

Wheel No. 5 was the same as No. 3 except that the weather angle was increased to 8°, making it correspond more closely to the angle of ordinary windwheels. This wheel would not run backwards, and behaved according to expectation except in one particular. It made about 1,860 r.p.m. in a left-hand direction. Wheel No. 6 was the same as No. 5 in all reversed. It ran at about the same speed when used with the tunnel, always running in a right-hand direction. These two wheels would make about 690 r.p.m. with their convex surfaces presented to the breeze. None of the wheels which ran indifferently in either direction would really *run*, with its convex back presented to the wind. No. 4 was the only one that ran with any speed with either side exposed to the wind. This too was the only wheel with both sides plain and exactly alike.

The one particular in which wheels No. 5 and No. 6 appeared paradoxical in performance was in the fact that when running freely without any applied load, it was found that the wind pressure against their wings was more than three times as great as when they were clamped to their axles so as to remain stationary. Fig. 3 shows an apparatus designed to weigh the pressure of the wind in an axial direction by means of weights placed in the pan hung from the horizontal arm of the balanced T lever. The pressure against the wings increased with increase of speed of revolution until at the maximum the pressure was greater than that on a solid disk of the same diameter as the wheel.

In measuring the power of the windwheels with a dynamometer we have invariably found that speed of revolution was reduced with every increase of load applied with a brake, and that the torsional effort of the wheel as shown by the dynamometer was progressively reduced as the speed of revolution increased. This, too, accords well with common sense. Nevertheless, the facts are as stated in the preceding paragraph. Also wheels Nos. 1, 2 and 3 received nearly as great wind pressure at full speed as Nos. 5 and 6, and fully as great, or greater, than the pressure against a solid disk of the same diameter.

These experiments serve to throw some light on certain puzzling facts which force themselves on the attention of those who observe closely the flight of soaring birds as they rapidly float along on rigid wings without any apparent means of propulsion. Certain authorities have asserted that propulsion in soaring flight must be due to a negative inclination of the wings sustained by rising currents of air. We believe that both of these professed observations are products of the imagination rather than of actual vision, though an equivalent must be substituted for the supposed rising currents.

If rising currents of air do really account for the possibility of soaring flight, it is not necessary to assume that the wings must have negative angles; since these experiments show that wings of windwheels (Nos. 1 and 2), without any weather angle are propelled by wind whose direction is at right angles to wing motion after sufficient headway has first been attained. In the same way birds must somehow get well started before they can soar. Mr. Chanute places the minimum soaring flight of birds at about seventeen miles per hour.

Eiffel has shown that an airplane wing driven against the air, or exposed to wind impinging in a direction parallel with the chord of a wing having its concave surface underneath (that is, without weather angle), experiences a very decided upward thrust and that a negative angle of three degrees does not entirely neutralize the lift. Our experiments show that a windwheel whose wings have a weather angle of three degrees will run backwards after being sufficiently started in the reverse direction. From this it follows that a bird's wings receive upward thrust in the same way by reason of their forward motion. We also know that vibrations in the air, or air waves, which crowd against the wing incessantly from every direction, all act more strongly against the under concave surface than against the upper surface which is convex.

The difference of thrust due to air vibrations against the two surfaces of opposite curvature is not very great unless the wing is traveling at considerable speed. The rapid motion multiplies the differences of opposite thrusts and produces an aggregate upward thrust sufficient to sustain the bird without supposing the necessity of rising currents of air. Prof. Langley has partially explained the effect of air waves on the wings of soaring birds in his treatise dealing with The Internal Work of the Wind, though he accounts for the action of horizontal impulses only, and it is not necessary to suppose that the bird instinctively adjusts its wings fore and aft, in the light of Eiffel's experiments. It is clear that horizontal impulses give a resultant-lift whhether impinging from the front or from the rear against horizontal crescent shaped wings.

Rising air currents more generally prevail over heated land surfaces. But what goes up must come down, and the cold southern seas must experience an excess of descending air currents. Yet there is the home of the most noted of soaring birds, the Albatross, a bird that habitually soars, and evidently does not have to hunt out exceptional streaks of rising currents or follow devious courses for the sake of their assistance.

How Insects Steer Themselves While Flying*

"Weight Steering" and "Pressure Steering"

By Dr. F. Stellwaag, Privat Dozent at the University of Erlangen

in the fighting among the rebel and government forces in the revolution zone, officers on the Borie declared today. They stated there has been plenty of fighting among the natives.

PATCHED PARK BILL GETS O. K. IN SENATE; MANY CHANGES MADE

(Continued from First Page.)

a cash working fund promptly after the next tax levy in the counties.

While the original bill ...

Opponents Heard on Legislation Affecting Montgomery and Prince Georges.

... space is dependent ... gravity on the one ... other. When any ... its direction while ... the center of gravity ... cases we are con... the manner of func... steering," if I may ... change of equilib... ry. Thus it is to be ... more heavily loaded ... is curved towards ... ntly the body must ... to the resultant be... ity and the original ... This sort of steering ... sliding weight. In ... which plays a decisive part.

Just as it is possible to think of the weight of a body as being united at one definite point, *i. e.* the center of gravity, in the same way in the case of a body which is moving forward and which is therefore subject to the resistance of the air, we can think of a single point, *i. e.* the center of pressure, as representing the force of the air pressure against the surfaces involved. The position of the center of pressure changes as soon as the surfaces of attack of the body of air in motion are altered. If this alteration is one-sided a change of direction will be produced. This "pressure steering" never operates through weight and may be even regarded theoretically as being without weight. The more rapid the motion of the moving body the greater the amount of work done by this pressure steering, since it operates by the capacity for work of the secondarily occasioned air pressure. The steering of water craft and air craft comes under this head of pressure steering almost without exception. It may be termed extra-directive steering in contrast to intro-directive or weight steering. It is precisely this difference which makes it possible to understand various phenomena concerned in the manner in which various animals move and to throw light upon various problems which are generally very obscurely treated in text books on biology.

We are chiefly indebted for such knowledge as we possess concerning the steering capacity or insects to Jousset de Bellesme.[1] His experiments with insects of all kinds led him to believe that the direction during flight is determined by the position of the head and thorax, *i. e.* of those parts of the body which penetrate the air; in his opinion it depends upon the center of gravity and upon the position of the axis of support, both of which are movable. In most cases it is the center of gravity alone which is responsible for an alteration of position. In only a few insects do the functions of motion and direction coincide, those which possess direct flying muscles and can therefore move the wings separately, like the *Aeschna*. However, the long and movable abdomen plays a part in modifications of the movement, as can be plainly seen in the Agrionids. The same thing may be considered to be true of the butterflies whose wing movements resemble those of birds.

In the Hymenoptera the wings serve merely to produce forward motion; the abdomen is very movable and is thus capable of altering the center of gravity and therewith the direction of movement by taking different positions. If the insect is deprived of this freedom of motion in the abdomen, it appears to be still able to fly but no longer to steer itself. In the *Megachile*, *Polistes* and other Hymenoptera, the legs also take part in the shifting of the center of gravity. In the Orthoptera the abdomen is only slightly movable; the hind legs might here be concerned as an organ of direction were they not specialized for the function of jumping. They are poorly adapted for steering and as a matter of fact the Acridia and Locustidae are but ill able to guide themselves.

In the insects just mentioned both wings on each side are designed for the purpose of forward movement. In the insects now to be treated of, functional adaptation has created organs suited for definite purposes. One pair of wings is used

*Translated from the *Biologisches Centralblatt* (Leipzig), January [2]0, 1916.

[1]Bellesme, Jousset de. (a) Recherches Exper. sur la fonction d. balanciers chez les insectes dipt. (Exper. Nesearches Concerning the Function of Balancers in Dipterous Insects). Paris, 1878. (b) Sur une fonc. de direct. d. le vol des insectes. (Concerning a Function of Direction in the Flight of Insects). C.I. Ac. Fr., 1879 b. vol. lxxxix.

for forward movement and the other for the alteration of the direction. Since in the beetles the abdomen is closely united to the metathorax, it possesses but slight freedom of motion. However, there is no need for it to be movable since the wing covers or elytra have assumed the function of steering. During the active flight they are lifted above the thorax and are thus placed above the center of gravity in such a manner that even very slight variations of their position serve to influence the position of the latter. If the wing covers are removed the insect is no longer able to direct its flight. This shifting of the center of gravity has been demonstrated with precision by Plateau.[2] Only those insects belonging to a small group, the *Cetoniidae* fly with covered wings, an interesting circumstance since the wing cover in this case acts upon the axis of sustentation which forms a *transition* to the state of complete differentiation in the *Vittera*.

Among these the capacity for steering is best developed. Only one pair of wings is employed for forward motion. But slight mobility is possessed by the abdomen and thus the only organ for determining direction is the "balancer" on each side. When this organ is amputated the center of gravity is shifted too far forward and this so affects the power of flight that the insect falls to the ground. If now, however, a small weight is attached to the abdomen so as to shift the center of gravity the proper distance to the rear, the insect is capable of flying in any direction in spite of the loss of its balancer.

According to the view of Jousset de Bellesme (just quoted) insects direct their flight, therefore, entirely by weight steering. In this he agrees with Plateau, Bert,[3] and other authorities. This opinion is contradicted, however, by the information now available. I have myself proved by anatomical-physiological and experimental methods that the wing covers of beetles by no means exercise the rôle hitherto ascribed to them.[4] They operate by pressure steering, or still better as stabilizing planes. In the balancers of the Diptera, however, a complex nervous apparatus has been detected by means of which flies perceive variations of equilibrium. That in spite of this they might influence the direction of the insect's flight as a weight rudder, was held indeed twenty-five years ago by Weinland.[5] But this view finds but little support at present; it certainly seems doubtful at least that an organ so light in weight is capable of producing an alteration in the direction of flight. This would be possible only in case the elytra lay in the same direction as the obliquely situated line of gravity. Various measurements made by me, however, proved clearly that the center of gravity in the different kinds lies behind the roots of the elytra, and that, furthermore, it is shifted still further to the rear after the filling of the intestine or the increase in size of the gonads.

Amans[6] has recently expressed an opinion contrary to that of Bellesme. According ot him insects steer by means of pressure. He calls special attention to the wave like form of the part of the body which is presented to the current of air during the act of flight. As he points out the profile of this part of the body forms a "line of double curvature." It is most marked in form in the Ichneumonidae in which the abdomen is shaped like a sickle. Within certain limits this wave form is of great advantage to the insect during the act of flight from a dynamic point of view; by reason of the fact that its curvature can be varied by the motion of the abdomen it operates as a pressure rudder. The abnormal curvature in the Ichneumonidae would be a hindrance except that we are here concerned with insects which fly very rapidly. For this reason, however, the air pressure is very slight and this has the effect of causing the body to take a horizontal position during flight. In this case, therefore, the abdomen pays the same extra-directive rôle that is exerted by the outspread and downward pressed tail-fan of many birds. Thus Amans, though starting from the same premises as Bellesme, comes to directly contrary conclusions, which appear to me to possess a greater degree of probability. However, in my opinion the problem of the steering capacity of insects deserves renewed and thorough examination.

Serious difficulties attend such an experimental investigation. It is not always possible to remove parts of the body of an insect without injuring the organism. . . . Furthermore, a decrease in the capacity for movement seldom attains the desired object, since such a decrease . . . is apt to affect the steering. For this reason I have made use of entirely different methods.

Anyone who has watched insects closely during their flight knows that they display extraordinary skill in steering in every direction and often deviate instantly from the original path. In case the steering be accomplished by the legs and abdomen in a manner similar to that attained by manipulation of the bow or stern rudder in the case of air and water craft then presumably the greater the skill with which the insect changes its direction the more definite the required alteration in the steering organ. However, I was never able to perceive by direct observation any distinct alteration of the position of the legs and abdomen for the purpose of steering. At first I ascribed this to the inherent difficulty of following with the eye the swift movements of the creature at the decisive moment; however, I obtained a welcome subject of study in the *Libellae*. In cloudy weather or at sunrise and sunset the motions of these insects are feebler than usual and as a result the change of position in the legs and abdomen can be readily followed. The *Libella* (dragon fly) readily steers itself forward, backward, or sidewise without moving its long abdomen for an instant, although the latter is admirably adapted for a rudder. In a swift flight, particularly, for example, when the insect is rapidly descending, the abdomen alters its position. But even in this case it does not alter the direction of flight, but is passively curved, on the contrary, after the insect has taken its new direction.

These observations, I believe, to be entirely trustworthy in spite of the contrary views of many authorities; but they are not yet entirely conclusive since they are subjective in character and are confined to a few favorable examples. In order to attain objective certainty likewise, I made use of a simple arrangement. When parallel rays fall on a body in a vertical direction the body casts a sharply defined shadow of full size upon a surface which is likewise vertically placed. . . . By this method I obtained, of course, only silhouettes, but these presented images of a character which a camera cannot furnish since the latter gives a sharply defined image only at a certain definite distance and an image, moreover, which is usually reduced in size, and since, furthermore, the swiftness of the flight prevents a sufficient time of exposure.

After many failures and after overcoming very serious difficulties I have succeeded in obtaining during the last few years a series of views of different insects by means of light falling through a shuttered slit. In no case have I been able to observe a change of position in the abdomen during the alteration of the direction.

I obtained the same results experimentally. According to their histological structure the elytra are to be regarded as sensory organs of equilibrium. Each passive movement

[2]Plateau, f. Recherches exper. sur la position du centre de gravité chez les insectes (Experimental Researches Concerning the Center of Gravity in Insects). Arch. d. sc. phys. et Nat. New Period, vol. xliii, 1872.

[3]Bert, Paul. Notes divers sur la locomotion chez plus. expec. anim. (Some Notes Upon Locomotion in Various Species of Animals.) Mem. of the Soc. of Phys. and Nat. Sc. of Bordeaux, Paris, 1866.

[4]Stellwaag, F. Der Flugapp. d. Lamellicorm (The Flying Apparatus of the Lamellcornia). Zts. f. wiss. Zoöl., vol. cxiii, 1914.

[5]Weinland, E. Ueber die Schwinger d. Dipteren (Concerning the Balancers of the Piptera) Zts. f. wiss. Zoöl., vol. li, 1890.

[6]Amans. (a) Géom. descript. et compar. des ailes rigides. (Descriptive and Comparative Geometry of Rigid Wings). Fr. Assoc. for the Advancement of the Sciences, Congress of Ajaccio, 1901. (b) Sur les lignes à double courb. dans locomo. animale: applications indus. (Concerning Lines of Double Curvature in Animal Locomotion: Indus. Applications.) Reports of the V. Internat. Zoölog. Congress. Nachtrag. (c) En planant (On Hovering); Causeries d' aviation (Talks on Aviation).

CHART SHOWING COEFFICIENT OF REFLECTION OF VARIOUS WALL COLORS COMPARED WITH A BLOCK OF WHITE MAGNESIUM CARBONATE (88%)

Insert to "The Light Reflecting Values of White and Colored Paints," by Henry A. Gardner.

X Encyclopedia Brit, 10th

PETROLEUM-GAS.- "Its preparation is effected by distilling it first at a low temperature into a rich vapour, which, when passed into highly heated retorts, is converted into permanent gas of an illuminating power about five times greater than common gas, and which is, moreover, absolutely free from ammonia, sulphur compounds, and carbonic acid."

ROCKING THE BABY.

Moses' Ark of Bulrushes Was Not the First Cradle.

From the London Globe.

The cradle, in some form or other, is, it may be confidently said, one of the very oldest of human institutions. Moses' little ark of bulrushes, it might be supposed, was one of the earliest things of the kind, but such a supposition would be very erroneous. Moses' little craft was pushed out on the Nile 1,300, or from that to 1,600, years before the Christian era. But there are in the British Museum some clay tablets found a few years ago on the site of ancient Nineveh, which, according to the archaeologists, make it quite clear that somewhere about 4,000 years before Christ there was another infant hero exposed in another little ark of bulrushes among the water-flags of another famous river. So that the cradle that was found by Pharaoh's daughter, and which no doubt was only the common form of the thing made water-tight by a smearing of pitch, was comparatively modern; and probably, if the light of history could be switched on far enough back, it would be found that Sargon's cradle, to which the clay tablets refer, was only the latest development of something far more ancient still.

There are very few peoples on the face of the earth who have not evolved some sort of cot or cradle for baby. There are some, though. The Eskimo, for instance, have nothing of the kind. When baby is indoors it lies cosily muffled up in the bear-skins of the igloo, and when it goes out for an arctic airing it is just slipped—quite naked—into the hood of its mother's otter-skin cloak. There is no cradle for the Eskimo baby, and there are no baby clothes. The bairns are allowed to be quite naked until they can walk, and then they are rigged out in a full suit of parky, breeches and boots, exactly similar to those its father or mother, according to sex. With the North American Indians, on the contrary, the cradle is quite as important institution as it is in the European nursery, and the expectant mother will de- a world of study and taste to the making of a little receptacle of shrub-wood and grass matting, and to its em- nent. The Indian cradle assumes forms in different tribes, but the feature everywhere is a board to child may be lashed flat on its board is padded with nice soft ry moss and sweet grasses, and of it seems to be highly ap- the Indian papoose. Such is habit and of inherited custom of the backwoods are said satisfactorily unless they are n their cradles. Some of a form of cradle which lly designed for hanging larly on the branches of mous writer, telling the twenty or thirty years hen among the Sioux In- to kneel down and drink orest stream, when sud- was arrested by queer sounds up among through the boughs, found five little pa- the branches, all alone amusing themselves by at each other, ap- as clams at high sight of the white- Then with one ac- dismal and terrified or seven squaws underwood to the

Broadly stated, Mr. Mageissen has invented a synthetic clay. He crushes to a powder any natural rock, such as granite and gneiss, rich in silicates and alumina, in short, a rock resembling clay in chemical composition as closely as possible, and to this powdered rock he adds sulphuric acid and iron sulphate in quantities varying with the chemical composition of the particular rock employed. No organic matter of any kind is added, wherein this synthetic clay differs most from the clay of nature. Clay is the only substance which when fired is preserved in permanent form. The impurities, such as organic matter, are the cause of the clay's cracking over iron or wood.

a few seconds.

(10497) C. L. asks how to make a pad for rubber stamps. A. The following is said to be a cushion that will give color permanently. It consists of a box filled with an elastic composition, saturated with a suitable color. The cushion fulfills its purpose for years without being renewed, always contains sufficient moisture, which is drawn from the atmosphere, and continues to act as a color stamp cushion so long as a remnant of the mass or composition remains in the box or receptacle. This cushion or pad is too soft to be self-supporting, but should be held in a low, flat pan, and have a permanent cloth cover. The composition consists preferably of 1 part gelatine, 1 part water, 6 parts glycerine, and 6 parts coloring matter. A suitable black color can be made from the following materials: 1 part gelatine glue, 3 parts lampblack, aniline black, or a suitable quantity of logwood extract, 10 parts of glycerine, 1 part absolute alcohol, 2 parts water, 1 part Venetian soap, 1-5 part salicylic acid. For red, blue, or violet, 1 part gelatine blue, 2 parts aniline of desired color, 1 part absolute alcohol, 10 parts glycerine, 1 part Venetian soap, and 1-5 part salicylic acid. The following additional receipt is also used for this purpose: 1. Mix and dissolve 2 to 4 drachms aniline violet, 15 ounces alcohol, 15 ounces glycerine. The solution is poured on the cushion and rubbed in with a brush. The general method of preparing the pad is to swell the gelatine with cold water, then boil and add the glycerine, etc.

Industrial Uses for Sugar.—In France efforts have recently been made to increase the consumption of sugar, in order to meet the new conditions which have arisen, owing to the abolition of the premium on importation. As a result of this, an immense increase in the industrial consumption of sugar has taken place. Thus, for instance, while in 1904 the total consumption of sugar in breweries in France amounted to 11,940 kilogrammes, in 1910 the figure was increased almost one hundredfold to 1,152,843 kilogrammes. The increase is even greater in the case of denatured sugar (that is to say, sugar to which salt or other material has been added), which is used for feeding cattle. In 1904 1,122 kilogrammes of this were used. Three years later this had risen to one thousand times the original figure. As a matter of fact, many more industrial uses for sugar could be found. Sugar is not only an excellent food material, it is also an antiseptic, which might be used for preserving butter, condensed milk and wood; it is absorbent for lime and could, therefore, be used for purifying phosphatic chalk, zinc mineral, etc. It is a reducing agent which may be used in indigo dyeing, or it may serve to precipitate the oxide in a preparation of chrome leather. Lastly, sugar forms the raw material for the preparation of lactic and formic acids, of certain cements, soaps, inks, show blacking, etc.—*La Nature.*

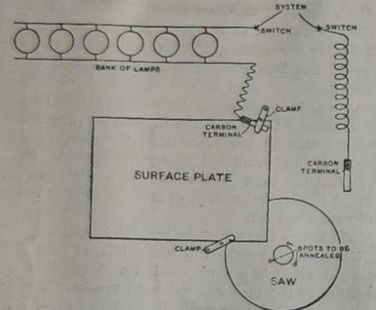
Zola!

Perhaps no writer known to the world during the past fifty years has attracted more general attention than Emile Zola. The works of none have occasioned more acute and vigorous controversy. His earlier efforts, which were wonderful, often appalling, triumphs of realism, raised a storm of protest, even horror. The picture in the morgue upon which Therese Racquin and her guilty lover gazed was almost intolerable in its ghastliness. The frightful tableaux upon which the reader of "Doctor Pascal," "Nana," "La Terre," &c., has to look are without parallel in the tortures of the imagination. Balzac wrote the human comedy. Zola set out to write the human tragedy. Few will challenge our verdict that Balzac succeeded better than Zola. Few will compare them in any other connection, for Balzac's "Lily of the Valley," while it has all the faults of the French school of sentimental romance, does not approach in insipidity "Le Reve" of Zola.

(9673) F. H. writes: For a red varnish to be used on electrical articles, allow me to submit the following recipe: Melt together 2 parts of Venetian turpentine (Terebinth Venet.) and 1 part pale shellac (orange shellac will do as well); when temperature reaches 60 deg. C. add 10 parts alcohol. Rub up 3 parts pulverized cinnabar (vermilion) with sufficient alcohol to form a paste, and add to the melted mixture. The operations should be carried on in a water bath, to avoid undue heating. Stir until a smooth liquid is obtained. This should be allowed to cool, continually stirring, and when required should be heated over water bath until it can be applied with a brush. Articles to be coated should be warmed. This paint dries somewhat slowly, but gives beautiful rich permanent color. Needless to say, the necessary precautions as regards fire have to be taken when preparing the paint, as same is inflammable.

SAW ANNEALING BY ELECTRIC ARC.

A CONTRIBUTOR to the Electrical World describes how in a simple manner the electric arc may be utilized for annealing the center of a circular saw. For a certain milling operation it was necessary to use a 4-inch saw, 1/16 inch thick, so close to a projection on the work that it could not be supported on more than one side. A special arbor was made with a shoulder, and the saw was soldered in place. The heat of the solder, however, made the saw buckle, and it broke loose after milling a few pieces. It was then decided to anneal the center of the saw, and fasten it to the end of the arbor with button-head screws. The device shown in the cut was used for the annealing. This device consisted of two pieces of arc light carbon connected up to the lighting system, which was 110-volt direct current, with six 16-candle-power lamps arranged so that one or more could be put in the circuit for resistance. The spots to be annealed were marked on the saw, and it was then clamped to one edge of a small surface plate. One of the carbon



SAW ANNEALING BY ELECTRIC ARC.

terminals was also clamped to the surface plate, and after turning on the current, the other carbon was held just far enough from the spot to be annealed to cause a good arc. This was continued until the spot was judged to be hot enough, and then the other spots were treated in the same manner. The result was so successful that the saw was easily drilled and countersunk at the annealed spots, and the screws put in flush with the side of the saw.

HYDROGENIT.

A NEW process for manufacturing hydrogen gas for aeronautic purposes is based on the decomposition of water at ordinary temperature by a specially prepared aluminium compound, made of aluminium filings, to which are added a small quantity of bichloride of mercury and cyanide of potash, both pulverized. This compound forms a coarse metallic powder, giving out a small amount of heat. Its apparent density is 1.42, and it keeps indefinitely in an air-tight vessel. Its most remarkable property is its action upon water. One kilo (2.2 pounds) of this compound, treated with an excess of water, produces about 1,300 liters (39 cubic feet) of hydrogen gas at a temperature of 15 deg. C. (59 deg. F.). About 800 grammes (28 ounces) are sufficient to produce 1 cubic meter (35.37 cubic feet) of gas. On account of this peculiarity it is called hydrogenit.

To produce the gas, the compound is placed in a receiving vessel, and a small amount of water is added to it. After a few seconds the reaction begins, making itself apparent by a progressive rise in temperature. This production of heat regulates the rapidity of the decomposition of the water, which is the more thorough the higher the temperature of the reacting products, although it should not surpass 80 deg. C. (176 deg. F.). By keeping the temperature at about 70 deg. C. (158 deg. F.) by the introduction of a variable quantity of water, the amount of the aluminium in the compound will become thoroughly oxidized in two hours.—Génie Civil.

HOW TO KILL FLIES

To clear rooms of flies carbolic acid may be used as follows: Heat a shovel or any similar article and drop thereon 20 drops of carbolic acid. The vapor kills the flies.

A cheap and perfectly reliable fly poison, one which is not dangerous to human life, is bichromate of potash in solution. Dissolve one dram, which can be bought at any drug-store, in two ounces of water, and add a little sugar. Put some of this solution in shallow dishes and distribute them about the house.

Sticky fly-paper, traps, and liquid poisons are among the things to use in killing flies, but the latest, cheapest, and best is a solution of formalin or formaldehyde in water. A spoonful of this liquid put into a quarter of a pint of water and exposed in the room will be enough to kill all the flies.

To quickly clear the room where there are many flies, burn pyrethrum powder in the room. This stupefies the flies, when they may be swept up and burned.

If there are flies in the dining-room of your hotel, restaurant, or boarding-house, complain to the proprietor that the premise are not clean.

Easy Waterproofing

A QUICK and easy method of waterproofing clothing has been devised by a French scientist as his contribution to the comfort and health of the French troops in the field.

Old coats can be made waterproof as easily as uncut cloth, and the whole operation is simpler than dyeing. He explained his method to the French Academy of Sciences, with assurances that it was practical and satisfactory.

The requirements he set out to meet were: Waterproofing that would wear well in the rough usage of a campaign; that would not change the colors nor injure the fabric; that would leave the cloth permeable to air and perspiration, so that the waterproofed coats would not be uncomfortable; and, most difficult of all, that would permit the treatment of old coats without destroying or even injuring the buttons and other attachments.

Wool fat was his answer. With a little chloroform or carbon bisulphide the scientist reduces the wool fat to a liquid and this liquid is then diluted with gasoline or benzine in the proportion of one part of wool fat to from ten to twenty parts of gasoline or benzine.

The rest of the operation is simple: The old overcoat is dipped in the solution and allowed to remain there a few minutes. Then it is wrung out and dried by hanging on a line in the open air. The fibers are, as a result, lightly impregnated with the wool fat.

The Frenchman suggests that the complete uniforms of all the men at the front be given this treatment; and, as the French Government gives much weight to suggestions made in the Academy of Sciences, it is quite likely something will come of his idea.

FIG. 5.

Prof. Broca. If the experiments of Mr.
unknown, it is no doubt due to the fault of
of this investigator. But we are no long
ment with Prof. Broca when he says "th
was not in effect capable of application, and d
sent any theoretical importance." This is
it is by these experiments of Mr. Onesti th
covered the properties of metallic filings. In

... screw manufacture and wherever thousands of duplicate threaded parts are required.

Waterproofing Drawings and Tracings Without Crimping. J. S. CARPENTER. (*Engineering News-Record*, vol. 81, No. 13, p. 597, September 26, 1918).—Waterproofing of drawings and tracings so that they can be used in wet places, as in mines, is done by the use of a preparation composed of rubber and benzol. The solution in less dilute form also makes a paste which may be used to join tracings and maps without the crimping of the joint that commonly occurs when water pastes are used. The pure gum rubber which is required for this waterproof paste can be bought at wholesale drug houses; the benzol can be obtained at most paint stores. The benzol-rubber solution will keep in any climate and under any conditions. As benzol is inflammable, it should be kept in a safe place in a covered jar. If proper precautions are taken in its use, however, it is no more dangerous than kerosene.

A convenient quantity of the solution may be made by adding a piece of rubber about 4 inches square to a half pint of benzol in a quart jar. The rubber will soon swell to three or four times its former bulk and will be ready for use in 24 hours. To prepare for use, pour about half the above quantity in another jar for thinning down. If drawings are to be coated, use a rather thin solution that will spread well under a brush. The drawing should be coated on both sides. For use as an adhesive, the solution should be fairly stiff, so that if it is desirable afterward to separate the joined parts, it can be done more readily than if a thin paste is used. There are cases where large tracings and blueprints must be made up of smaller sections, and for this work the paste is invaluable, as the joints will not be crimped out of shape and alignment. An additional use for the preparation was suggested when some of this solution was spilled accidentally on a dirty drawing. When the benzol was mopped up with a rag, the rubber was rolled up into a ball and the drawing was effectually cleaned by the operation.

Rubber bands instead of pure gum were tried, but it was found that they would not dissolve; they merely swelled up to many times their former size. Formaldehyde also was tried as a solvent, but its objectionable odor and certain other characteristics have proved it to be undesirable. When diluted as above directed the pure gum paste will not be costly.

Fixing a Photographic Plate Before Development. ANON. (*Revue Generale des Sciences*, vol. 27, Nos. 15–16, August 15–30, 1916.)—At first sight it may appear absurd to think of fixing a photographic plate before the latent image has been developed, because fixing consists in dissolving the reduced bromide of silver. When an exposed sensitive plate is treated with hyposulphite of soda the opaline coating becomes completely transparent; not the least trace of an image is discernible, and the gelatine appears to contain nothing that can be disclosed by photochemical action. Nevertheless, paradoxical as it appears, this method is not only theoretically possible but has also several practical applications. If it were not limited to plates greatly over-exposed (six to eight times normal exposure), it would solve, better than any other process, the problem of development in open light.

The plate, protected from actinic light, is first immersed in a 2 per cent. solution of hyposulphite of soda. This bath dissolves the bromide of silver much more slowly than the usual fixing bath of 20 to 25 per cent. strength, but the latter has the disadvantage of destroying the delicate half-tones. Dissolution requires about 30 to 40 minutes, according to the thickness and hardness of the gelatine. The plate can then be developed in full daylight. If desired, the plate may be washed and dried and laid aside for future development. The image is disclosed by *physical development*, that is to say, by bringing a reducing agent and a soluble salt of silver in contact with the exposed film. The developer will contain, for instance, pyrogallol and nitrate of silver. The pyrogallol decomposes the nitrate of silver, and the silver so precipitated is deposited upon those points of the sensitive coating which have been exposed to the light and in quantities proportional to the exposure. The exposed points constitute in fact so many centres of attraction for the deposit of silver which are progressively reinforced.

... of another opinion to the effect of the alcohol question on German culture.

Electrolyte for Pocket Lamp Batteries

THE following instructions are given in a German publication for preparing the electrolyte used in the batteries for the ordinary pocket flash lamp:

One hundred and forty grammes of well-powdered salammoniac, 40 grammes of zinc chloride, 10 grammes of ammonium sulphate are mixed together in a porcelain bowl with 10 grammes of thick refined glycerine. The mixture is then covered in small quantities with distilled water at a temperature of 40 deg. Cent. and energetically stirred until the materials are dissolved into a concentrated solution. This mixture is allowed to soak into the binding material, and the paste so formed is filled into the cells, which are closed with a paraffined card top sealed with bottle-wax. In the cover two small glass tubes are provided for the escape of such gases as are generated within the cell. In compounding the electrolyte calcium acetate can be mixed with advantage with equal parts of the salammoniac. Such a solution possesses excellent conductivity, is hygroscopic, and does not crystallize or creep.

Binding materials used for making a paste of the electrolyte are glass-wool, sawdust, gelatine, starch, kieselguhr and water-glass. Ordinary flour, either wheat or rye, is, however, most generally used.

Note on Chlorate of Potash.

(Potassium Chlorate)

By William J. Tallamy.
(Member N. F. P. A.)

In view of the many serious disasters that have been directly or indirectly attributable to the presence of chlorate of potash, the writer believes that a brief note on this substance may perhaps be instrumental in leading to a more general knowledge of its dangers, resulting in further restriction and more careful handling, both of which are necessary if a repetition of the disasters of the past is to be avoided.

Chlorate of potash, one of the important salts of chloric acid, is a white crystalline substance, usually handled in lump or powdered form.

It is produced largely by electrolytic decomposition of potassium chloride, though it may also be produced by passing chlorine gas through milk of lime and adding potassium to the mixture, or by adding chlorine to hot concentrated caustic potash.

It is composed chiefly of chlorine, potassium and oxygen, and will decompose with the liberation of oxygen from slight mechanical or chemical action, which fact is the chief cause of its danger.

Pure chlorate of potash will decompose and burst into flame with explosive tendency instantly if brought in contact with sulphuric acid, phosphorus, antimony sulphide, or potassium cyanide. Under ordinary conditions chlorate of potash gives off oxygen at about 350° C., the amount of oxygen increasing with the temperature, until a maximum of about 40 per cent oxygen gas is produced, potassium chloride remaining. Owing to its valuable properties its uses are many. In laboratories it is used in the production of oxygen gas. It is used extensively in the manufacture of fireworks, matches, colored fires, explosives, in fabric printing and bleaching establishments, and also for medicinal purposes. Hence the demand for it is great, and suitable provision must be made for handling and storing it.

Chlorate of potash should never be housed in the same building with organic or combustible substances, and premises in which it is to be stored should be thoroughly cleaned and free from any accumulation of particles of combustible material before the chlorate of potash is brought into the building. If, for example, a cargo of chlorate of potash in kegs be received into a warehouse that has been used for the storage of flour, starch, charcoal, sulphur, wood pulp, or any combustible material producing dust in handling, the mixture of small particles of chlorate of potash such as are likely to slip through the cracks and seams in the kegs and particles of inflammable dust remaining on the floor would be exceedingly dangerous and might easily be ignited by the frictional heat of a footstep, or by a smouldering match, cigarette or cigar.

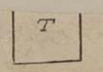


FIG. 11.

B is the coherer arranged to rotate and connected to the transformer. *n*, *m*; *l* is the antenna; and *T* a telephone.

Electroplating with Cobalt. C. H. BUCHANAN and THOMAS HADDOW. (*The Metal Industry*, vol. 13, No. 6.)—This paper, prepared for the New York Branch of the Electroplaters' Society, contains data and results of experiments covering a long period, made by the writer, C. H. Buchanan, and a report of experiments of recent data in collaboration with Thomas Haddow. Early experience showed that a chloride-cobalt solution deposited more rapidly than did a nickel solution. Subsequent work done with cobalt proved so satisfactory that if the cobalt metal could have been obtained in sufficient quantities from commercial sources, even at a cost higher than paid for nickel, it would have been adopted for general work. The results of recent tests are summarized as follows: Cobalt plating has a beautiful bluish-white color. The deposit does not tarnish as readily as nickel; it is homogeneous, with a fine, close grain; it is smooth and not brittle, and will easily withstand bending tests. The time required in order to secure a satisfactory deposit is much less with cobalt than with nickel, and the current density with cobalt may be greater. Metallic cobalt costs more than nickel, but the cost of the salts is of small importance in a comparison of the two as to economy in results. Because of the greater conductivity of cobalt as compared with nickel, a current of higher density may be used in combination with a solution of less concentration. The time required in the solution is, with cobalt, one-third that required for nickel, and there is a similar saving of time in the buffing-room. The substitution of cobalt for nickel would thus greatly increase the speed of production in any established plant.

Physical Properties of Cobalt. H. T. KALMUS and C. HARPER. (*J. Ind. Eng. Chem.*, vii, 6.)—The cobalt examined was reduced from the oxide. The pure metal, containing 99.1 to 99.9 per cent. cobalt, resembles nickel in appearance, but when electro-deposited and polished has a slightly bluish cast. The specific gravity referred to water at 4° C. is 8.7918 at 17° C. for the unannealed metal, 8.8105 at 14°.5 C. after annealing, and 8.9253 at 16°.5 C. after swaging. The Brinell hardness determined in a standard Olsen machine, with a load of 3500 pounds, was about 124 for cobalt cast in an iron mould, that of nickel cast under similar conditions being about 83 and of cast-iron about 102. The presence of 0.06 to 0.37 per cent. carbon had less effect on the hardness of cobalt than slight variations in heat treatment. If the melting-point of nickel be taken as 1452° C., pure cobalt melts at 1478° C. ± 1.1° C. It has a tensile strength of about 34,400 pounds and a compressive strength of about 122,000 pounds per square inch as cast, the corresponding figures after annealing being 36,980 and 117,200 pounds per square inch respectively. Cast cobalt containing 0.06 to 0.3 per cent. carbon has a tensile strength of about 61,000 pounds, and a compressive strength of about 175,000 pounds per square inch. Both the tensile and compressive strengths are greater than those of pure iron or nickel cast and tested under similar conditions. The reduction of area and elongation are low for pure cobalt, but rise to above 20 per cent. in the case of "commercial" cobalt, 96.5 to 99.6 per cent. Co, containing carbon and other impurities. Pure cast cobalt can be machined in a lathe and, if the casting be cooled under high pressure, can subsequently be rolled or swaged at 500° to 600° C. Commercial cobalt is easily machined and can be rolled or swaged at red-heat without any special preliminary treatment. The specific electrical resistance of cobalt wire of high purity is 89.64×10^{-7} ohms per cubic centimetre, and is largely influenced by the presence of occluded gas, being increased by annealing in an inert gas at low temperatures and diminished by annealing *in vacuo*. The electrical resistance of commercial cobalt is 231×10^{-7} to 103×10^{-7} per cubic centimetre, and is greatly reduced by annealing *in v*[illegible] The specific heat of pure cobalt between 0° and 890° C. is [illegible] by the formula:— $0.1058 + 0.0000457t + 0.0000000066t^2$. The [illegible] is illustrated by eleven photomicrographs.

Long [illegible] **Bridges.** ANON. (*Sc*[illegible]

Electrolytic Cleaning of Silverware. ANON. (*Metal Record and Electroplater*, vol. xi, No. 11, November, 1916.)—A bulletin recently published by the United States Department of Agriculture deals with the electrolytic method of cleaning tarnished silver, which is recommended as an easy and effective way of performing this task. It consists in boiling the article in a soda and salt solution in contact with a clean piece of aluminum or zinc. Experiments made under the direction of the Bureau showed that when silver spoons were polished with whiting paste, nearly 0.01 grain of silver each was lost, whereas with the electrolytic process, only one-twenty-fifth of this amount was wasted.

The tarnish which occurs in silver is not due to oxidation, but to the action of sulphur. The electrolytic cleaning depends upon the slight solubility of the silver sulphide in the hot solutions employed.

has for three years been making field investigations of these deposits. The examinations have been accompanied by mapping of the areas of hydrocarbon shales and by such field measurements of the thickness of the shales in workable beds and such rude field distillation tests as will afford primary information concerning the amount and richness of the shale in different parts of the region.

Very rough but cautious calculations of the contents of the shale in parts of the area examined indicate that the distillation of shale from beds over 3 feet thick in Colorado alone will yield more than 20,000,000,000 barrels of crude oil, from which more than 2,000,000,000 barrels of gasoline can be extracted by ordinary methods. A report giving the results of these explorations and tests and an account of experiments as to possible gasoline production, both by the ordinary commercial processes and by the Rittman process, are now in press.

[illegible] Borneo, Sumatra, and elsewhere.

platinum [illegible]

Measuring the Pressure of Light. G. D. WEST. (*Proceedings of the Physical Society of London*, vol. xxviii, part v, August 15, 1916.)—The pressure of the radiation emitted by a carbon filament lamp at a distance of a few centimetres is sufficient to cause a microscopically measurable deflection of the end of a strip of gold or aluminum foil suspended in a closed test-tube. By this means the radiation pressure may be measured, and the results may be checked by a comparison with the energy density of the radiation as deduced from the initial rate of rise of temperature of an exposed blackened copper plate. Previous experiments were carried out in atmospheres of air and hydrogen, and at pressures extending from 76 centimetres to one centimetre of mercury. The present experiments deal with pressures from one centimetre of mercury down to the highest exhaustions that could be reached.

As the pressure is lowered certain gas-action effects make their appearance, but, inasmuch as there is no appreciable difference of temperature on the two sides of the strip, the effects are somewhat different from those that occur in the ordinary type of Crookes radiometer. When the surface of the strip is closer to one side of the containing vessel than to the opposite side, a deflection away from the closer side occurs, and the direction of the deflection is independent of the side of the strip upon which radiation falls. With symmetrically placed strip the deflection should be negligibly small. An explanation of these effects is suggested and a special type of radiometer is described. The nature of the residual gas in the tube does not seem to be very important, but it is found that the repulsive force acting on the strip increases with decreasing pressure until a maximum is reached at about 0.002 centimetres of mercury. With a further reduction of pressure a progressive decrease takes place. By symmetrical suspension and by the use of liquid air and charcoal, it is possible to so reduce the gas-action effect that measurements of the pressure of light of reasonable accuracy are again possible. Experiments on the pressure of light may thus be advantageously carried out at the highest vacua obtainable, or at pressures as far above 0.002 centimetre of mercury as convection currents will permit. The latter alternative is easier and leads to more consistent results.

New Way to Detect Over-Heated Bearings

CERTAIN double iodides of mercury with other metals are dimorphic and exhibit a more or less pronounced color change at the transition point, says a writer in a leading chemical journal. He has made a study of these in order to determine which compounds are most suitable for use as visible indicators of over-heating in bearings and machinery.

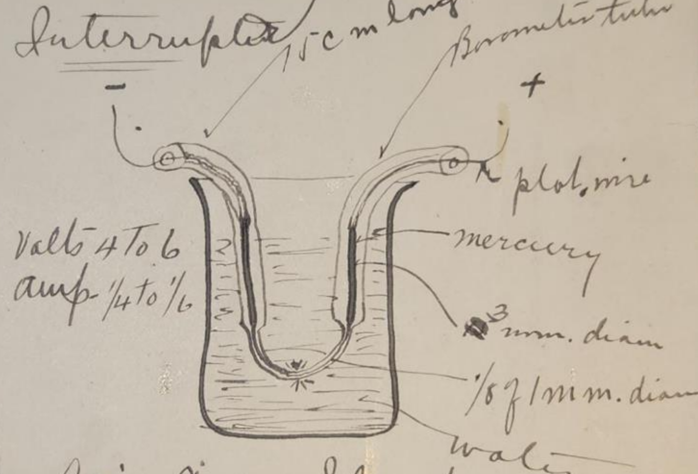
The double iodide of silver and mercury, $AgI.HgI_2$, is a pale lemon yellow powder at ordinary temperatures, but changes to a vivid carmine at 90 to 100 degrees C., the change in both directions being fairly sharp. With copper mercuric iodide, $Cu_2I_2.2HgI_2$, the change from a vivid scarlet vermillion to a chocolate brown takes place at 60 to 70 degrees C. It was found that a mixture of the two, consisting of 85 per cent of the copper salt and 15 per cent of the silver salt, was more sensitive and gave an exceedingly sharp transition from vermillion to almost black at 60 to 70 degrees C.

For application to bearings, etc., these compounds are mixed with white shellac spirit varnish or, for more elevated temperatures, a medium such as is used in aluminum paints for steam pipes, in the proportion of 100 g. compound to 70 cc. of medium. This paint is best applied as a bullseye or band on a zinc white background. After the paint is dry, it should be protected with a coat of colorless oil-proof varnish.

Science & Industry Jan 02

PICTURE TELEGRAPHY

MANY attempts, more or less successful, have been made to transmit pictures through a telegraph line. Elisha Gray and others have used the writing telegraph to make facsimile drawings at a distance, and Sczepanik has devised an apparatus intended to enable us to actually see by telegraph, but this apparatus is complicated, and has not as yet been practically successful. Herr Otto von Bronk has devised a simple and ingenious apparatus for printing at the receiver a photograph of any illuminated object placed in front of a lens at the transmitter. Herr von Bronk makes use of the wonderful susceptibility of steel wires to magnetic strain, utilized by Poulsen in his telegraphone. The image of the object is thrown by a photographic lens on a surface made up of a mosaic of selenium cells. Selenium is a substance whose electrical resistance varies with the intensity of the light that falls upon it. Each cell is in circuit with one of a series of electromagnets arranged so as to produce transverse magnetic strains in a ring of steel wire, each strain being, of course, proportional to the intensity of light acting on its corresponding selenium cell. These strains are reproduced on a similar ring at the receiving station by a synchronous rotating arm. By reversing the original operation, the magnetic copy of the picture is retranslated into an optical one, a photographic negative being produced.—Electrical Review.



Sci. Am. July 29/05

The most and least economical of foods belongs to the vegetable kingdom. The nutritive value of "breakfast foods" is no greater than that of flour or meal. White flour is more economical than Graham or whole wheat flours. There is more protein in the bran and germ of wheat than in the remainder of the kernel, it is pointed out, but flour containing the bran while having somewhat more protein, is of less advantage to the body. The protein is bound up in material so tough that it is not readily acted upon by the digestive juices. Careful experiments made by the Government chemists have proved that the finer flours are more digestible than the Graham or whole wheat flours.

Bread can be made at home about half as cheap as it can be bought if the baking is done with the same fire needed for other purposes. Oatmeal and rolled oats furnish more than twice as much protein and energy as the same investment in a cheap cut of beef, such as brisket, worth six cents a pound. White cornmeal is as nutritious as yellow cornmeal.

Sulphocyanide of iron — Red
Chloride of Copper — Green
Amonia Copper Sulphate — blue-violet

OXYGEN MADE BY ELECTRIC PROCESS

Owing to its widespread use as an agent in cutting and welding operations, oxygen gas has become an important commercial product and is now being produced from water in large quantities by an electrolytic process in a number of factories in this country. The electrolyte used is a 10 or 15-per-cent solution in water of caustic soda or of caustic potash. A direct current is passed through this electrolyte with the result that oxygen is given off a

1. Cooling photographic solutions; hypo packed in a large tray cools the solution in the smaller one. 2. Cooling a bottle of milk with hypo. 3. Hot water bottles filled with the hypo are preferable to the ordinary ice-pack. 4. This device, with hypo in the can under the conical hood, cools the water as it flows from the faucet. 5. Fruit closets and cupboards may be cooled by allowing the incoming air to pass over an open tray of the cold hypo

Some of the places where the cooling action of ordinary photographer's hypo may be utilized

A New Use for Our Old Friend Hypo

By Frank B. Howe

THE use of common "hypo" (sodium thisulphate) as a cooling medium, in place of ice or any of the expensive chemical cooling processes, is the innovation of a California chemist who recently disclosed the surprisingly simple and costless process he has devised.

It is common knowledge to photographers that hypo, when dissolved in water, causes the temperature of the solution to become very low. Starting with this natural property of the cheap chemical, the inventor has adapted this quality to practical use and so harnessed the hypo that it may be substituted for ice for use in the kitchen, in hospitals, in the photographic laboratory, in house ventilation systems, and so on indefinitely through the whole list of places where lowering of temperatures is desired.

For cooling milk and other kitchen commodities the bottle of milk is placed in an ordinary kettle; hypo packed around it in the same manner as an ice cream freezer is packed; and the hypo dampened with water. The temperature immediately becomes very low and remains so for several hours.

For hospital use the wet hypo is packed in ordinary hot water bottles. Where ice would quickly melt the hypo keeps cool for hours.

Similarly, the hypo method of cooling is used to cool off houses by passing the incoming air over a pan of wet hypo. For cooling drinking water as it comes from the tap, a glass jar of wet hypo, fitted with a conical top, is suspended below the faucet. The water passing over this becomes cold in the same way as water passing over ice would do.

The use of hypo in this way in no way affects its later use in the usual ways for photography and other purposes. Hypo costs around five cents a pound; hence this method would be cheaper than ice cooling, were the hypo thrown away. However, it can either be subsequently used for photography, or else it can be evaporated and used again and again for cooling. In either case, it is not only much cheaper than ice, but a great deal more convenient to handle.

Thus far the possibilities of this medium in the cooling line have been barely touched. There seems to be no limit to its possibilities and possible adaptations. It is simply a matter of taking advantage of the natural property of this chemical and utilizing a medium of cooling that nature has supplied gratis.

Work is now under way upon mechanical apparatus which will permit the use of hypo in great quantities for wholesale and commercial uses of lowering temperature. In such cases the advantage over ice would be very great. Likewise in eliminating a great deal of the cost of chemical cooling, as now known, the humble hypo is a great improvement and advantage.

However, hypo has its limitations. It will not produce a great drop in temperature, such as is required for many purposes, but it is suitable for many household duties.

Three-pole prot

corresponds to a 7 per cent solution of sugar; while 120 mg. of dulcin corresponds to 3 per cent sugar solution. Hence when the two are added together they have a combined sweetening power equal to a 10 per cent ution, whereas to attain this same degree would require either 535 mg. of saccharin mg. of dulcin. Professor Paul calls this f substances 'the pairing of sweeteners.'"

nusing tests were made at this meeting of the the distinguished chemists present to detect of the sweetening substance employed. They red cups of tea sweetened with one or the he three substances, but designated only by Twenty-one out of 34 persons who tasted tea with sugar were quite sure that an artifici had been used. In another test the gu ed to sip alternately from cups of tea s sugar and with the combination of sa , but without knowing which was w 15 out of 16 persons affirmed that th the artificial sweeteners was th his experiment was repeated w ea, and in this instance 23 in favor of the artificial s which was which. These merriment, since many previously declared uishing between t l substitutes.

Safety in

By

device a system from ances.

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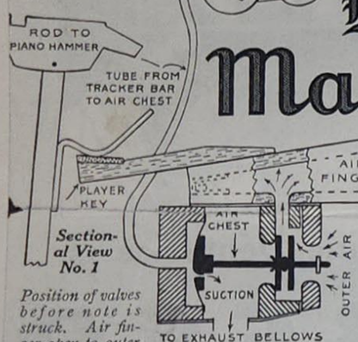
very appreciable we have als

How AIR becomes a wonder-worker in the Baldwin Manualo



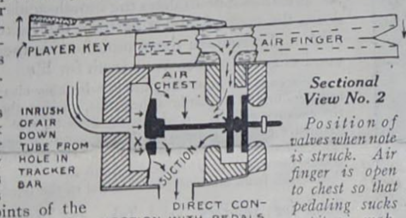
The Player-Piano that is all but human

Section-al View No. 1

Position of valves before note is struck. Air finger open to outer air. Pedaling reduces the air pressure in chest and tube so that when a perforation in music roll passes over a hole in tracker bar, air rushes down tube and pushes valves over to position below.

AIR, as you know, operates most player-pianos. The principle is this: Pedaling sucks the air from little bellows or air fingers (one for each note) which collapse and make the piano hammers strike the strings. Then outer air refills the air fingers for the next striking of those particular notes. But—

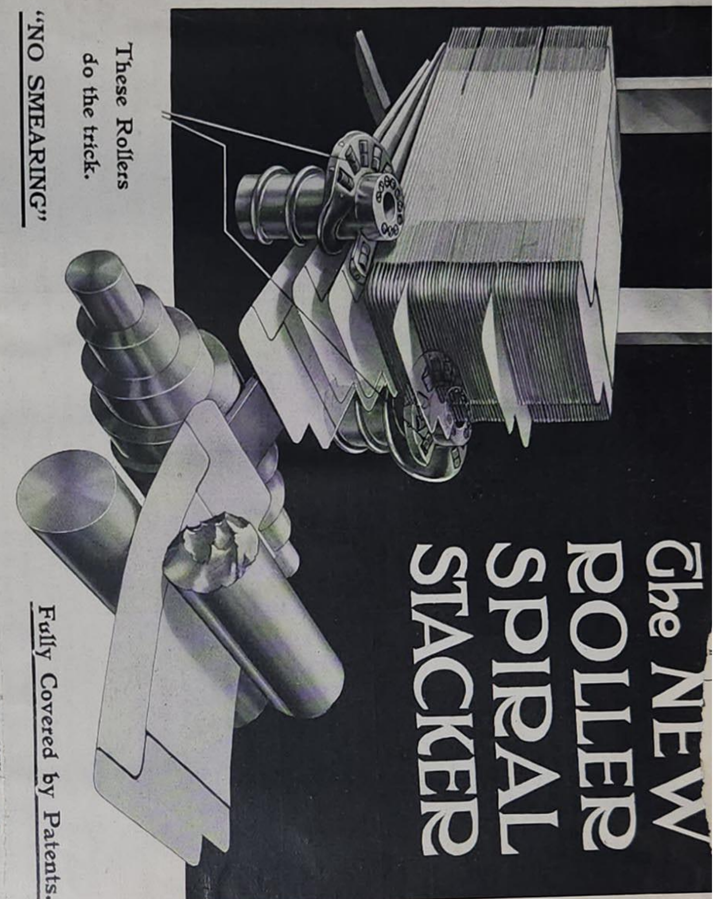
Whether the air fingers make *every* note sound depends upon how quickly and surely they are sucked out and refilled. And whether they make the notes sound with varied expression and accent like hand-played music depends upon whether or not your instinctive changes in the force of your pedaling makes them collapse with varying force similar to the various degrees of energy in hand-playing.



Sectional View No. 2

Position of valves when note is struck. Air finger is open to chest so that pedaling sucks out its air, making it collapse and raise player key which, in turn, makes the hammer strike the string. As soon as hole in tracker bar is closed, air in tube escapes through pin hole (X), outer air pushes back valves as in View No. 1 and air finger is refilled.

With air, as with electricity or any other power, its efficiency in doing this work and its obedience to your control depends upon how much resistance it meets and how much of it leaks through the valves and joints of the mechanism. It is because of the reduction of resistance to practically nothing and the successful elimination of leakage that the Baldwin Manualo is absolutely perfect in its fingering and instantly responsive to every change in your pedaling.



Another remarkable alloy has appeared in Germany, called Ruebel bronze, after its inventor, Walter Ruebel. Its main ingredient is magnesium, to which zinc, copper and aluminium are added. A fine-grained homogeneous alloy of considerable strength and no specific gravity is thus obtained. This new alloy is important in constructing airships. The Zeppelin airship, with its mechanical parts of the new metal, would weigh 3½ to 4 tons less than at present constructed.

"Dutch Tears."

From the London Globe.

"It is a great wonder to me," said an old chemist, "why more boys do not take up chemical experiments as an amusement. Why, I can do things with the common materials of everyday life which really seem to be more magical to the uninitiated than any of the wonders that are ordinarily performed by magicians on the public stage. Some of them are so simple that by carrying them out at a parlor entertainment a bright boy could achieve the reputation of a magician. Now there are those curious little bubbles of glass known variously as 'Prince Rupert's drops' and as 'Dutch tears.' Apparently they are merely little globules of glass with elongated tails made by heating a small glass rod in a flame and allowing the molten drops to fall into water. After they have cooled you may pound the thick part with a hammer or mallet, yet you cannot break them. On the other hand, if you break a little piece off their tails, or touch any part of them with a quartz-crystal, they will disappear into the surrounding atmosphere quicker than snow will melt on a hot fire. To the person who doesn't know how this has happened the performance is so astonishing as to seem uncanny.

A German patent gives, as an excellent, rapid, non-inflammable or explosive, solvent for rubber, as bichloride of ethylene. Safer and better than the usual solvents, ether and chloroform [illegible]

It is stated in the Brass World that plaster of Paris will harden rapidly if 0.25 per cent of sodium bisulphate is added to it. The sodium bisulphate should be dissolved in the water used for making the plaster. The strength of the hardened mass is also stated to be increased nearly three times.

A New Briquetting Material

A NEW binding material for making briquettes has been patented in France, consisting of 15 parts of glassmaker's sand, 18 parts Portland cement and 10 parts carbonate of soda, or other flux of silica, such as sea salt or sulphate of soda. From four to six per cent of this binder is mixed with the fine coal and coal dust, together with about eight per cent of water, and compounded in a mixer into which steam at about 16 pounds pressure and at a temperature of 170 deg. Cent. is admitted. This mixture is then pressed into briquettes. Heat may be applied as the blocks come from the press to increase the cohesion. This binder fuses to a vitreous mass at 200 deg. Cent.

Wind Pressure.

From Technical Literature.

Messrs. Stanton and Bairstow have recently made some experiments at the National Physical Laboratory, London, which bring out a new and practically very valuable fact—namely, that pressure is not the same on large surfaces as on small experimental models. If, for example, a given wind velocity is brought to bear on a square foot of surface it will be 18 per cent less a square foot than if it were directed on 100 square feet of surface. It was demonstrated, too, that this relation is constant for flat forms, however complicated. A builder or engineer who knows that a structure may be exposed to a wind of eighty miles an hour and that the pressure a square foot as determined by model is, say x pounds, should allow for his larger construction 20 per cent extra. The reason for this seems to be the more thoroughly reduced pressure on the lee side of a larger area.

20

STUDY THE CONVENIENCE OF YOUR PATRONS

and **show this slide** once or twice during the performance.

Secret Photographs

It is well known that photographs may be rendered temporarily invisible by treatment with potassium ferrocyanide; and in actual practice occasion is found to make use of this fact. The more usual photographic papers, however, coated with chloride or bromide of silver, lend themselves poorly to this business of secret writing or secret pictures. The coating of gelatin or collodion which masks the image betrays its nature at once and, at the least suspicion, nothing is easier than to make the hidden image disappear.

This difficulty may be avoided, says a writer in a recent number of *La Nature*, by using the ordinary commercial sepia paper, obtainable everywhere at a very reasonable price. This paper, when used for the purpose under discussion, offers the great advantage that it is in no way distinguishable from paper of ordinary printing. In fact, it is not specially coated for invisible printing at all, being simply treated with silver nitrate and iron citrate. For this purpose the following solutions should be prepared separately:

(*A*)	Water	50 cc.
	Green ammoniacal iron citrate....	20 gr.
	Citric acid.......................	5 gr.
(*B*)	Water	10 cc.
	Silver nitrate.....................	5 gr.

At the moment of use these solutions are mixed, together with enough water to make up a total volume of 100 cubic centimeters, giving a thick liquid which is spread just as it is on the paper. If it seems likely that a single application will not afford a sufficiently strong image, a second coat may be applied after the first has dried. When kept thoroughly dry the paper thus prepared will remain in good condition for several months.

The length of the printing exposure is shorter than in the case of chloride papers. In fact, the printing must be halted as soon as the details begin to be faintly visible. The developing is accomplished very simply, by a mere bath in pure water, which should be renewed several times. The image then rapidly acquires its full intensity; it is of a disagreeable yellow shade, shifting to brown in a 10 minute fixing bath of 3 to 5 per cent solution of hyposulphite of soda. Upon drying, the print then gains strength and takes a handsome sepia tone. It is not very rich in mezzotints; but for the present application this lack is of no consequence.

To make the image invisible, the paper is now immersed in:

(*C*)	Water	1000 cc.
	Copper sulphate..................	10 gr.
	Potassium bromide...............	20 gr.
	Hydrochloric acid................	5 drops

The image disappears instantaneously. The print should be washed briefly, and allowed to dry. If necessary or convenient the paper thus bleached may be written on. For this purpose India ink diluted with a little gum arabic may be used. This is easily removed, when the time comes, by plain water.

The bleached image will reappear on immersion in any developer whatever, in a bright light. An old bath of hydroquinone, metol, etc., is perfectly satisfactory, and will restore the print in an instant. Fixation is useless, as each point of the surface contains only just so much of the bromide as is strictly necessary and sufficient for its restoration. If occasion arises, the restored print may again be bleached by the bath (*C*), again restored with developer, and so on indefinitely. It is thus possible, our French authority naïvely adds, to have about one "secret papers which can be consulted only when well sheltered from indiscretion."

Breath Figures. T. J. BAKER. (*Phil. Mag.*, October, 1922).—"If one breathes upon a sheet of glass which has been cleaned with soap and water and polished with clean linen, water-vapour condenses uniformly on the glass in such manner that the surface as seen by reflected light appears dull and rather white. If the tip of a small blowpipe-flame is made to traverse the surface of such a plate and the plate is then breathed upon as soon as it is cold, a whitish deposit appears on those parts which the flame has not touched, whilst the track of the flame is marked by a form of condensation which, owing to its transparency, appears black by contrast with the neighboring parts." A generation ago this phenomenon was discovered but its cause is not yet known. The extent of our knowledge of this subject is greatly increased by the studies made public in this paper. It is found that not glass alone but also porcelain, rock-crystal, mica, Iceland spar, platinum, nickel, silver, brass and mercury can be used. Aitken suggested that a change in the character of the surface is responsible, but this cannot be true since platinum and rock-crystal act as glass does. Again, a blowpipe-flame might well leave a slight solid deposit on its path over the glass, but this deposit is not necessary for the formation of breath figures since a hydrogen flame is just as effective. On the other hand, the figures are not obtained at all, or at most, to an imperfect extent, when chemically cleaned glass is used. The treatment with soap and water and linen leaves something on the surface that is needed for the production of the effect, and the flame removes some or all of this.

The most striking discovery of the author is that the condition that makes one glass plate capable of showing breath figures can be transferred to another. A plate that had been traversed by a flame was put in contact with another that had not been so treated. "Next day the plates were separated, and it was observed that both plates gave breath figures, one being an exact copy of the other. Moreover, the original showed no diminution of intensity." Later it was found that only a few minutes were needed for the perfect transfer when the plates in contact were under low atmospheric pressure. Even with an interval of 2 mm. between the plates a transfer was obtained. In one case a plate produced a transfer eighteen days after it had been treated with a flame. "Since the process is hastened by reduction of pressure and by rise of temperature, and occurs even when the plates are not in contact, it is clear that some gaseous material passes from one to the other." In spite of his long familiarity with the effect and of his intimate acquaintance with all that is known concerning it, he is unable to present a theory of the phenomenon that is satisfactory to himself. He has varied the surface on which the figures form and the nature of the flame. Why not employ for the third stage of the process something not so complicated in its origin as the human breath?

G. F. S.

A Valuable Cement for Pipe Joints

A CEMENT which has stood the action of sixty pounds of steam in a pipe connection where rubber gloves and white lead have failed is made of ten parts fine iron filings and three parts chloride of lime, with enough water to form a paste.

So tough is this cement that when two joints of three inch cast iron pipe, which had been secured with it and left one night were broken apart the cement scaled off a portion of the solid iron of the flange on one of them.

ROPE HORSESHOES IN GERMANY.

[From Consular Assistant Louis G. Dreyfus, jr., Berlin.]

Owing to the rapid increase in the mileage of streets paved with asphalt and wood blocks and to the congestion of traffic in the large cities it was found necessary to afford greater safety for horses, to prevent their slipping and to enable them to come to a quick stop. This has been attained by fitting them with "rope" horseshoes. These shoes were first manufactured some 25 years ago, but it is only during the last decade that the industry has grown to large proportions.

Various forms and shapes of shoes are used. Some are open at the back, like an ordinary horseshoe. Others are closed; and very often, besides being closed, there is a bridge or crosspiece joining the two sides. When this is the case the bridge is constructed like the rest of the shoe, inclosing a tarred rope. There are usually eight nail holes in each shoe; and in order to strengthen the bottom, and especially to make the nail holes more secure, the walls of the groove are sometimes reenforced by braces. The space in the center of the shoe is often covered over with various kinds of inserts to protect the frog from injury. The latest novelty, which has been adopted by the royal stables, is the insertion at the back of the shoe of a block of wood into which stiff bristles have been driven. This is an additional preventive against slipping. When the ground is covered with snow, a special ice plate is inserted in its stead.

It is customary to use special nails with long heads in attaching the shoes to the hoof. When the long-headed nails are used, it is possible to drive them in and to extract them without taking out the rope. These nails, which are driven between the outer side of the groove and the tarred rope, also help to hold in the rope. The tarred rope wears down simultaneously with the rest of the shoe, and it is only on rare occasions that the rope must be withdrawn and new inserted. This change can be made without removing the shoe. The average life of a rope horseshoe is 6 to 8 weeks.

Advantages and Prices.

The advantages and disadvantages of the rope shoes can be summarized as follows: Advantages—They are light and comfortable for the horse; they help to prevent slipping; they break the concussion and deaden the sound of the hoof. Disadvantages—The driving of the nails requires more care; the blacksmith must have in stock a larger quantity of shoes of various shapes and sizes. Great care has to be taken in the preparation of rope horseshoes not to overheat the iron nor to hammer it when too cold, otherwise it will crack on the anvil.

In addition to the plain tarred rope horseshoes there are shoes in which rope interwoven with wire, wood, rubber, copper, wirework, rush, etc., is used. These are heavier, somewhat more expensive, and less practical than the plain rope shoes, and therefore have not become so well established.

The sale of rope horseshoes in Germany is regulated by the Deutsches Tauhufeisen Syndikat, with headquarters in Berlin. This syndicate, which is composed of the eight principal manufacturers in Germany, was formed in July, 1911, to maintain a uniform price for rope horse-

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... receptacle containing a solution of the citrate in the proportion of one part of the salt to one hundred parts of the blood to be drawn. This mixture makes the fluid incoagulable, without robbing it of any of its vital properties; and since the citrate thus employed is inoffensive to the organism, the solution may be injected into the forearm of the receiver without danger. In this simple manner are sidestepped all the difficulties which have hitherto hampered the transfusion process.

The method has been subjected to exhaustive tests in Buenos Aires, under the most severe supervision, and has made good without reservation.

...nment employs an ex- ... E. Munroe, to experi- ...ese high explosives. In ...ents he has made a ...lection of explosive en- ...One of these is the ex- ...of a young maple leaf ... iron. This was made ...leaf on a bar of iron ...g it with gun-cotton. ...n-cotton was exploded ...s reproduced, perfect in ... even to the finest fiber, ...gilding metal. Lace de- ...e faces of coins are simil- ...d. These are not *imprints* ...*ections*, for strangely, the ... leaf, the filaments of ... the lettering of the ...nd out in relief just as the original.

...ler **Corks Impermeable.**—Referring to the ...re of impenetrable corks for vessels con- ...tracts, we would draw attention to the fol- ...cess, taken from the Deutsche Destillateur- ...r making corks absolutely impermeable: 5 ... glycerine is added to a 5 per cent solution ... and the corks, which, of course, must be weighted, allowed to remain for several ...he liquid. Care must be taken that the tem- ...f the bath is warm enough to retain the ...olution in a fluid condition. The gelatine ...e pores of the corks, while the glycerine keep the latter elastic. The corks remain ...th till they are completely saturated, and ...lowed to dry in the ordinary way, no special ...ing necessary. Tightly-fitting corks, elastic ... same time impenetrable even by gases, can ...d by this process.

Barometers

IT is well known that when an absorbent material is immersed in a certain solution it changes color according to the amount of moisture in the atmosphere. Two or three of these solutions are available and by making use of them a picture that tells the weather may be formed. The following articles are necessary for the formation of the pictorial hygrometer. A stout piece of cardboard, a sheet of white blotting paper, a small amount of strong paste and a paint brush. The solutions mentioned below must also be prepared; these could be secured from any chemist, and only a very small quantity of each would be needful. The proportions are on the following lines:

Solution 1.	Cobalt chloride	1 part.
	Gelatin	10 parts.
	Water	100 parts.
Solution 2.	Cobalt chloride	1 part.
	Gelatin	20 parts.
	Nickel oxide	75 parts.
	Cupric chloride	25 parts.
	Water	200 parts.
Solution 3.	Cupric chloride	1 part.
	Gelatin	10 parts.
	Water	100 parts.

The three bottles should be well stoppered and placed aside until required for use.

The chemical barometer was invented by the meteorologist Admiral Fitzgerald. Into a long narrow bottle put two and a half drachms of camphor and eleven drachms of spirits of wine. In a separate vessel dissolve thirty-eight grains of saltpeter and the same amount of sal ammoniac in nine drachms of water. When the salts are dissolved add this solution to the camphorated spirit, shaking the two well together. Now put a cork in the bottle and close with sealing wax, finally making a small hole with a red hot needle through the top. Another way is to put the mixture in a narrow glass tube, the open end of which is drawn out to a point; while the glass is in a soft condition a small hole is made with a needle.

Leeches are astonishingly ...

Nov. 1-02

Scientific American

RUHMER'S OPTIC TELEPHONE.

Dispatches have been published in the daily press, which state that Ernst Ruhmer, who is not unknown to readers of the SCIENTIFIC AMERICAN, has successfully tested a wireless telephone apparatus of his own invention. A description of the apparatus used will probably not be without interest.

Instead of using the speaking or whistling arc light, Mr. Ruhmer employs a small acetylene flame, thereby avoiding a multiplicity of electrical circuits. The gas is produced in a small generator not unlike that of a bicycle lamp, and is led to the burner. If the diaphragm or membrane of the transmitter be spoken against, the acetylene flame flickers in accordance with the sound waves impelled against the diaphragm. Light impulses of corresponding fluctuating intensity are sent forth into space directly, and also indirectly by means of a small reflector, and encounter a sensitive selenium cell mounted in the rear wall of the instrument frame. If the selenium cell be connected with a source of electricity such as a primary or secondary battery and with two telephones, every word spoken into the transmitter can be distinctly heard in the telephone receiver. In order that the direct sound waves may not give rise to any disturbing sounds the optic telephones are in most instances placed in another room, or some distance away.

Fig. 1.—REFLECTOR TRANSMITTER OF RUHMER'S APPARATUS.

That the transmission of the sound waves is effected only through light oscillations can be easily enough proved by inserting between the acetylene flame and the selenium cell, an opaque body, such, for example, as a piece of pasteboard; it will be found that the transmission of the sounds is completely interrupted.

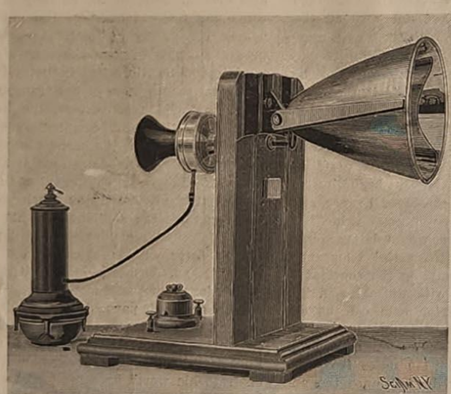


Fig. 2.—RUHMER'S LONG DISTANCE TRANSMITTER.

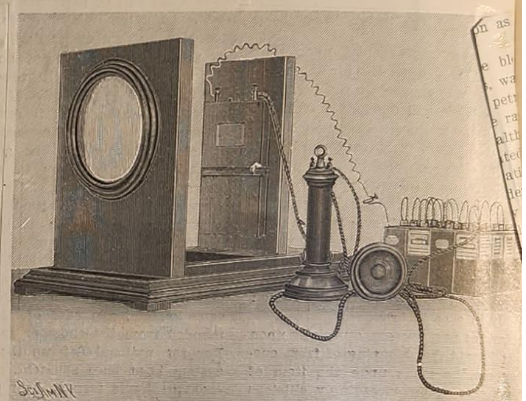


Fig. 3.—THE RECEIVER.

In carrying on experiments at fairly long distances, the selenium cell is detached from its mounting, and in its place a parabolic mirror (Fig. 2) is inserted, which serves the purpose of causing the pencils of light sent forth by the flickering flame to be emitted parallel to one another. It is a well-known optical principle that parallel light waves thus transmitted, travel great distances.

At the receiving station (Fig. 3) the light is collected by a condensing lens and concentrated upon a sensitive selenium cell, which is connected exactly in the manner before described, with a battery and two telephones. There is no particular reason why two telephones should be used—it is simply a German practice. Every public telephone station is fitted with two receivers in Germany.

For etching glass

Formula:

Sodium floride	1 oz.
Glacial acetic acid	10 drams
Water	25 oz.

Dissolve sodium in the water, then add glacial acetic acid.

Use rubber stamp

FOAM AS FIRE EXTINGUISHER.

NEW GERMAN APPARATUS FOR SUBDUING FLAMES AMONG COMBUSTIBLES.

Consul Thomas H. Norton, of Chemnitz, submits the following description of a new German mechanism for fighting fire:

Fire chiefs and insurance companies are familiar with the dangers and difficulty inherent to combating conflagrations where petroleum, gasoline, benzine, or other liquid hydrocarbons, lighter than water, are involved. As is well known, the attempt to extinguish with streams of water in such cases results usually in a spreading of the inflammable liquid, an increase of the area of combustion, and a greater intensity of conflagration. The use of steam or of a current of inert gas is available only for incipient conflagrations in well-closed rooms. It presupposes, also, the permanent location on the spot of stationary apparatus for the purpose.

A distinct step forward in the means of battling with such conditions has been made in Germany, where the use of a tenacious foam, dissipated with difficulty, has been found of great value in cutting off the supply of air necessary to maintain combustion, and thus extinguishing flame. The method and the requisite apparatus have been perfected by a well-known Prussian manufacturing company at Salzkotten, near Minden, Prussia, and have been submitted to exhaustive tests by fire chiefs and others interested in the question of protection against the dangers from combustible liquids. The apparatus employed consists of a simple metal cylinder provided with a long spout and divided into two chambers. One chamber is charged with an aqueous solution of potash alum and sodium sulphate, the other with a similar solution of sodium bicarbonate, sodium sulphate, and licorice-root extract.

EFFECT OF THE CHEMICAL COMBINATIONS.

The cylinder is so arranged that on being inclined or reversed the two solutions mingle as they issue from the spout. There is no pressure evolved, and consequently the liquid does not issue with sufficient force to cause a spattering of the burning hydrocarbon upon which it may be poured.

The result of the chemical reaction between the alum and the bicarbonate is a prompt evolution of carbon dioxid, which, in contact with the licorice solution, forms an exceedingly stiff and persistent foam.

Such a layer of foam containing an inert gas upon the surface of a burning liquid effectually cuts off all access of air and combustion necessarily ceases. The temperature of the liquid may have reached a sufficiently high point, so that through evaporation bubbles of the vaporized hydrocarbon rise for a time through the stratum of foam and tongues of flame flutter over its surface. These soon cease, for simultaneously with the evolution of the carbon dioxid there is a loss of latent heat, the temperature of the foam-yielding solution falls, and this, in turn, cools down the combustible liquid. The solution acts thus in a double manner as a protective agent.

Cracking Coal for Cutting Glass.—Take 8 parts of finely pulverized brown coal, sifted through gauze, and mix it with half a part of sugar of lead pulverized as finely as possible. With the addition of tragacanth mucilage this forms a stiff paste, of which the cracking carbons are formed in the shape of elongated rods, and dried. Such a coal, when perfectly dried, will break off the object to be cut very evenly.

Yellow Varnish for Windows of Dark Rooms.—This is made by dissolving 5 parts of xanthorrhœa or acaroid gum in 5 parts of 95 per cent alcohol. When solution has been effected, it is advisable to add about a quarter of a part of copaiba balsam, or castor oil, to prevent the cracking or peeling off of the gum coating. This will not permit the passage of any chemically effective rays of light and is to be preferred to the ordinary gold varnish because it does not bleach out in the light.

Space telegraphy by means of ultra-violet rays is carried out by J. Köhler in Germany. If two poles of a frictional electric machine are connected to two metal points facing each other, such as needle points, these will pass a silent discharge between the points. As such discharge is sensitive to ultra-violet rays, if we let fall rapidly repeated rays on the points we can hear a sound in a telephone which is connected across the latter. M. Köhler's apparatus consists of a receiver of this kind and a transmitter at a distance which has a source of ultra-violet light and a rapidly-revolving disk provided with holes, so that there is sent out a rapid series of light impulses and these fall upon the receiver. We hear a continuous sound in the telephone corresponding to the rate of the impulses. Signals by dot and dash can then be sent by covering and uncovering the rays with a piece of cardboard. He was thus able to send letters and afterward entire sentences.

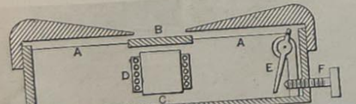
WHEN TO HEAT WOOD BEFORE GLUING.

HETHER a hide glue joint will be strengthened or weak-
by heating the wood before gluing depends on the size
ne joint. It is assumed, of course, that the work is being
in a glue room that is warm and not draughty, and that
wood itself is at room temperature. Under these condi-
is, if the joint to be made is of small area, heating the
od is unnecessary. In fact it may be detrimental, for the
rmth of the wood will keep the glue thin; and, when pres-
sure is applied, too much glue may squeeze out, leaving a
starved joint. It is very easy to apply too much pressure to
a small area.

In making glue joints of large size (several inches each way), heating the wood before gluing is of distinct advantage. Many experiments at the Forest Products Laboratory, Madison, Wis., have proved that when the wood in large joint work is not heated, the joints develop full strength only in spots. Weak spots and even open joints are too frequently discovered.

Uniform high strength in joints of large size may be secured by heating the wood in a hot box for 10 or 15 minutes at 120 to 130 degrees Fahrenheit just before gluing. The heat from the wood prevents the glue from chilling and keeps it liquid until pressure is applied.

It should be remembered that heating the wood retards the setting of the glue to some extent. In heavy woods, from which the heat escapes slowly, this retarding effect is more marked than in lighter woods. In all species glued cold at the laboratory the time under pressure required to develop full joint strength was less than 8 hours. When heated wood was used at least 10 hours were required to develop full joint strength in mahogany, and more than 12 hours in red oak and maple.

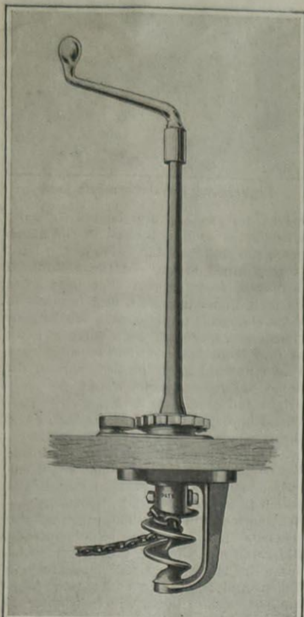


A, wire; B, armature; C D, electromagnet; E F, wire tightener.

THE NEW "MONO-TELEPHONE."

The undulatory currents which the instrument is thus able to sift out are not limited to a single octave. These currents can therefore correspond to notes of any height in the scale, provided that they in turn do not contain harmonics. But we can easily produce these undulatory currents without harmonics. Thus it is seen that we can produce an inexpensive device whose characteristic frequency can be regulated to any desired point and which has a much greater sensitiveness than the best telephone receivers. It is to be hoped that the new mono-telephone will aid in solving the present problem.

In a recent number of Comp
suggests a method of obtainin
direct vision. Take one neg
lenses whose images coincide;
so that the black lines of this
one image, while the linear sp
in by linear strips of the other
thus a single negative presenti
ing to the two images alternate
fixation so as to make a positiv
sembling the screen, the positiv
glass, in proper register and lo
toward the eye) a distance w
each eye sees only its own component of the mixed positive, and the appearance is one of relief. The registration is, however, troublesome; and Estanava simplifies by making the black-and-clear ruled screen on one side of a glass plate, coating the other side with emulsion, taking the photograph through the glass, developing, reversing, fixing, and then coating with matt varnish. An autochrome plate may have a screen at the back of its glass (before being coated with its starch and emulsion) with similar effect in colors.



The gearless brake that pulls like a geared one

Increased Hand-Brake Efficiency

THE simple staff hand-brake in use on passenger and freight trains is largely a survival from the day of lighter loads and lower speeds. Under present conditions it is often entirely inadequate to meet the loads put upon it. While geared brakes meet the need for greater power and a number of these are in use, objections based upon initial cost, weight, size, or failure to release satisfactorily have prevented their general installation. An interesting design of brake staff has just been put forward, giving all the advantages of the geared brake with none of its disadvantages, according to the manufacturer.

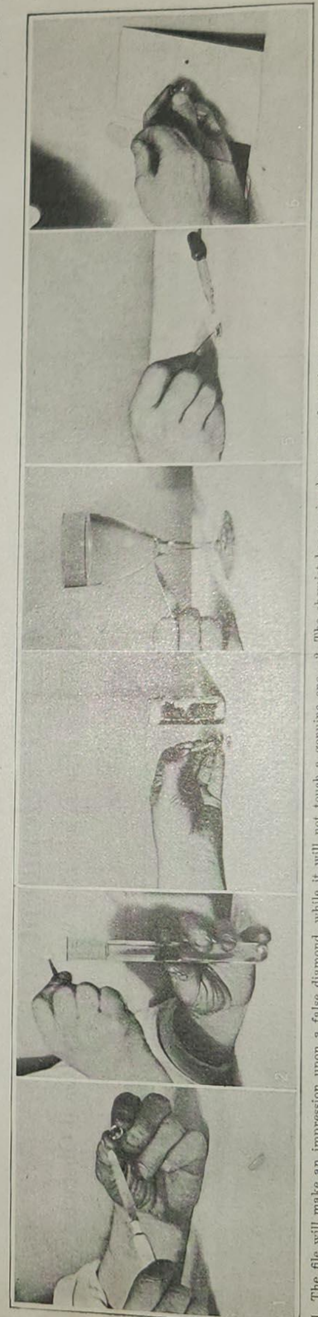
For any given pull on the brake handle of a staff brake the tension on the chain varies inversely as the distance from the center of the chain, in winding, to the center of the staff. The brake which we illustrate has a winding channel for the chain to run in, and the shank around which this channel passes tapers toward the bottom and at the same time runs out of the true centerline of the upper portion. The result is to give less tension and rapid take-up of the slack in the chain at the start of the braking operation, with slower take-up and greater braking tension toward the end, where it is useful. The ultimate result is that, operating with the ease of a gearless brake, the efficiency is that of a geared brake with ratio of three to one.

A NOVEL TYPE OF BOLT

RECENTLY one of the government departments requested the Bureau to investigate various means for fastening two heavy steel plates together in a situation where ordinary bolts and rivets could not be used. Two means were suggested for accomplishing this object: one was by inserting a pin which under normal conditions would have a diameter slightly in excess of the holes in the plates and which by some means could be contracted sufficiently to enter the holes; while in the other a pin or bolt was to be used having drilled along its axis a small hole in which an explosive charge could be inserted, the idea being that the bolt would be an easy fit in the plates and would afterward be expanded by the explosion of the charge.

Practical experiments using both means for accomplishing the object were tried at the Bureau of Standards. The first method tried was by the use of liquid air; the pins were about 0.001 inch too large for the holes and were immersed in liquid air until they could be driven into the plates rather easily. As the pins warmed up they became a tight fit. When the strength of the joints thus secured was determined in the Bureau's testing machines, it was found that it would meet the requirements. In the second method, that using the explosive charge, a strength almost as great was obtained.

The practical application of these methods, of course, may not prove as satisfactory as has been indicated in the tests, but it is of considerable interest in any event.



1. The file will make an impression upon a false diamond, while it will not touch a genuine one. 2. The chemist has a simple means of causing a fake diamond to burst, by a process that will not harm the real gem. 3. Hydrofluoric acid will dissolve an imitation, but will have no effect upon true diamond. 4. The real diamond will shine with some brilliancy when immersed in clear water; the paste article is entirely dull under these conditions. 5. On a true diamond a drop of water will hold its globular shape, much as quicksilver does; on a fraudulent stone it will "spread." 6. A real diamond can be used as one of a pair of lenses, and will give sharp focus; the paste stone will never do this

Six simple tests that will separate the imitation diamond from the genuine stone

To sharpen Files

Clean in 4 oz washing Soda in quart of hot water, using brush. Then transfer to solution 4 oz H_2SO_4 and quart of water for 10-12 hours.

Having given up as practically hopeless the attempt to define life, we may next approach the seemingly easier task of describing life in terms of its most characteristic manifestations. But here also we are confronted with difficulties. The man in the street, if he thinks about such things at all, will, in answer to our inquiry after the most characteristic property of living beings, probably mention their power of spontaneous movement. But quite apart from the fact that a large class of living forms—the higher plants—possess this power at most in very rudimentary form, recent developments of science have disclosed purely physical systems—liquid crystals and similar bodies—which manifest seemingly spontaneous motions resembling with astounding closeness those of living forms.

Another property which is commonly cited as specially characteristic of living matter is its power of growth by assimilation from the surrounding medium of matter similar to its own substance. But in this respect also crystals resemble living organism, and the analogy even extends to the formation of new individuals when the "parent" has reached a certain size.

Turning from the physical phenomena of life to the chemical aspect of life processes, a similar observation must be made: the early workers in the field of organic chemistry supposed that the compounds met with in the living organism were peculiar, could be produced only under the influence of a specific "vital force," and were beyond the reach of the creative powers of the chemical laboratory. This illusion was shattered in 1828 by Wöhler's synthesis of urea, followed by innumerable further results all pointing in the same direction, and culminating in the recent work of Fischer and others who are building up polypeptides—substances of the nature of the albuminoids and proteids of the living organisms. There seems to be no vestige of evidence that, in order to explain the chemistry of the living body, we must invoke the aid of a specific "vital force"—we have in fact here, apparently, another case of a mere name without objective counterpart.

Having reached this point of view, the question naturally presents itself to our minds, whether living matter itself may not some day be produced in the chemical laboratory—whether the chemist is destined some day to "create" a living thing. Indications are wholly favorable, in Prof. Schaefer's opinion, to the ultimate realization of this, if only we are reasonable in our expectations. It is not a complicated organism which we must look for (even the lowest forms of life known to us *in nature* are highly complex structures) but something exceedingly elementary, to which inde[illegible] we may at first hesitate to attribute "life" as ordina[illegible] understood. It must be remembered that the ear[illegible] that, owing to the cessation of respiration, the supply of oxygen to the tissues is cut off. And since the manifestations of life cease without this supply, the animal or patient appears to be dead. If, however, within a short period we supply the needed oxygen to the tissues requiring it, all the manifestations of life reappear.

"It is only some cells which lose their vitality at the moment of so-called 'general death.' Many cells of the body retain their individual life under suitable circumstances long after the rest of the body is dead. Sherrington observed the white corpuscles of the blood to be active when kept in a suitable nutrient fluid weeks after removal from the blood-vessels. A French histologist, Jolly, has found that the white corpuscles of the frog, if kept in a cool place and under suitable conditions, show at the end of a year all the ordinary manifestations of life. Carrel has succeeded in substituting entire organs obtained after death from one animal for those of another of the same species, and has thereby opened up a field of surgical treatment, the limit of which can not yet be discerned."

It is thus evident that in the higher animals the "aggregate life" is closely dependent on a proper adjustment and coördination between the "cell life" of the separate organs. Such coördination is secured by a two-fold mechanism: On the one hand by nervous control, and on the other by the diffusion through the system of so-called *hormones*. Nervous control of body-functions may be purely reflex and unconscious, or at least, outside the scope of our will, as is the case, for instance, with heart action in normal individuals. Or it may be more or less directly governed by our will and emotions.

The influence of hormones upon bodily functions is of a somewhat different character. Hormones are internal secretions produced in various glands and poured through various channels into the general circulation. Their action is presumably of the nature of a chemical stimulus. Nervous impulses are apparently carried [illegible] propagation along nerve strands somewhat as e[illegible]icity travels along a wire (though the velocity [illegible] a nerve impulse is very much smaller). Hormo[illegible] on the other hand, depend for their action on a[illegible] convection from their place of manufacture, th[illegible]ernal gland, to the points at which they produce [illegible] effect. Among the glands which secrete hormones [illegible] various structures whose significance remained a mystery until the function of their substances was understood. Such glands are the suprarenal capsules, secreting adrenalin (the only hormone which has so far been reproduced by synthesis in the laboratory), the pituitary body, abnormal development of which is accompanied by abnormal bodily growth (gigantism), [illegible]

be "no moaning at the bar when we go out to sea," we could anticipate the coming of death after a ripe old age without apprehension.

A Natural African Silk

IT is proposed to make a commercial use of a native silk coming from the African region which does not appear to have been utilized heretofore. This is a silk found in the Belgian Congo region, and it is furnished by worms of the anaphe, which variety is widespread in the Uganda, the German east Africa, Cameroon and Congo as well as other regions. The African silk corporation has already begun to install plants of the kind in the Uganda and elsewhere, and two other firms are soon to begin work in Belgian Congo. The worms are very voracious and are covered with hairs which have a stinging effect on the skin. They hardly ever change their place except during the night in order to seek food or search for good places for building their nests. They feed on plants such as *Abizza fastigiata*, also *Bridelia micarantha* and others. On the under side of this latter leaf, the anaphe lays 200 or 300 eggs placed in piles and covered with a protecting down. About two months after hatching, the worms proceed to make a combined effort in order to build a kind of nest upon the plants which furnish their food. The nest is of a silky appearance and has a color varying from coffee color to a rusty red. Of an irregular shape, the nests have a size ranging from that of an egg up to a child's head, and they contain from 10 to 100 cocoons tightly pressed together. When the butterfly is hatched, it secretes a liquid which attacks the cocoon and the envelopes of the nest, so that it can find its way to the outside. It appears that this does not injure the silk of the cocoons, so that it is not required to smother the insect within the chrysalis to avoid hatching the butterfly. The nests must be handled under water in order to prevent the nettle-like action of the hairs upon the skin, such hairs and also fragments of skin being scattered through the nest. The silk of the envelopes and that of the cocoons are treated separately, the operation being a washing with carbonate of potash solution until no more color is discharged, then the silk is dried in the air and packages of it are sent to the factories. The yield in the present case is estimated at 1 pound of silk thread coming from 6 pounds of raw silk. It does not seem difficult to carry on silk raising in this case, as the matter of acclimating the silk worm, which is such an important one with the usual kind, does not need to be dealt with here, either for the insect nor for the food plants. No diseases attack the insects, as far as can be noticed.

How to Make an Ultra-violet Ray Objective

By G. Michaud and J. F. Tristan, Costa Rica College

BECAUSE ultra-violet rays are black light to our eyes we are in ignorance of many of their properties; yet there is an artificial eye, which—as Prof. Wood has shown—can tell us much about their behavior. Amateur photographers with a scientific turn of mind (owners of a camera, who read the SCIENTIFIC AMERICAN belong *de ipso facto* to that class) may contribute to the progress of science, and will find considerable pleasure in the practice of photography with ultra-violet rays. There is no need of expensive apparatus; the only necessary addition to the camera is an objective transparent for ultra-violet rays and only for them; that is, a silvered quartz lens. This is easily made by the amateur himself, with a common spectacle pebble lens. For many reasons it is desirable that this quartz lens be of the same focus as the ordinary objective regularly used on the camera. Moreover, it should be of the periscopic type which, with the diaphragm placed as shown in Fig. 2, will give a satisfactory definition evenly distributed all over the field. All manufacturing opticians sell spectacle pebble periscopic lenses of any desired focus. (Price: $0.50 per lens.) The covering of such a lens with a thin silver film requires the preparation of Liebig's bath: Two grammes of pure fused silver nitrate are dissolved into 40 cubic centimeters of water. Ammonia is added, little by little, until the precipitate formed by the first additions has disappeared. Then 90 cubic centimeters of a 3 per cent solution of caustic soda is slowly poured into the liquid. A black precipitate appears. It is dissolved by means of a few drops of ammonia. Water is then added until the total volume of the solution is 290 cubic centimeters. Last, a weak solution of silver nitrate is added, drop by drop, until one last drop causes a permanent precipitate.

The lens, which has been cleansed, first with soap and water, then with alcohol, is laid horizontally in a glass vessel with its two extreme ends resting on two glass stoppers, the inferior face being about two inches from the bottom of the vessel. Nine volumes of the silver solution are rapidly mixed with one volume of a 10 per cent solution of milk sugar. The mixture is poured into the vessel until it bathes the interior face of the lens. The whole is then left for about four hours in a dark place. Then the lens is immersed ten minutes in rain water and left to dry.

The same operation should be repeated for the other face. The writers found the silvering of the lens on both sides to give more complete and reliable results than a single silver film. It seems difficult to get a film totally free from capillary holes. These do not correspond on two films and the experimenter feels sure that if some visible light has been admitted it had no share in the formation of the image.

With the help of a few strips of black paper the lens is glued, with its convex face upward, over a black pasteboard tube which can be telescoped, at any time, into the objective tube of the camera, behind the shutter, in lieu of the regular objective. Fig. 1 is a section of the ultra-violet ray objective thus made, and Fig. 2 shows it in place, mounted on a Unicum shutter, in lieu of the regular rectilinear combination, the two lenses of which have been unscrewed and put aside.

With a lens made as stated, exposure for a landscape in full sun at noon in June and with an aperture of F/16 should last at least twenty minutes. Photographs of pigments, chemicals, spectra, landscapes, skies, microscopic objects and portraits should always be made twice, once with the ultra-violet rays objective and once with the regular objective. Any peculiarity of the invisible light reflected by the object is thus easily detected. While working on these lines the writers found that while chalk, lime phosphate, arsenious oxide, starch, caffein, and veratrin reflected ultra-violet light about as well as ordinary light, papaverin, quinine sulphate, bismuth subnitrate, practically did not reflect ultra-violet rays. If our retina were sensitive for these rays only, such substances would appear to us as black, in spite of their white color in ordinary light. On the other hand, mercury biiodide, mercuric oxide and orpiment reflected ultra-violet light relatively better than actinic light. Figs. 3 and 4 show a curious result of such differences. Upon a copy of the SCIENTIFIC AMERICAN a layer of mercuric iodide was deposited in the middle of a concentric layer of papaverin. On the photograph made with the ordinary objective the extremely white papaverin looks, of course, whiter than the paper and the red mercuric compound darker than both. The reverse relation can be observed on the photograph made with the silvered quartz lens.

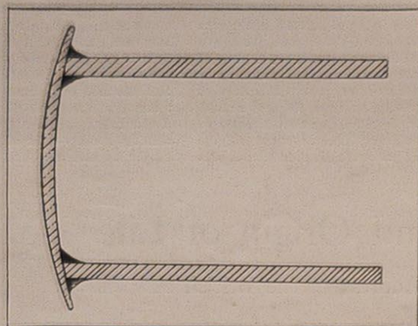


Fig. 1.—Longitudinal section of the ultra-violet ray objective.

Fig. 2.—The ultra-violet ray objective in temporary position.

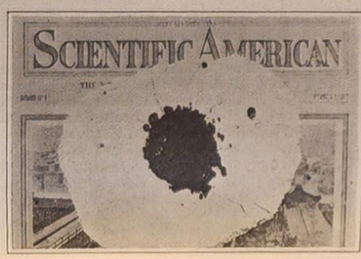


Fig. 3.—Photograph of mercuric iodide, white papaverin and white paper.

Fig. 4.—Ultra-violet ray photograph of materials shown in Fig. 3.

HOW TO MAKE AN ULTRA-VIOLET RAY OBJECTIVE

The World's Production of Gold

By Edward B. Howell

THE accompanying chart shows graphically the world's production of gold from the discovery of America to the close of the year 1911. The horizontal divisions of the chart measure the lapse of time by ten-year periods. The vertical divisions represent the value of the production in American money, each division representing ten million dollars. The production of silver until its demonetization in 1873 is also shown, superimposed on the gold production. Anterior to the discovery of America, the existing stock of gold and silver money in the world is estimated by William Jacob, an English economist who made a very careful investigation of the subject nearly a century ago, to have been from 33,000,000 to 34,000,000 pounds sterling. In round numbers this was $170,000,000 of our money. This amount, relative to the subsequent production, is indicated on the chart by the small square in the circle.

In 1911, the world's production of gold was $466,000,000. Comparing this with the world's stock of money when Columbus discovered America, it may be said that the gold miners of the world last year produced two and three fourths times as much gold as was represented by the world's total accumulations of gold and silver money in 1492. To make the comparison in another way, in 1911 it took the gold miners of the world less than five months to produce an amount of gold equivalent to the world's entire stock of gold and silver money when Columbus discovered America.

It will be seen from this chart that the production of gold in any considerable quantities is a modern function. The sudden increase in gold production began within the memory of many men now living. It began near the middle of the last century when placer gold was discovered in California and Australia.

When the supplies from these newly discovered placer mines began to fail, there followed a period of waning production. During this period silver was demonetized in the leading commercial countries of the world, and this demonetization, coincident with a waning gold supply, and occurring during an era of rapidly expanding trade, occasioned a sharp advance in the purchasing power of gold. In 1873, it required $1.15 per bushel on an average to purchase the wheat crop of that year from the farmers of the United States, but in 1893 the same crop was bought for an average

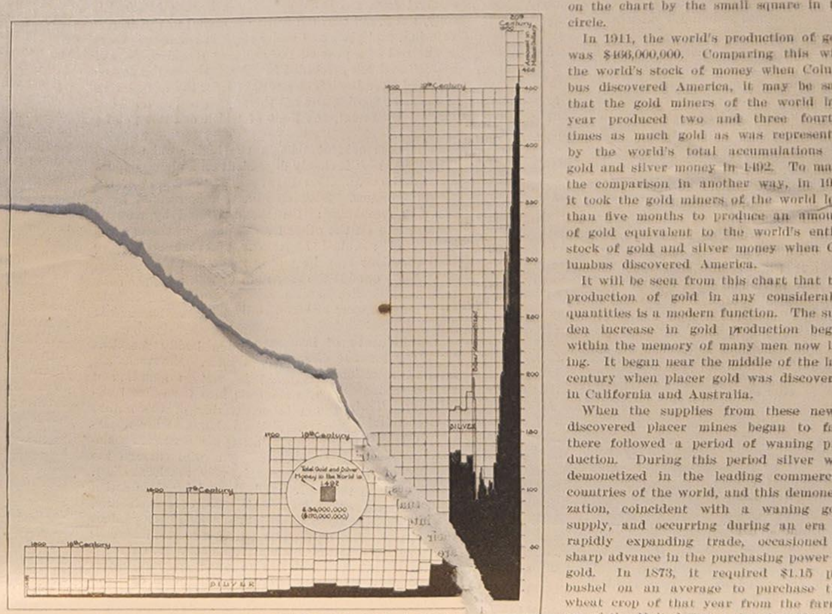


CHART OF THE WORLD'S PRODUCTION OF GOLD AND SIL

The Preservation of Our Fish Supply

The Banks on Our East Coast and Their Origin

By George Carroll Curtis

Though recent disaster to the greatest ship by collision with ice has directed public attention to the presence of icebergs off our Atlantic coast, few realize how great a part ice has played in these regions during the past, or know how remarkably the configuration of our northeastern shoreline has been altered by glacial forces.

Icebergs themselves have played a comparatively minor part in these changes by dropping over the bottom of the sea the land debris carried frozen in their masses. The bergs, however, are small manifestations broken from the great continental glacier now melted back to Greenland, but which in earlier times was so extended that its terminal iceberg-breeding foot lay in the vicinities of New York and Boston.

While lately associated with disaster, in the past the ice has acted as a very powerful constructive agency, and is to be credited for the peculiar formation giving the fishing banks which produce our chief supply of fresh sea food. Our menace to-day is probably not so much the ice of the North Atlantic as irreparable disaster to the ice-formed fishing banks, the chief source of inexpensive fresh marine food for the masses.

WHENCE COMES THE BULK OF OUR FRESH FISH?

Georges Shoals is regarded by fishermen as the richest fish ground in the world, and the Georges cod, which are here found in great size and abundance, are said to be the finest caught. The shoal water, and the strong Bay of Fundy tide, and frequency of gales make these nearby sea-banks exceedingly rough and the record of disaster here is long and terrible.

Of late years improvement in design in the fishing vessels and method of fishing have diminished loss. February and March have seen the greater number of shipwrecks. On the evening of February 24th, 1862, a terrible gale from the northwest burst suddenly upon the fishing fleet on Georges, there being about seventy sail at anchor in a small space, for fish seem to congregate in comparatively small spots here. Without sufficient warning, they were unable to heave up anchors. Thirteen vessels with their entire crews were lost, largely through collisions, and two abandoned. Nearly every vessel was damaged—one hundred and twenty men lost, leaving seventy widows and one hundred and forty fatherless children.

Only a few vessels, known as "Georgiamen," ancient hulks with crews of old fishermen aboard, who use the hand line from deck, now anchor on Georges, so danger of collision from parting cables has been greatly lessened. The modern fishing schooner, with her yacht-like design, rides out the hardest gales, either under her foresail or with a triangular riding sail set in place of the mainsail, she "jogges it out." That is, with one small sail set and trimmed flat down, she is left to ride out the gale in the wind's eye. This she usually accomplishes in a remarkable seaworthy way.

How the fish are caught to-day may be illustrated from the notes written during a recent trip.

FISHING ON THE BANKS.

Saturday, March 16th:

Leave "T" Wharf at 10 A. M. Course east by south. Wind lightens toward evening and continues thus through the night.

Sunday:

East to northeast winds. We see a few schooners returning from Georges, and a steamship passes. Am awakened by the sawing of the lead line over the rail. It is shortly before daylight. We are in thirty-five fathoms of water, and on the northern edge of Georges Shoal.

Monday, Daylight:

The skipper from his bunk gives the order to "bait up." Breakfast is ready in the forecastle; the men are below in the waist of the vessel baiting the trawls (long lines with many hooks attached) with chopped-up frozen squid. Several schooners now come in view, some within a mile or less, others near the horizon. They also are preparing to fish. Soon the first dory of the string of ten is hooked upon the tackles, and lifted from the "nest" over the side. Two half kegs of baited trawl line are placed in each boat with a basket of extra squid bait. There is also a sail, two pairs of oars, gaff, fish fork, jug of water, a "girdy" or hand windlass to start the trawls, a pail, compass, some food, knife and anchor. Two dory mates tumble into the bouncing little boat and are cast off. One man rows, the other with a little stick, throws out the trawl line, hook by hook. As the vessel sails on, the other dories, first from one side then the opposite quarter, are put overboard, and set adrift about a fifth of a mile apart. The first dory is now but a speck in the horizon, seen occasionally as she rises on a sea. The schooner is headed back passing down her line of busy fishermen to leeward of the first boat, and hauls up to wait.

An oar is raised in one of the dories. The skipper bears down toward it—the vessel is thrown into the wind—the dory's painter is caught, and the men begin to pitch upon deck the catch with which they have loaded the boat. It consists of medium sized haddock and big codfish, many four feet long, weighing thirty pounds and over. Wooden partitions are set athwartships and held between the bulwarks and house by cleats, the cod and haddock being heaped in separate pens. Some of the fish are about all a man can lift on his three-tyne fork. Other boats which have become laden by this time are also picked up, some running down the wind with their sails. The deck pens grow in number and become filled to overflowing with silvery haddock, and huge, greenish, glasseyed, gaping-mouthed codfish. The dorymen hurry below for a "mug up"—hot coffee and tea—and a "layout" of ham, corned beef, potatoes, pies, doughnuts, bread and butter, cheese, and whatnot, spread by the cook on the racked table.

By the time this pair of dorymen has swallowed a substantial lunch effected with great rapidity, and are off again, another dory is alongside, with a heavy burden of still flapping fish. All day long, for this was an exceptionally good fish day, this program is repeated, the vessel ranging up and down, trying to keep run of the dories which are continually getting out of vision, some drifted away by the strong wind or tide, from others which have caught their gear on bottom and are "hung up" to windward. We counted twelve other schooners likewise tending their fishing boats. Just at dark, in a rising wind, the dories came for the last time, each being hoisted on deck and lashed down. The decks from the afterside of the cabin to the mainmast were now level full to the tail with fish, mostly large cod, thirty-five thousand pounds, the skipper estimated.

After supper the men hastened back on deck and under the light of a dozen flaring torches began to dress the fish. These were then washed in hogshead tubs, and when they were stowed away with chopped ice in the hold it was late in the night and the weary workers, save the two whose turn it was to be on half-hour watch, crawled into their stuffy bunks.

March 23rd:

Not a "fish day." Seas ran high and frequently came aboard as we "jogged out" the gale. In the afternoon it let up somewhat and the vessel headed for Browns Bank, some sixty miles away to the north. As we drew off the bank into the deeper water of the channel the sea became less disturbed.

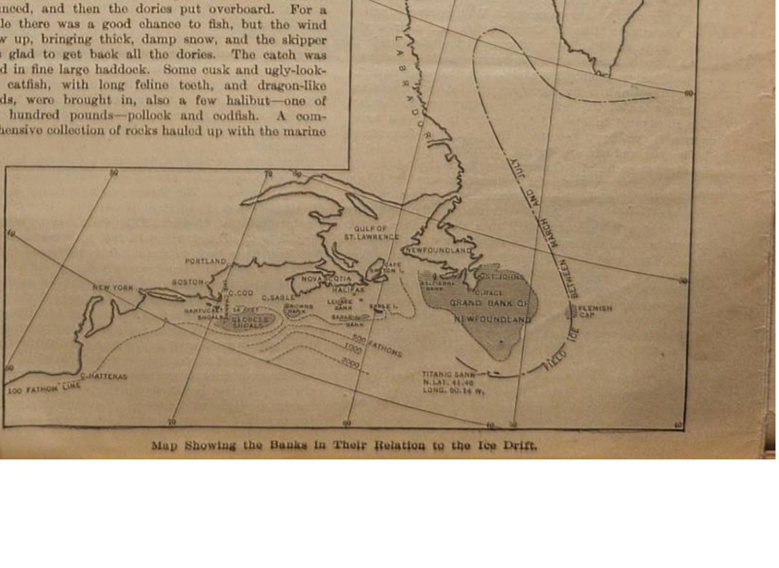
Having sailed at a ten-mile clip, sunset found us in thirty-eight fathoms over Browns Bank, and here we "hove to" till daylight.

At 2:30 the cook was called and all hands went on deck to bait trawls by torchlight. Breakfast was announced, and then the dories put overboard. For a while there was a good chance to fish, but the wind blew up, bringing thick, damp snow, and the skipper was glad to get back all the dories. The catch was good in fine large haddock. Some cusk and ugly-looking catfish, with long feline teeth, and dragon-like heads, were brought in, also a few halibut—one of one hundred pounds—pollock and codfish. A comprehensive collection of rocks hauled up with the marine growth attached was gathered. There were long-stemmed, stone lillies, crinoids, which the fishermen called "lemons," soft sea slugs or holothurians they called "pumpkins"—a yellow growth, termed "corn," sponges, and a large variety of other marine life. The rocks were of similar character to those of Georges, though seemingly of greater variety, somewhat smooth and rounded, but subangular. Quartz and quartzite predominated, both in sand and pebbles. Slates, granites, diorites, schistz, sandstones, similar to the variety usually found in glacial deposits on the neighboring shore, were abundant, testifying to the glacial origin of these sea banks.

Georges Bank is a shoal of the open sea lying in the ocean about one hundred miles east of Cape Cod. The depth of this bank, which is roughly seventy miles square in extent, averages from fifteen to thirty fathoms, though in its middle portion there are spots with so little as fourteen feet of water over them, where in a storm seas run "mountain high." Between this shoal ground and the mainland there are depths of over a hundred fathoms, nearly nine hundred feet being found in spots, while on the eastern side the water falls off rapidly from the fifty fathoms to the one hundred, five hundred and one thousand fathoms line of true oceanic depths.

On the south between the lands of Cape Cod and the shoals of Nantucket is what mariners call "the Channel," with depths from fifty to one hundred fathoms, while to the north of Georges is another trough where the soundings average considerably over one hundred fathoms or six hundred feet. These "gullies" probably represent old channels once draining northern New England. On the north side of this deep gully lies a shoal ground of similar depth and character as "Georges," but about a third of its area, known as Browns Bank, some sixty miles off Cape Sable, Nova Scotia, from which it is separated by a moderately deep depression. These elevated portions of the sea bottom are so situated that they have long been the chief source of fresh fish supply for the eastern seaboard of the United States.

There are various other banks or off-shore shoals along the Nova Scotia, Cape Breton and Newfoundland coasts, terminating in the largest of all, the Grand Banks of Newfoundland. All these banks lie upon the comparatively shallow marine margin bordering the Atlantic coast, known as the continental shelf, which is usually assumed to be composed of the waste worn from the lands and deposited in the sea along the shore margin of its basin. It has been held indeed, that the greater width of this Atlantic shelf compared to the narrow bordering coastal rim in the same latitude on



Map Showing the Banks in Their Relation to the Ice Drift.

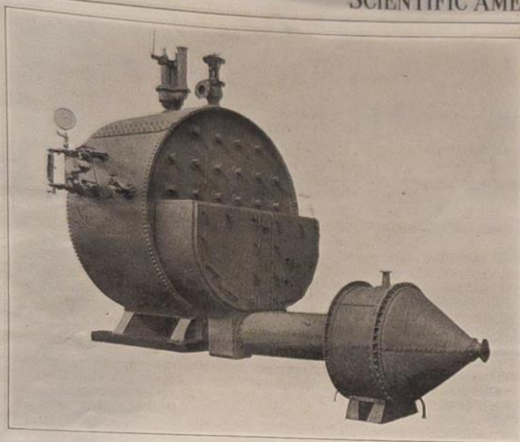


Fig. 8.—General View of the Boiler Tester.

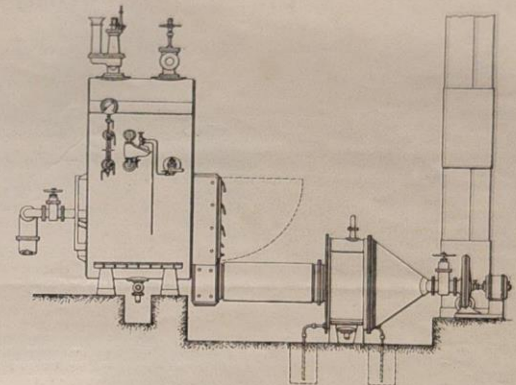


Fig. 9.—Side Elevation of the Boiler.

This causes the flame to strike back, heating the refractory packing to incandescence. When this condition is reached, the flame disappears entirely, being replaced by surface combustion. The maximum temperature attained depends on the conditions of working. With coal gas, water gas, or natural gas a temperature of 2,000 deg. Cent. can be reached without the use of regenerators, and with Mond gas in the same conditions a temperature of 1,500 deg. Cent. is attained. By providing for a little recuperation of the waste heat in warming up the air, this limit can, however, be exceeded.

With a small muffle furnace heating a muffle measuring 9½ inches by 5¼ inches by 3¼ inches, the results recorded in the accompanying table were obtained.

Results of Test on a Muffle Furnace.
Dimensions of Muffle, 9½ × 5¼ × 3¼.

Temperature in Middle of Muffle.		Gas Consumption to Maintain Temperature Constant.	Temperature of Products.	
deg. C.	deg. F.	cub. ft./hr. at 15 deg. C.	deg. C.	deg. F.
815	1449	21.0	540	1004
1004	1840	35.3	645	1195
1205	2201	58.0	870	1598
1424	2596	79.0	1085	1985

Mean net cal. value of gas* = 540 B.Th.U. per cubic foot at 15 deg. Cent.

The most noteworthy point is the relatively low temperature of the escaping products of combustion. This is in every case considerably lower than that of the muffle. Thus with a temperature of 1,424 degrees at the middle of the muffle, the temperature of the products of combustion was some 300 deg. Cent. less. There was no appearance of flame at the vent even with the highest temperatures. In some comparative experiments with a good specimen of the ordinary type of muffle furnace, the maintenance of a temperature of 1,057 deg. Cent. required the consumption of 105 cubic feet per hour of the same gas. With surface combustion a consumption of 43 cubic feet per hour would have sufficed. In a series of competitive trials made in the United States with American gas-fired furnaces, the flameless combustion system required only half the gas to maintain a given temperature. A very important application of the principle to a large muffle furnace is illustrated in Fig. 5. The muffle in question measures 8 feet by 3 feet by 3 feet internal dimensions. The gas and air are fed in at the front to a bed of granular material. On escaping from the top of the furnace the products of combustion are led down through a second bed of refractory fragments, embedded in which is the pipe furnishing the supply of air, which is thus preheated to a temperature of 300 deg. to 500 deg. Cent. This results in a saving of 20 to 25 per cent of the already low gas consumption. Thus, if a surface-combustion furnace without this regenerator requires 50 cubic feet of gas per hour, with the regenerator in use 37 cubic feet to 40 cubic feet of gas would suffice. Further, this regenerator makes it possible to reach temperatures with "poor" gas which are otherwise only attainable with gas of high calorific value.

An important adaptation of the system is to boiler firing. Gas-fired boilers have hitherto been far from satisfactory. The efficiency of a good water-tube boiler thus fired does not exceed 55 per cent or so, and in some experiments made with Lancashire boilers, similarly cent, although economizers were fitted. A small experimental boiler, arranged to work with surface combustion, is illustrated in Fig. 6. This is a cylindrical boiler, 3 feet in diameter by 3 feet long, traversed by 10 horizontal tubes, 3 inches in diameter. These tubes are fitted at the inlet ends with a plug of fireclay as indicated, this plug having a ⅜-inch hole through its center, through which the explosive mixture is forced at a speed which prohibits the possibility of back-firing. The remainder of the tubes is packed with refractory material, on which the surface combustion is effected. The air supply is very little in excess of the theoretical requirements, but the combustion is absolutely completed within a distance of about 6 inches from the point of entry. The remainder of the packing then serves to baffle the flow. Though the temperature of the material in the zone of combustion is very high, the boiler tubes there never attain a red heat. The supply of gas to the tubes is at the rate of 100 cubic feet of coal gas per hour, or an equivalent amount of a power gas. A ten-tube boiler, therefore, takes 1,000 cubic feet of gas per hour and 5,000 to 6,000 cubic feet of air. The temperature of the escaping gases is never more than some 70 deg. Cent. above the temperature of the water in the boiler, and this is further reduced by passing them through a feed-heater consisting of water-tubes immersed in a bed of refractory material. From this the products of combustion escaped at a temperature of less than 100 deg. Cent.

On a test of this boiler the air and gas pressure was, he stated, 173 inches water-gage, the drop of pressure being about 15 inches in the boiler and 2 inches in the feed-heater. The steam pressure was 100 pounds per square inch, corresponding to a temperature of 168 deg. Cent. The products of combustion left the boiler at a temperature of 230 deg. Cent., and the feed-heater at a temperature of 95 deg. Cent. The total gas supply was 996 cubic feet per hour, the calorific value being 562 British thermal units per cubic foot, so that 559,800 British thermal units were supplied per hour. The actual evaporation was 450.3 pounds per hour, equivalent to 550 pounds evaporated from and at 212 deg. Fahr. The heat transferred to the water was thus 527,800 British thermal units, so that the efficiency was 0.943. The carbon dioxide in the escaping gases was 10.6, as against a theoretical value of 11, and the free oxygen was only 1.6 per cent. The rate of evaporation was 21.6 pounds per square foot, or double that of a locomotive.

Since last November a 110-tube boiler has been at work with coke-oven gas at the Skinningrove Iron Works, Cleveland. The boiler was built to the designs of Mr. Michael Longridge, by Messrs. Richardsons, Westgarth & Co., Limited. This boiler is illustrated in Figs. 7 to 9. The drum is 10 feet in diameter and 4 feet long from back to front. It is traversed by 110 tubes 3 inches in diameter, packed, as already explained, with fragments of firebrick. The draught required is supplied by a suction fan, behind the feed-heater, giving a 20-inch water-gage. On test the mean evaporation was 20 pounds per square foot, but of this 70 per cent was effected in the first part of the length of the tubes, and 22 per cent over the next third. This steep temperature gradient along the tubes promotes circulation. Experience has further shown that scale would not adhere to the tubes. Once the thickness becomes about 1/32 inch, it scales off, falling to the bottom of the boiler.

of readily fusible metals. One of the London newspapers requires to keep 20 tons of type metal molten for 16 hours out of the 24. Coal-firing is inconvenient for this purpose, and gas-firing had hitherto been costly. The apparatus they proposed to use is illustrated in Fig. 10. It consists of an iron tank lagged outside with asbestos, while inside is a 3-inch tube stopped at the bottom with a fireclay plug, on which rests the column of refractory material. A ¾-inch hole in the plug admits the supply of gas and air, which is fed in through the down tube on the right. In a test of the apparatus lead was melted at the rate of 1,176 pounds per hour, the gas consumption being 100 cubic feet. The efficiency worked out at 0.686 per cent. The

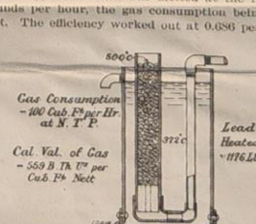


Fig. 10.—Melting Fusible Metals.

gas left at only 130 degrees above the temperature of the lead, and if it were assumed that the temperature of the latter was a limit to that of the escaping gases, the efficiency was really greater than was represented by 0.686 per cent, being actually about 80 per cent of what was theoretically possible.

Lectures on the Smoke Problem

We read in the *Journal of Industrial and Engineering Chemistry* that the Department of Industrial Research of the University of Pittsburgh has been provided by a Pittsburgh business man with funds for a thorough investigation of the smoke nuisance. This investigation is being conducted by a staff of twenty-five specialists. These men are studying the effect of smoke and soot on the atmosphere, on the weather, on plant life, on buildings, and on the public health; the economic damage done by smoke and soot; the mechanical devices for preventing or abating smoke; the chemistry and physics of smoke and soot; the laws concerning the smoke nuisance; and the history of the subject as a whole.

Recognizing the interest in the smoke problem manifested by a large number of American cities, and in response to inquiries that have been made, the department announces that the members of its staff are prepared to lecture on the following phases of this problem: "The Smoke Nuisance" (a general presentation of the main phases of the subject); "Smoke and the Public Health;" "Smoke and the Cost of Living;" "Smoke and Plant Life;" "Methods and Means of Smoke Abatement;" "The Effect of Smoke on Buildings and Building Materials;" "The Psychology of Smoke;" "The Smoke Nuisance and the Housekeeper." These lectures will be given any place east of the Mississippi, provided the expenses of the lecturer are assumed. For further particulars apply to Dr. R. C. Benner, Department of Industrial Research, University of

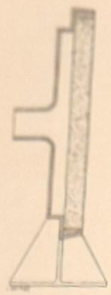


Fig. 1.—A Simple Form of Heater.

ferences in the efficiency of different surfaces, but this difference diminishes much at high temperatures.

If an explosive mixture is forced through a porous, refractory, and hot material, the rate of combination is accelerated at the surface in contact with the escaping gases. There is no flame, and this method of causing the gases to combine seems destined to greatly increase the efficiency of industrial heating operations. I had satisfied myself that this was the case in 1897, and since then I have, in conjunction with Mr. McCourt, put the system into practical operation. The methods developed are based upon a number of considerations which might be specified as follows:

In the first place, all surfaces, it is found, act equally well, the combustion is flameless, the temperatures attained are higher than in ordinary combustion, and there is a great economy of fuel. Secondly, in considering this process it is necessary to think in molecular dimensions, discharging from the mind all ordinary measures of time and space. Thus, when the combustion is spoken of as occurring within the pores of the material, these pores must be understood as being of molecular dimensions, since a body may be very dense and yet quite porous in the sense in which the word is here used. Only vitreous substances, such as glass, can be considered as non-porous from this standpoint, and even glass becomes porous when devitrified. Further, the incandescent solid must not be considered a mere idler or looker-on at the crowd of reacting molecules; actually it galvanizes into life the dormant affinities, with the result that the stately minuet of ordinary flame combustion gives place to the wild intoxication of the Venusberg. This fact can no longer be disputed. At the meeting of the British Association in 1910, Sir J. J. Thomson insisted that combustion was not a matter in which molecules and atoms alone were concerned, but that the electrons played a very important part; and he then suggested that the effect of hot surfaces in promoting combustion might be due to the emission of charged particles from such surfaces. These particles were given out at high velocities from incandescent surfaces, and the effect of the latter might therefore be due to the formation of an electrified layer of gas in which chemical changes proceeded with extraordinary velocity.

Leaving this theoretical aspect of the question, and passing on to describe some of the more important features of the two systems of effecting surface combustion which have been developed at the works of Messrs. Wilson and Mathiesons, Limited, of Leeds, it may be

Fig. 2.—Heating a Smith's Hearth.

said that the distinguishing feature of this method of heating is that an explosive mixture of gas and air is burned without flame in contact with a granular incandescent solid, and in this way a large proportion of the potential energy of the gas is converted into the radiant form. The rate of combustion is greatly accelerated, and the heat developed can be concentrated just where required. Perfect combustion is attained with a minimum of air and very high temperatures can be reached without the use of regenerators, while the radiant energy liberated is, moreover, transmitted very

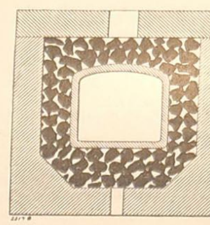


Fig. 3.—Muffle Furnace.

rapidly to any object exposed to it. In this way a new system of heating has been developed, which is very economical of fuel, as well as very easy of application.

One form of heater is a plate of fireclay, which (see Fig. 1) forms the front side of a flat cast-iron chamber, to which air and gas are admitted under pressure. The plate of fireclay is porous, and easily traversed by the air and the gas. In starting up the heater, gas only is turned on in the first instance, and ignited on the front face of the fireclay. Air is next turned on, and the flame first becomes colorless, and,

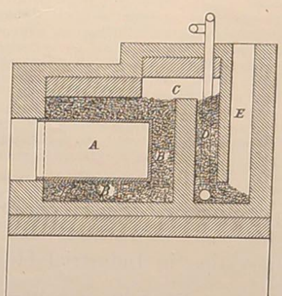


Fig. 5.—Large Muffle Furnace.

as the surface heats up, finally disappears from the face of the fireclay, which grows brighter, and glows vividly under the surface combustion which supervenes. The pressure required in the feeding chamber is ⅛ inch of water. Where a supply of air under pressure is not available, the apparatus may then be worked with an injector, the gas drawing in the air necessary for its own combustion, but to do this the gas has to be supplied at a pressure of 1 pound to 2 pounds per square inch. The layer in which the combustion proceeded is very thin, extending not more than ⅛ inch to ¼ inch below the surface. There is no development of heat elsewhere.

With the air and gas properly adjusted the combustion is perfect, no gas escaping unburned. The temperature can, moreover, be varied by altering the rate of feed, and the response to this change is instantaneous, there being no temperature lag. The highest temperature attained depends, of course, on the conditions of working. With free radiation and with coal gas as the fuel, temperatures of from 1,500 deg. Fahr. to 1,600 deg. Fahr. are readily reached. The diaphragm will work with any gas; coal gas, water gas, natural gas, and Mond gas being all well suited to its operation.

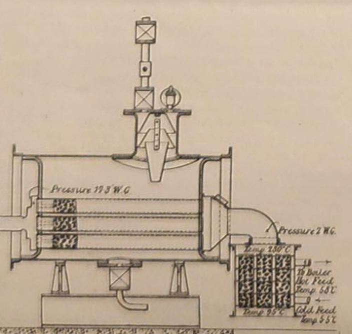


Fig. 6.—Experimental Boiler.

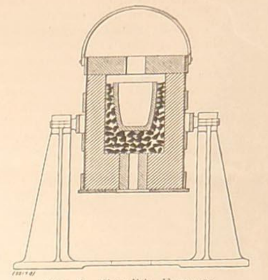


Fig. 4.—Crucible Furnace.

Exhaustive experiments have been made at Armley with one 4 square feet in area, and has enabled us to vouch for its durability in prolonged use.

It is important to note that the incandescence is in no way dependent on the outer atmosphere. Once started, a diaphragm will work as well in an atmosphere of carbon dioxide as in air.

The fact that the diaphragm can be operated in any position makes it possible to evaporate liquids by a supply of heat from above. Thus a solution of sodium silicate can be readily evaporated by one of these diaphragms, a feat very difficult to accomplish with flame-contact heating. With a top heat supplied by the diaphragm the sodium silicate which separates collects on the top of the solution and can be skimmed off. The method is also applicable to completing the evaporation of other highly concentrated liquids.

Another application of the method is that to the heating of a smith's hearth, as shown in Fig. 2, or to the heating of muffles and crucibles, as illustrated in Figs. 3 and 4. Here the interspace between the walls of the furnace and the muffle, or of the crucible, is filled with fragments of porous refractory material. After having heated up this by means of gas, supplied alone, air is turned on, forming an explosive mixture, which, however, is fed in too fast for back-firing to occur. Surface combustion then arises, there being no production of flame, but the combustion is so rapid that very high temperatures are attained.

In another method of applying the same principle the refractory material is placed in tubes immersed in the material to be heated. This method is applicable to water-heating, steam-raising, and to the melting of metals having a fusing point below 700 deg. Cent.; but for the highest temperatures the plan first described is adopted. With this the upper limit of temperature attainable is, in the case of rich fuels such as coal gas, fixed by the nature of the refractory material available. A No. 39 Seger cone has, for example, been melted in a crucible furnace of this kind, the temperature being 1,880 deg. Cent. Platinum is easily melted, and an alundum crucible consisting almost wholly of pure alumina has been melted down. At one stage of the experiments, indeed, difficulty had been experienced in obtaining material which would withstand the temperatures attained, but this has been overcome, and muffles can now be run steadily at a temperature of 1,500 deg. Cent.

The bed used must, of course, not be such that it will flux either the crucible or the furnace walls. With coal gas as the fuel, magnesia is now used for the packing, or else a neutral refractory material is specially prepared to meet the requirements.

In starting up one of these furnaces, the gas is first turned and lighted, and then the air supply admitted.

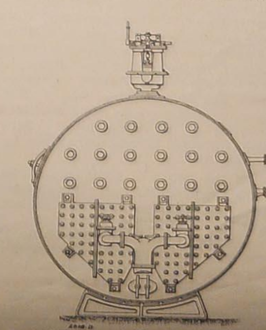


Fig. 7.—Large Multitubular Boiler.

the perfect special apparatus of the Yerkes observatory.

In any case, the spots, at their maximum epochs, cannot diminish the solar radiation by more than 0.1 per cent, and our instruments cannot detect so small a difference. Moreover, the hot protuberances increase with the spots and produce a compensatory effect.

Langley, who measured the intensity of solar radiation in every part of the spectrum with his sensitive and accurate bolometer, thought that he had detected a periodic variation, but his results have been disputed.

Another American astronomer, Humphrey, thought he had proved, despite the approximate invariability of the solar constant, that the temperature of the earth varies with the solar activity. He reasoned as follows: Although the total energy emitted by the sun remains constant, its distribution through the spectrum may vary according to the condition of the solar atmosphere. The fact that the luminous intensity of the sun diminishes from the center to the periphery, and that the diminution is greatest in the violet and ultra-violet regions, proves that the solar atmosphere absorbs some of the radiation and that the absorption increases as the wave length increases. The ultra-violet absorption probably increases with the number of sun spots, for in our own atmosphere this absorption is increased by any disturbance. As ultra-violet rays convert oxygen into ozone, it is probable that large quantities of ozone are formed in the higher strata of our atmosphere, where the greatest absorption of ultra-violet rays takes place. But ozone, though quite transparent to the luminous solar rays, strongly absorb the non-luminous radiation from the earth. Hence an increase in the quantity of ozone in the atmosphere would diminish terrestrial radiation and consequently increase the temperature. To the production of ozone in the polar regions by the electric discharges of the aurora Humphrey attributes the following remarkable phenomenon observed by the German expedition to East Africa. At the equator the temperature of the upper strata of the atmosphere is about 15 degrees lower than that of strata of the same altitude in the temperature and frigid zones. Sun spot maxima are accompanied by maximum auroral discharges, which increase the quantity of ozone in the atmosphere. But the diminution in ultra-violet radiation caused by the sun spots would, according to Humphrey, predominate to such an extent that the final result would be a diminution in the production of ozone, an increase in terrestrial radiation and a lowering of temperature.

Abbot and Fowle claim to have proved, by a study of the temperatures recorded at numerous stations during many years, that the mean temperature at the earth's surface is lowered about 1 deg. Cent. at the epochs of sun spot maxima.

But a lowering of temperature at one station is usually accompanied by an elevation of temperature at other stations. Hence this demonstration cannot be conclusive unless the stations chosen are distributed uniformly over the globe, a condition that cannot be satisfied while the oceans, the polar regions and other vast areas are entirely destitute of meteorological stations. For this reason the conclusions of Abbot and Fowle have not been generally accepted.

The most serious objection to Humphrey's reasoning, as he admits, is the frequent occurrence of variations in the violet and ultra-violet radiation which cannot be correlated with variations in sun spot activity.

Let us now consider the third and most important question. We find a great diversity of opinion concerning the relations existing between sun spots and the weather. Newcomb concludes, from the records of a number of tropical and temperate stations, that the mean annual temperature of the earth, like the number of sun spots, has an eleven-year period of variation, with a difference of 0.26 deg. Cent. between the hottest and the coldest years. Koppen deduces a difference twice as great from records of tropical stations between the years 1827 and 1877. Other meteorologists, however, deny the existence of such a period, and attempts to establish a correlation between sun spots and exceptionally hot and cold seasons have yielded contradictory results.

On the other hand, the existence of a correlation between sun spots and rain appears to be established. Hellmann, in his treatise on the rains of northern Germany, asserts that the maximum rainfall coincides with the sun spot minimum and the year preceding, but that a secondary maximum of rainfall occurs in the year of maximum sun spot development. This conclusion is drawn from the records of twenty-one stations for the years 1851 to 1900. Hergyfoky deduces the same result from observations made during fifty years at Vienna, Milan and a dozen Hungarian stations.

This correlation between rainfall and sun spots is in agreement with Humphrey's theory. I have shown elsewhere that the formation of rain is facilitated by the presence of nuclei of condensation. In the upper strata of the atmosphere there is very little dust, and the nuclei of condensation consist chiefly of ions, or electrified molecules, produced by the agency of ultra-violet rays. According to Humphrey the ultra-violet radiation is greatly diminished at the epochs of sun spot maxima. At such times, therefore, the rainfall is likewise diminished and the water vapor remains suspended in the atmosphere. As this vapor is transparent to the luminous rays of the sun, but absorbs much of the non-luminous radiation of the earth, the increase in the amount of vapor should produce an elevation of temperature—an inference which Humphrey does not make.

It appears, furthermore, from the observations made by Meldrum in Mauritius and by Poey in the Antilles, that the frequency of cyclones increases with the number of sun spots.

Klein claims to have found a correlation between solar activity and the frequency of cirrus clouds.

The phenomena of terrestrial magnetism exhibit an unquestionable correlation with the sun spot period. In addition to the small annual and diurnal variations in the magnetic declination, which may be regarded as direct effects of solar heat or ionization of the atmosphere there are occasional greater perturbations which continue for hours, and which are most frequent and violent at the epochs of maximum sun spot activity. These magnetic storms, in which the deviation of the needle may attain one degree, are often observed almost simultaneously over a large part of the earth's surface. They occur usually when conspicuous groups of sun spots directly face the earth; and Ricco asserts that the magnetic influence of a sun spot is propagated with a velocity of 1,000 kilometers per second, so that it reaches the earth in 42½ hours.

Hale, at the Yerkes observatory, has demonstrated the existence, in the sun, of magnetic fields of considerable but variable intensity. This discovery was made by utilizing the peculiar effect of magnetism upon luminous vibrations which was suspected by Faraday, but first observed by Zeeman.

In view of the close correlation existing between auroras and terrestrial magnetism the former might be expected to exhibit a dependence upon solar activity. As a matter of fact, this dependence was demonstrated before the sun's influence upon the magnetic needle was proved.

The effect which solar radiation exerts upon terrestrial magnetism is unquestionably indirect and is produced by ironization in the upper atmosphere. If this ionization varies with solar activity, rainfall, temperature and other meteorological phenomena may reasonably be expected to vary concurrently. Hence attempts to show a correlation between sun spots and weather appear promising, though they have been successful, hitherto, only in isolated cases. Amateur observers may find here a vast field for researches which involve little expense, as the astronomical and meteorological elements of the problem are easily accessible, and records of sun spots are published in popular scientific journals. The observer should, however, be endowed with a critical faculty which will prevent the discovery of imaginary correlations based on preconceived opinions.

The correlation which has been supposed to exist between sun spots and earthquakes appears very improbable.

The search for a correlation between sun spots and weather has generally been conducted by looking for analogous periodic variations in the two phenomena.

Another possible method consists in seeking abnormal weather conditions occurring simultaneously with abnormal solar activity. Krebs, a firm believer in the influence of sun spots on terrestrial phenomena, has long published in *Natur und Kultur* regular records of extraordinary occurrences in the atmosphere and the interior of the earth which he attributes to sun spot activity. Although these coincidences are very interesting they have not yet converted me to belief in the author's theories, because it is not proved that similar phenomena occur only when spots appear on the sun. Earthquakes, volcanic eruptions, tempests and heavy rains are so frequent that one or the other is reported almost weekly from some part of the globe. I have already remarked that temperature changes in one region are often accompanied by inverse changes in another. In addressing the Congress of Naturalists at Stuttgart, Krebs attributed to sun spots the wet weather which had recently prevailed throughout northern Germany. During the same period western Switzerland suffered from a very severe drought, and very little rain fell in the southwestern part of Germany.

Surface Combustion*

A Radical Innovation in Industrial Heating Practice

By Prof. W. A. Bone, F. R. S.

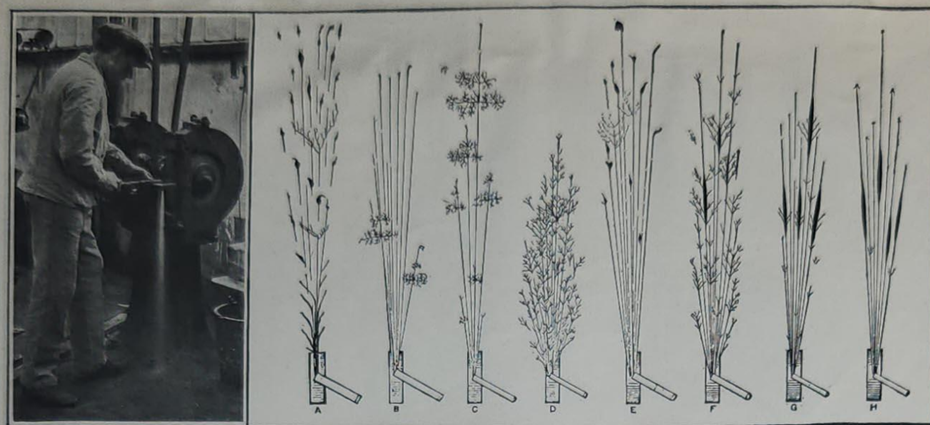
The influence of hot surfaces, such as that of metallic platinum, in promoting combustion at low temperatures occupied during the first third of the last century the attention of Sir Humphrey Davy, William Henry Thomas Graham, Faraday, and de la Rive in England, and in France of Dulong and Thénard, and also of Döbereiner, but not one of these distinguished men succeeded in finding a satisfactory explanation of the phenomenon, and the Döbereiner lamp constituted the only practical outcome of the whole investigation. A long controversy on the subject between Faraday and de la Rive terminated in 1836, and interest in the subject then dropped.

Indeed, while the power of platinum in inducing combustion was recognized as a scientific anomaly, in technical circles the belief prevailed that contact between gases and hot surfaces should be avoided. This conviction was mainly due to the work of Mr. Frederick Siemens, who was the first to recognize the importance of radiation in furnace operations, but was under the erroneous impression that contact with hot surfaces would retard combustion by lowering the temperature of dissociation. My own connection with the subject arose during the course of an investigation into the mechanism of the combustion of hydrocarbons at low temperatures, which was carried out at Owens College in conjunction with Mr. R. V. Wheeler. The subject proved so attractive that it was extended into an inquiry as to the behavior of a variety of hot surfaces in promoting combination at temperatures below the ignition point. As a result of these and subsequent researches it is possible to state definitely that all hot surfaces accelerated combustion, but the extent of their action is dependent on the temperature and character of the surface, and was perhaps connected with corpuscular discharges.

Combustion may proceed "homogeneously," that is to say, equally throughout the system as a whole; or "heterogeneously," that is to say, in layers immediately in contact with an incandescent surface. The latter is a far more rapid process than homogeneous combustion, but the activity of a surface can, it is found, be accelerated or retarded at will by means of previous special treatment. Thus the combination of hydrogen and oxygen or of carbon monoxide and oxygen, in contact with a non-oxidizable metal, can be greatly stimulated by previously putting the metal into contact with the combustible gas, or, conversely, it may be diminished by letting the surface have previous contact with oxygen. There is evidence that surface combustion is dependent on a prior absorption or condensation of the combustible gas, and perhaps also of the oxygen, but to what exent this occurs is not yet clear. Nevertheless, in some way or other the condensed gas becomes "activated," probably ionized, and this activity increases according to the compound interest law. There are, moreover, certain other important differences between homogeneous and surface combustion; thus the presence of water vapor accelerates the homogeneous combustion of carbon monoxide, but it retards the surface combustion of this gas if the surface is that of fire-clay. Again, in ordinary combustion, methane has a greater affinity for oxygen than hydrogen has, but the presence of a hot surface reverses the position of the two gases in this regard. This is a very remarkable fact, and affords proof that surface combustion was a real phenomenon.

As stated, all hot solids accelerate combustion, and this acceleration is the greater the higher the temperature, becoming especially marked when the surface is incandescent. At low temperatures there are great dif-

* The report here given is adapted from *Engineering*.



A: Magnetic steel (orange). B: Quick steel (dull red). C: Manganese steel (white). D: High-carbon steel (white). E: Quick steel of another sort (very clear red). F, G, H: Hard, semi-hard and soft steels (white or pale yellow)

Spark testing of steel, and some characteristic sparks shown diagrammatically

NOTES FROM THE RESEARCH LABORATORY EASTMAN KODAK COMPANY.*

SOME NEW SENSITIZERS FOR THE DEEP RED.[1]

By C. E. K. Mees and G. Gutekunst.

THREE dyes have been selected as having interesting properties from a number investigated. The first of these is naphthacyanole, prepared by the condensation of betanaphthaquinaldine ethiodide with quinoline ethiodide in the presence of formaldehyde in alcoholic potash, the dye being a homologue of pinacyanol. It sensitizes with a strong maximum in the deep red at 690$\mu\mu$ and a minimum in the green.

Acetaminocyanole was prepared by the condensation of 6-acetaminoquinaldine ethiodide with quinoline ethiodide in the presence of sodium ethylate and formaldehyde. This gave a maximum at 730$\mu\mu$. It was unstable in the presence of small amounts of water and is not thought to be generally useful.

Kryptocyanine was prepared by the condensation of lepidine ethiodide as described by Adams and Haller. In normal concentrations it gives severe fog, but in dilute concentrations good results are obtained, the maximum being at 760$\mu\mu$. It is thus the most powerful sensitizer for the near infra-red known and is expected to have applications in astronomical photography. In the extreme infra-red, it is inferior to dicyanine.

Jeweler's wax
Weaver 10/9/12

1 part beeswax
2 parts shellac
1 part gas tar pitch
trace of turpentine
Melt and mix in ord

Try writing on a
photographic negative
with tartaric acid
before exposure or
before development.

9/22

Coloring and Frosting Incandescent Lamps

By A. S. Neumark.

The following lamp colors are especially adapted for stage lighting and interior decorations; if applied properly they will outlast the lamps. A clear lacquer is first made by dissolving 32 pounds of gum copal in 20 gallons of alcohol (denatured) to which has been added 4 gallons of amyl alcohol (fusel-oil). It takes quite some time for the gum to dissolve completely, and the process should be assisted by shaking. Allow to settle, then draw off or decant; strain through several layers of cloth. It is not necessary that the liquid be completely clear. In the liquid so obtained dissolve the aniline dyes as given below. To every gallon of clear lacquer:

Red.—Rhodamine B extra 2 ounces; chrysoidine E cryst. 2 ounces; methyl violet ½ ounce.

Blue.—Blue Sp. t. 2 ounces; Victoria Blue 1 ounce.

Green.—Victoria green E 2 ounces; Methanyl yellow O 7/8 ounce.

Yellow.—Methanyl yellow 1 ounce; Chrysoidine E cryst. ½ ounce.

Straw.—Chrysoidine E cryst. ¼ ounce.

Amber.—Chrysoidine E cryst. 1 ounce.

Orange.—Chrysoidine E cryst. 2 ounces.

Pink.—Rhodamine B extra 1½ ounces.

Purple.—Methyl violet 1½ ounces.

Moonlight.—Blue S. B. 1½ ounces; Methanyl 3/8 ounces.

Light Blue.—Blue S. B. 1½ ounces.

Blue-green.—Victoria green E 2 ounces.

Not all coal-tar dyes are suitable for coloring lamps. I have found that Blue S. B. (which is usually used) soon turns green and fades quickly; but the combination of the two dyes indicated will be lasting. There is also no single red dye, which furnishes a satisfactory dark red effect. The combination of amber, pink and purple, however, results in the desired shade.

The solution is filled into a suitable cup and the *hot* globes, which previously have been thoroughly cleaned, are dipped into this solution. Care must be taken that the solution is free from air bubbles and that the globes do not touch the sides of the cup. Amber and yellow can be applied to the cold lamps. One dipping is sufficient in most cases, provided the globes have been cleaned carefully.

FROSTING LAMPS.

Mix 1 gallon of acetone with 3 quarts of benzol and 1 quart of turpentine. Dissolve 24 ounces gum sandarac, 8 ounces gum benzoine and 8 ounces gum mastic. Shake well, let stand over night and strain through cheesecloth. The liquid will be perfectly clear, provided the bottles used have been perfectly dried; they should be rinsed out with alcohol before using. This solution is applied to the globes by dipping. The lamps must be *cold* and they should not be used before they are perfectly dry.

Both coloring and frosting liquid should be kept in glass bottles or stoneware jugs, but *never* in tin cans.

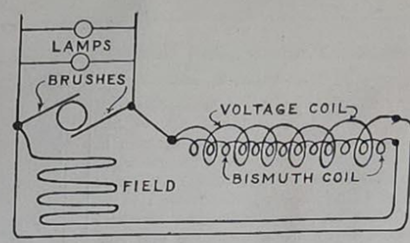
Frosting may be tinted with rhodamine, methanyl yellow and other dyes, although some of these dyes such as chrysoidine are nearly insoluble. The colors and the frosting can easily be removed from the globes by washing with a solution of caustic soda or alcohol.

Cell Which Reverses Polarity When Illuminated.—In a paper read before the British Physical Society, Mr. A. A. Campbell Swinton describes a curious phenomenon in a galvanic cell having for one electrode a plate of zinc and for the other tinned copper, coated on one side with selenium and varnished with enamel over the remainder of its surface. When these plates are immersed in tap-water the galvanometer shows that in the dark the zinc is electro-positive to the selenium, but when light falls on the selenium the polarity is reversed. If in place of the zinc plate, a plate of carbon or copper is employed, then the selenium proves to be electro-positive in the dark and electro-negative when illuminated.

Automatic Voltage Regulator

By J. Naveman

The writer recently installed a shunt-wound dynamo on a motor car to supply current for lighting purposes, the drive of the motor being taken directly off the cooling fan pulley. However, the regulation



Automatic voltage regulator.

of the output at the varying speeds offered a serious problem.

The resistance of bismuth increases when it is placed in a magnetic field, and the amount of increase varies directly as the strength of the field, within certain limits. Forearmed with this knowledge, the regulator shown by the accompanying sketch was constructed. A coil of bismuth wire was placed in series with the field of the dynamo, and the bismuth coil was made the core of a voltage coil which was connected across the lamp circuit. Under these conditions, the bismuth was subjected to the fluctuations of the voltage as indicated by the varying strength of the magnetic field of the voltage coil, and the resistance of the bismuth varied accordingly. When the voltage rose, due to increased speed, the field strength and resistance increased in proportion, cutting down the strength of the field circuit.

The chief difficulty lay in forming the bismuth coil, since that metal is too brittle to be drawn to a filament. It was solved by embedding a long, loosely coiled steel spring, previously oiled, in plaster of Paris, and, after the material had set, unscrewing the spring from the plaster. The bismuth, molten of course, was forced into this mold with the aid of a dentist's vacuum casting machine. When the plaster was carefully broken away, a perfect coil of the desired metal was left.

Production of a Deep-black Coating on Copper and Its Alloys by the cold process. The process described by B. Müllaner makes it possible to coat objects of copper and its alloys with a firmly adherent, deep black layer of copper oxide, resistant to mechanical influences and which also withstand carbonic acid, ammonia, nitrogen and water. The objects, cleaned mechanically and treated with dilute sulphuric acid, are moved about for perhaps five minutes in a five per cent soda lye, at 100 deg. Cent., to which has been added one per cent of pulverized per-sulphate of potash. When the development of oxygen that occurs on their immersion, has ceased, add a further one per cent of per-sulphate of potash until the desired color is obtained. The articles are then rinsed with cold water, dried and rubbed off with a cloth. The stain can be used repeatedly, only when used again a new addition of per-sulphate of potash must be made. The thickness of the coating, its color and durability, are dependent on temperature, length of exposure and development of oxygen. If the temperature drops below 70 deg. Cent., we obtain a less durable coating which readily assumes a blue or yellowish tint. After prolonged use, the stain, owing to the formation of sulphur by the decomposition of the per-sulphate and its absorption of carbonic acid from the air, becomes ineffective. Copper alloy articles with varying proportion of copper, require a longer staining period, perhaps five to ten minutes. Articles of tin, zinc, aluminium, iron, nickel, German silver or soft solder must at first be heavily electro-coated with copper and then stained. By this means soldered places may be given exactly the same color as the rest of the metal.—*Electrochemische Zeitschrift.*

Perpetual Plates for Photography

The recent rise in price of photographic materials lends interest to a method newly devised by French photographers for making use of the same plate to secure a practically unlimited series of negatives. The method is not adapted to all sorts of photographs, since considerable length of time is required for the exposure, and because of a lack of delicacy of detail, but for suitable subjects it not only works well, but naturally effects large savings. As outlined in *La Nature* (Paris) it is as follows:

In 1839 Daguerre noticed that a plate coated with calcium sulphide, exposed in the dark room and afterward placed upon a surface prepared with iodide of silver, made an impression on the latter of such nature that when it was submitted to the action of mercurial vapors a faithful reproduction was obtained of the image delineated by the objective. Shortly after Edmond Becquerel proved that red, orange, or yellow rays destroy phosphorescence. In 1880 these phenomena were applied by Darwin to the production of countertypes. A plate having a phosphorescent surface was first exposed to the sun for several seconds, then placed in contact with the negative to be reproduced and exposed to the light under a red glass for one or two minutes. The red rays extinguished the phosphorescence in proportion to the transparencies of the phototype; so successful was this action that it sufficed to place the phosphorescent plate against a gelatino-bromide plate, in the dark, to obtain upon development a positive print of the initial negative.

More recently M. Georges Bellais has perfected this method, rendering it applicable to the reproduction of images in the dark room and to prints on paper. A plate with phosphorescent surface is exposed to the full light; it is then placed in the camera as if it were a gelatino-bromide plate, and exposed in the apparatus, to the focus of an objective provided with a yellow or orange screen. A phosphorescent negative is thus secured, which, placed in contact with a gelatino-bromide paper, yields a positive print. This print is obtained as usual by developing and fixing.

As for the phosphorescent plate, it is sufficient to expose it afresh to the light to efface the image; it thus becomes capable of receiving a new impression in the camera, and of furnishing, in consequence, other photo-copies. The obvious advantage of this is that all the negatives are produced on a single plate, without developing, fixing or washing.

Let us add at once that this very seductive method is unhappily limited to a very small number of cases. In the first place, it is not suited to animated subjects or to poorly lighted views. The length of exposure demanded forbids its application except to reproductions or very well lighted landscapes. (However, underexposure can be rectified by prolonging the contact between the phosphorescent surface and the sensitive paper for several hours or even entire days.) In the second place, the images lack delicacy and have a granular aspect, which is not suitable for all subjects. This defect inheres in the very constitution of the plate, which is prepared by sprinkling with calcium sulphide of a violet phosphorescence a sheet of cardboard, of glass, or of slate, previously coated with a pitchy varnish.

If, in order to reduce the granular effect, the sulphide be ground to an impalpable powder, one risks altering it so as more or less to destroy its phosphorescent properties.

As to the colored glass to place over the objective, M. Bellais considers the Lumière screen for autochromes to be the best. . . . The economy is obvious, since all the proofs are printed while sheltered from actinic light under the same plate, which serves successively as a negative for all the subjects to be reproduced.

(14094) M. J. asks: What is the relative frequency of letters and numerals in the English language? A. In cryptography, the relative frequency of letters in the English language is taken as follows:

A	B	C	D	E	F	G	H	I	J	K
20	4	8	11	33	6	5	16	17	1½	2

L	M	N	O	P	Q	R	S	T
10	8	19	21	6	¼	18	17	23

U	V	W	X	Y	Z
8	3	5	1	5	—

The frequency of numerals is not subject to the same laws governing the frequency of letters.

Chlorine Gas on the Battlefield

reached the trenches in a concentrated form to cause death unless the death was due in part to psychological effects, for to produce death rapidly it is necessary that the air breathed shall contain at least one part of chlorine in 1,000 of air. Long exposure to air containing 1 part of chlorine per 100,000 is dangerous and even smaller amounts are troublesome.

It is of some interest to know how much chlorine is needed to be effective. On the supposition that there is a breeze of 4 miles per hour and that it takes two minutes to empty the containers holding the chlorine, the drift of air during that time would be about 700 feet, to charge the lower three feet of this air current with chlorine to a concentration of 1 to 1,000 would require about 6 cubic feet, or one pound for each yard, or something like one ton per mile of battle front. Chlorine can be obtained commercially compressed into liquid form in cylinders for 5 to 8 cents a pound, and as a by-product in the electrolytic manufacture of hydrogen for balloons it may well be of less value.

Under proper conditions then it is quite feasible to use this inexpensive and powerful offensive weapon. But the conditions must be right. Too strong a breeze would diffuse the gas, a variable wind or calm would injure the user. It would hardly be safe to use the gas unless the battle line were straight or convex toward the enemy since otherwise the fumes would be apt to drift in part over the users' own lines.

And then undoubtedly effective preventive or antidotal measures can be used. A sponge or towel wet with water or better with some basic substance like cooking soda or borax kept ready to put over the face might hold off the danger and more special respirators charged with basic substances or with reducing agents like oxalates or sodium hyposulphite might enable the attacked force to tide over the worst of the attack.

There are several other poisonous gases besides chlorine which might be used, of which the following may be mentioned: hydrocyanic acid, sulphur dioxide, arsine, carbon disulphide, hydrogen sulphide, the oxides of nitrogen and bromine vapor. From the field of organic chemistry could be taken the cacodyl compounds and the isocyanides.

Since several of these do not act at once they are probably not suitable as the effect to be produced is not so much actual poisoning as the forcing of an opening for an attack in the ordinary way. Some of them are too light to flow readily along the ground and are less suitable.

Probably sulphur dioxide and bromine might be used in a similar way to chlorine as they are extremely irritating, act at once, and are heavy. But they could both be absorbed by respirators similar to those effective for chlorine. Sulphur dioxide is colorless, and on that account not to be detected by the eye, but it is not as

The Expansive Power of Lime

The expansion of quicklime when wet develops an enormous force that acts slowly and almost irresistibly, and has long invited use for mechanical purposes. Successful efforts to make use of this force have been noted in a recent issue of *Rock Products*, that describes its efficient use in breaking up heavy brick masonry. A number of 12 feet by 20 feet piers, 12 feet high, was situated between similar foundation piers for engines in operation, and it was necessary to remove them without injuring the machinery. Blasting was therefore inadmissible, and hand cutting and breaking too slow and expensive. The work was accomplished by drilling 3-inch vertical holes 3 feet deep and 3 feet apart in both directions over the entire areas of the piers and filling them within six inches of the top with fresh slaked lime in pieces ½ inch to 1½ inches wide. As soon as the lime was thoroughly wet the tops of the holes were filled with brick drilling well tamped, and in about ten minutes cracks started in every direction and the entire foundation pier was broken into cubes.

Bengal Papers are made, according to *Drogisten Rundschau*, by immersing unsized paper in a watery solution of the proper metallic salts. Red flame is obtained by solution of 2 parts nitrate of strontium and 1 part chlorate of potash in 2 parts alcohol and 10 parts water; green flame by dissolving 2 parts of chlorate of varium in 2 parts of alcohol and 10 parts of water; yellow flame by dissolving 1 part each of chlorate of potash and oxalate of strontium in 2 parts of alcohol and 10 parts of water; blue flame by dissolving 2 parts of copper and 1 part of chlorate of potash in 2 parts of alcohol and 10 parts of water; violet flame by dissolving 15 parts each of strontium, chlorate of copper and chlorate of potash in 100 parts water and 50 parts alcohol; lilac flame by dissolving 2 parts chlorate of potash and 1 part each of chlorate of copper and chloride of strontium in 5 parts of alcohol and 10 parts of water.

Enamel Pencils for Writing and Drawing.—Dissolve 2 to 10 parts of gum dammar or shellac, 1 to 2 parts bichromate of potash, 50 to 100 parts of leaf-gold or pulverized gold-bronze, copper-bronze or other metallic bronze or color in 100 parts of paraffin and add 5 to 20 parts of naphthol. The last serves to prevent oxidation of the mass and bleaching out of the colors, and with the paraffin furnishes the binding material for the mass. For colored pencils the required quantity of color is added to the above mass. To procure a more rapid shading of the colors and produce a moiré-like stroke, from 1 to 10 parts of ground mica is added to the mixture. According to *Neueste Erfindungen und Erfahrungen* all the ingredients should be heated in a vessel and thoroughly mixed together by stirring; the mass obtained is then dried until it attains a certain consistency, and finally is pressed in molds.

A New Vacuum Gage of Extreme Sensitiveness*

By Irving Langmuir

At very low pressure the viscosity of gases is one of their most marked characteristics. This property is made use of in the new gage.

The gage consists of a rotating disk above which is suspended, by a quartz fiber, another disk carrying a mirror. The viscosity of the gas causes it to be set in motion by the lower disk and this motion produces a torque on the upper disk which can be measured in the usual way by a beam of light reflected from the mirror.

The rotating disk is made of thin aluminium and is attached to a steel or tungsten shaft mounted on jewel bearings and carrying a magnetic needle. The suspended disk is of very thin mica. The lower disk can be rotated easily at a speed of 10,000 revolutions per minute by means of a rotating magnetic field produced outside of the bulb containing the two disks. This field is most conveniently obtained by a Gramme ring supplied with current at six points from a commutating device run by a motor. In this way the speed of the motor determines absolutely the speed of the disk, since the two revolve in synchronism. The speed of the disk may thus be varied at will from a few revolutions per minute up to 10,000 or more.

The sensitiveness of the gage is extremely great. At 1,000 revolutions per minute, with a scale at about 60 centimeters distance, we obtain about 400 millimeters deflection for 0.001 millimeter of air. We find the deflection exactly proportional to the pressure below about 0.01 millimeters, proportional to the speed of the revolving disk and practically independent of the distance between the two disks. For different gases at the same pressure the deflections are proportional to the square root of the molecular weight. All these facts are in accord with the kinetic theory. At 10,000 revolutions per minute, one millimeter deflection corresponds to 0.00000025 millimeter. There should therefore be no difficulty in detecting pressures as low as 10^{-7} millimeter.

* Abstract of a paper presented at the New Haven meeting of the Physical Society, March 1st, 1913, and published in the *Physical Review*.

How to Clean Spark Plugs.—A good way to clean spark plugs or any mica substance is to first wash in a 10 per cent solution of acetic acid, which cuts grease and carbon deposits. This should be washed off by gasoline and then the plug dried by rubbing with a cloth or waste shreds. This works exceptionally well on all mica substances, but is good for removing carbon deposits from other articles.

The Red Radish in Science.—An alcoholic solution of the skin of a red radish serves as an excellent indicator or test for acids and bases. In the presence of acids the colorless solution turns pink while with bases—alkaline solutions—it turns yellow. It is well known that many plant extracts such as litmus and animal products like the cochineal bug possess this property of developing marked colors with acids and bases, but no other indicator is so simply made.

Gelatin Protection.—Gelatin belongs to the class of protective colloids possessing the ability to surround minute particles of suspensions with a film that prevents their aggregation into precipitates. Since the formation of crystals is a growth from very small nuclei this process also may be hindered by a small amount of gelatin. Commercially this principle is applied in the making of marshmallows. The presence of a little gelatin does no harm, in fact it is a food, and it effectually prevents the crystallization of sugar within the marshmallow. Commercial ice cream contains some gelatin for the same purpose, to prevent the graininess of sugar crystallization. But further than this the gelatin surrounds the particles of casein in the milk with a protective film which hinders curdling and greatly aids digestion.

Useful Cements

One of the simplest hard cements is the well-known mixture of litharge and glycerine made to a stiff paste. It sets hard as a rock, and is oil-proof. A solution of water glass mixed with powdered calcium carbonate serves the same purpose.

A mixture of boiled linseed oil and fire clay resists acid better than most cements, though sulphur melted with glass powder is also ranked as very resistant to chemicals in general.

A good stone cement is made by mixing two parts of magnesium oxide, one part of magnesium chloride, powdered stone to suit as a filler and water to make a stiff paste. Basic magnesium chloride is formed.

It is an axiom that much depends upon the light in which a subject is viewed. An invention based on the physical law concerning the complementary colors of the spectrum has been made by a graduate of the Moscow School for Painting, Sculpture and Architecture, by which it is possible to paint several different scenes or designs on one and the same canvas. This interesting artistic device may be used with effect on the stage or utilized for home decoration. When the light changes, the canvas, chameleon like, changes in appearance. Thus a panel was exhibited at the Moscow Artistic Theatre which represented a scene with beautiful autumn tints in the red light of a sunset. When the light was changed the scenery changed with it, and a nymph was discovered in front of a tree, bathed in moonlight. It is claimed that wallpaper printed by this method is one color in daylight, different during twilight, and changes again by moon or lamp light. By the use of differently tinted lamps the changes may obviously be controlled by electrical switches.

Lightning Spot Remover.—This preparation is for the purpose of removing spots of all kinds from woolen fabrics, making black cloth glossy, cleaning carpets, etc. It consists of 31 parts strong fluid ammonia, 93 parts potash soap tincture, 7.8 parts soda, 7.8 parts borax, 31 parts ether, 31 parts alcohol and 798.4 parts water. In making it up, the salts are dissolved in a suitable quantity of the water, then the other materials, and finally the alcohol and ether added. As the fluid readily evaporates and thereby loses efficiency, it must always be kept tightly corked.—*Neueste Erfindungen und Erfahrungen.*

Blackening Tan Leather

To blacken tan leather it should be first rubbed with a ten per cent solution of tannic acid. Let this solution dry thoroughly, when a ten per cent solution of iron sulphate should be applied. This gives an intense black, is easily applied and is harmless to the operator.

A Simple and Efficient Canoe Gum

Considerable need is often experienced by canoeists and boatmen generally in the lack of a good canoe gum to stop leaks or breaks which may occur in the calking of the boat. When canoeing in the northern waters of Canada or on the lakes in the Adirondacks and the Rockies, it is often inconvenient or impossible to obtain a ready-made gum which will answer this purpose.

A good canoe gum must answer several demands; first, it must be sufficiently pliable so as not to break and powder when in the cold water and under strain; second, it must not melt and run in the sun when the canoe is beached for a short time; third, it must not dissolve or soften when in the water; and last, it must set hard in a few moments if it is to meet the requirements of an emergency. It goes without saying that the raw material must be easily accessible, and the price as low as possible.

All these demands are adequately met by a gum compounded of rosin and vaseline, and the gum can be made in any watertight dish which may be heated over an open fire. One part of vaseline and four parts of rosin, by weight, heated until dissolved in each other will give a gum which, at summer temperature, is soft and easily dented. This is the consistency required for a gum to prevent crumbling in cold waters, such as Lake Superior.

A material compounded of 10 per cent vaseline and 90 per cent rosin is quite brittle when cold. However, in warmer waters farther south, this gum is sufficiently pliable and does not soften or melt readily in the sun.

Addition of rosin makes the gum harder and more brittle, adding more vaseline makes it softer and tougher, so that any consistency may be had from the hardness of rosin to the softness of vaseline.

The above ingredients compounded in the proportions of 10 to 20 per cent of vaseline and 90 to 80 per cent of rosin will answer all the requirements of a first-class canoe gum. It may be carried in a tin or wrapped in paper, and it melts easily over the flame of a match and sticks like glue to warmed surfaces. Any coloring matter may be stirred into the hot liquid gum; for example, Chinese blue gives a bluish green color, red lead gives a brilliant red, and chrome green yields a brilliant green. The best proportions are one part of mineral pigment to one part of gum. The addition of pigments makes the gum very hard.

"MOVIE" FIRE HORRORS MAY BE ELIMINATED

Revolution in Art of Animated Photography Promised by Invention.

Foreign Correspondence of The Star.

LONDON, December 5, 1912.

Immunity from fire in cinemato- graph shows and an ultimate revo- lution in the art of animated photography are promised by the develop- ment of an invention demonstrated in a West End picture palace. The invention consists of animated photographs pro- duced without the use of celluloid or transparent films.

The invention, which is that of a Frenchman named Dupuis, is an entire departure from the present principle of projecting pictures by transmitted light. The transparent ribbon of celluloid gives place to a ribbon of mirrorlike silvered and fireproof paper. The small photo- graphic images printed on this paper in the usual manner are projected on [illegible] screen by the light reflected from t[illegible]

Brilliancy Not Reduced.

In spite of the more complex course taken by the illuminant there appears to be no great diminution in brilliancy, the lamps at present in use giving a picture far superior in lighting to those commonly shown until quite recently.

If looked at only from the point of view of public safety, this invention has considerable importance, for it demonstrates the practicability of quite a new means of projection. It paves the way for the popular adaptation of the cinematograph as an aid to teaching, and will open up paths of progress that have hitherto been barred by the risks of fire and prohibitive insurance rates.

Other Possibilities.

Other possibilities are opened up by this invention outside the world of cinematography. One of these is the production of unbreakable paper lantern slides. Another and still more novel possibility is that of publications to read in the dark. These magazines are designed to consist of metal-faced paper, the pages abounding in illustrations. To read and enjoy them to the full each page should be separately placed in a special but simple projection apparatus, illuminated from the ordinary electric light supply.

Whitewash that Will Not Wash Off.

Will you please inform me how to mix a whitewash for use in stable, etc, so as not to rub off on clothing?

New York. C. B. W.

Mr. R. T. Gillespie of Ontario, an expert painter of many years' successful experience, gives the following recipe for whitewash. It will not rub off especially when applied to smooth surfaces:

"Whitewash requires some kind of grease in it to make it most durable. Any kind of grease, even though it be old and partly spoiled will be all right, though tallow is best. The grease imparts to the whitewash an oil property the same as in good paint.

"To a 40-gallon barrel, say, of whitewash thinned ready to use, have incorporated in it ten pounds of tallow or any grease, mix in lime in the slacking stage, also ten pounds salt. In order to incorporate the grease properly, it is necessary to put it in a vessel on the stove and boil it into a part of the whitewash so as to emulsify and get it into such condition that it can be properly incorporated with the whitewash mixture. Use your judgment; on smooth wood or hard stone it needs a stronger binder than it would on cement or rough sawed timber which would do with less. Experience will lead you up to doing or having a good job done this way."

ain

Welding Extensions on Small Drills

By Nathan C. Johnson

A NECESSITY of very frequent occurrence in practically every workshop is the lengthening of the shank of a small twist drill. This is particularly true of the amateur shop; and when the necessity arises of drilling a hole deeper than the length of the shank on the standard twist drill, the problem of welding on an extension is one of serious aspect. Indeed, it may be said that a weld of this kind, particularly if the drill be under 3/16ths of an inch, is a very difficult matter, even for a skilled blacksmith, as it is almost impossible to heat the shank of the drill to a welding heat without spoiling the steel, or drawing the temper in the rest of the drill at the very least.

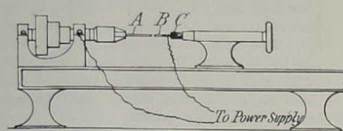


Fig. 1.

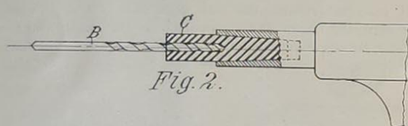


Fig. 2.

Welding with the aid of a lathe.

With the object of overcoming these difficulties, the following simple method of making the weld was devised. It will be seen at a glance from the drawings that the means used was the electric current, but it was impracticable to use a current heavy enough to heat the drill, owing to its resistance, so the heat of the electric arc was employed.

To hold the drill and the extension rod in line and also to regulate the arc, a small bench lathe was pressed into service. From Fig. 1, it will be seen that the extension rod *A* is held in the chuck on the headstock. To this latter is also attached one terminal of the electric circuit. In the tail stock is fitted a plug of hard rubber, or fiber *C*, tapered at one end to fit the tailstock and having a socket at the other of such a size as to hold the drill *B* to be lengthened. This rubber, or fiber, piece holding the drill is to insulate it from the rest of the machine; and the other terminal of the electric circuit is attached to the drill directly.

It will now be seen that if we turn the handwheel on the tail stock so as to bring the extension rod and the drill into contact, we will complete the electric circuit. If then we unscrew the tailstock a little, we shall draw out an arc between the two pieces. It takes but a few seconds to have the two pieces at a melting heat; and if the arc is looked at through blue glasses, it will be easy to determine when this condition has been attained. When the metal is seen to be molten at the extreme tips of the drill and the rod respectively, screw in the tailstock quickly. This forces the two butts together; and after cooling off, it will be found that a most excellent weld between the two has been produced, the electric weld having the added advantage over common welds that it is most sound at the center, with imperfections on the outside, while the reverse is true with blacksmith welds. All that is necessary now is to remove the terminals from the pieces and dress the weld off with a fine file.

Drills down to the very finest can be easily and accurately welded to extensions of any length by this means. There is no roughness to the weld; it is strong; and because of the use of the lathe, not only is the arc under perfect control, but the resulting drill is in perfect alignment—a most desirable quality.

As a source of current, an attachment to an electric light socket has been used for the finer sizes. For larger sizes, it may be necessary to re-fuse the rosette from which the drop is taken; but even for large drills, up to ¼ inch, 2 amperes at 110 volts is amply sufficient.

Color Pencils for Writing on Glass, Porcelain and Metal.—Black: Lampblack, 10; wax, 40; tallow, 10 parts. White: Krems white, 40; wax, 20; tallow, 10 parts. Pale blue: Berlin-blue (light), 10; wax, 20; tallow, 10 parts. Dark blue: Berlin-blue (dark), 15; mucilage, 5; tallow, 10 parts. Red: Cinnabar, 20; wax, 20; tallow, 20 parts. Yellow: Chrome yellow, 10; wax, 20; tallow, 20 parts. Yellow: Cadmium yellow, 10; wax, 20; tallow, 20 parts.—*Der Chemisch-Technische Fabrikant.*

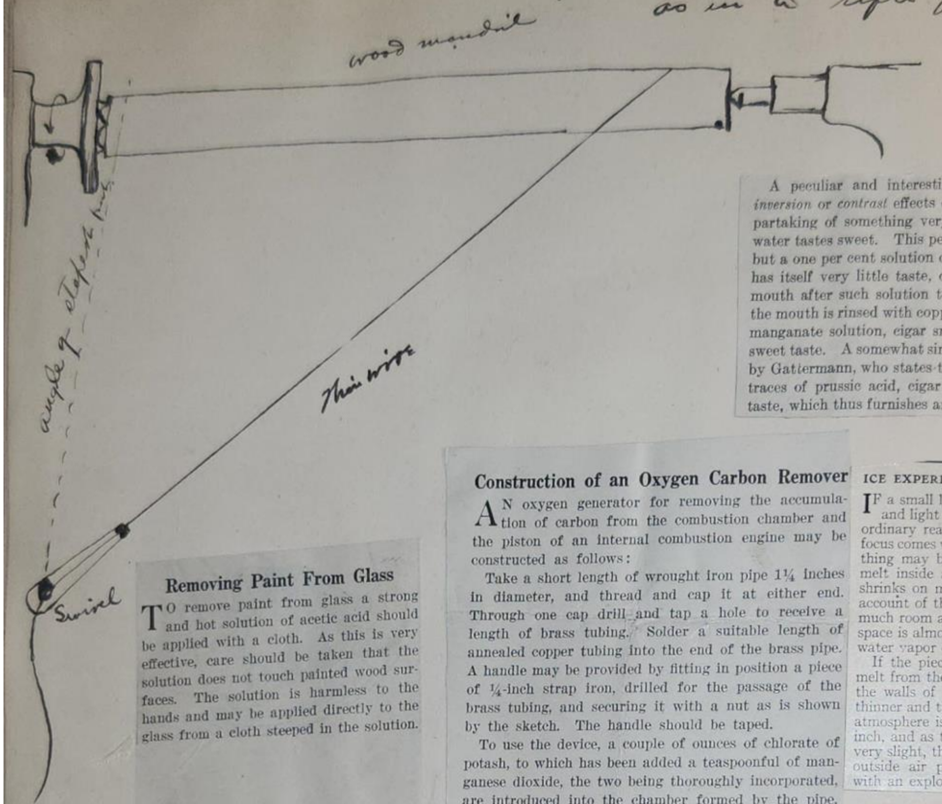
Priming for Metals.—The ordinary varnishes do not attach themselves to the surface of metals but merely coat them and soon crack off. This defect can easily be remedied if the metal, after being freed from grease by a pickle, is treated with an etching mixture, consisting of 15 parts nitric acid, 20 parts alcohol, 5 parts liquid gum arabic and 10 parts water. This mixture is applied as a thin coat. After it is dry, smooth with a polishing agate and the varnishing can then be done in the ordinary manner.—*Praktischer Wegweiser.*

Cement for Hard Rubber Goods.—Dissolve gutta percha in sulphide of carbon (combustible) until a thick fluid is obtained, so thick that it can only just be painted on, coat the broken parts on both surfaces of the break, paint them with chloride of sulphur solution (1:20) and press them together. It is advisable for a second person to smooth the pressed out cement with the back of a knife, in all directions, and after the mass is half dry, which will be in a few seconds, to go over the cemented place carefully with a hot iron. Only when the cement has set, which will also be in very short time, can the pressure be released. These repairs usually hold well because the gutta percha has been vulcanized and forms, with the ebonite, a homogeneous mass. Very often the cemented place is stronger, because the cement is somewhat elastic, than the ebonite, which possesses but moderate strength.—*Drogisten Ztg.*

To Stick Drawings to Sheet Tin.—Paper can be attached to sheet tin only by means of an elastic, flexible adhesive, as otherwise it will peel off, owing to the expansion and contraction of the tin, due to changes in temperature. Such adhesives almost always contain sugar or syrup, that prevents brittleness. For this purpose the following adhesives may be used: 1. Water-glass, with a small addition of sugar syrup or starch syrup (glucose). This adhesive will even hold the paper fast to the metal when the latter is heated. 2. Glue-starch paste, made by mixing thick solution of hot glue with two parts of freshly prepared starch paste and stirring into the mixture one part of thick turpentine and one part of alcohol. This glue-paste holds very fast, and is notable because it does not pass through the paper. 3. Sixty parts of gum arabic are dissolved in as much water as may be needed for the boiling with it of forty-five parts of fine wheat starch. Then add the forty-five parts of fine wheat starch and fifteen parts of sugar to the solution and boil down to the desired consistency. This adhesive sticks fast and can be kept a long time in closed cans, if when boiling, a little camphor is added to it.—*Drogisten Ztg.*

To Readily Distinguish Cast Iron, Steel and Bar Iron.—On the surface, previously filed bright, or on the article itself if it is already bright, a drop of aqua fortis is placed. After the acid has been allowed to work a few minutes, it is wiped off and the place rinsed with water. In the case of bar iron, a dull-white ash-gray spot, with steel, a brownish-black, with cast iron, a deep black spot is distinctly visible, so that this simple operation suffices to readily distinguish the above-mentioned different materials from one another. By this means, we can readily determine whether a wrought iron object is edged with steel and how far the welding extends. The entire test is based on the varied proportions of carbon in the iron products, cast iron containing proportionately the largest quantity of carbon, steel coming next and then wrought iron, in percentages about 3:0.6:0.3. The effect of the nitric acid on the metal surface is to expose the carbon, the acid dissolving the iron. A similar phenomenon occurs when meteoric iron is exposed to the action of aqua fortis, peculiar figures being formed.—*Neueste Erfahrungen und Erfindungen.*

To layoff a gradually increasing twist as in a rifle barrel.



A peculiar and interesting phenomenon is that of *inversion* or *contrast* effects of the sense of taste. After partaking of something very salty or very bitter, pure water tastes sweet. This perhaps is not very surprising, but a one per cent solution of potassium chlorate, which has itself very little taste, causes water taken into the mouth after such solution to taste intensely sweet. If the mouth is rinsed with copper sulfate or potassium permanganate solution, cigar smoke acquires a repulsively sweet taste. A somewhat similar observation is recorded by Gattermann, who states that if the air contains mere traces of prussic acid, cigar smoke acquires a peculiar taste, which thus furnishes an efficient alarm signal.

Removing Paint From Glass

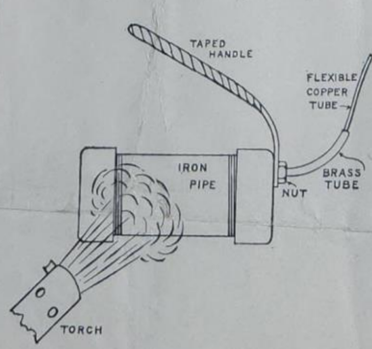
TO remove paint from glass a strong and hot solution of acetic acid should be applied with a cloth. As this is very effective, care should be taken that the solution does not touch painted wood surfaces. The solution is harmless to the hands and may be applied directly to the glass from a cloth steeped in the solution.

Construction of an Oxygen Carbon Remover

AN oxygen generator for removing the accumulation of carbon from the combustion chamber and the piston of an internal combustion engine may be constructed as follows:

Take a short length of wrought iron pipe 1¼ inches in diameter, and thread and cap it at either end. Through one cap drill and tap a hole to receive a length of brass tubing. Solder a suitable length of annealed copper tubing into the end of the brass pipe. A handle may be provided by fitting in position a piece of ¼-inch strap iron, drilled for the passage of the brass tubing, and securing it with a nut as is shown by the sketch. The handle should be taped.

To use the device, a couple of ounces of chlorate of potash, to which has been added a teaspoonful of manganese dioxide, the two being thoroughly incorporated, are introduced into the chamber formed by the pipe, the rear cap being removed for the purpose. After the cap has been screwed tightly in place again, the chamber is heated with a blow torch and the end of the flexible copper tubing is introduced into the combustion chamber of the motor. As soon as the ingredients are sufficiently heated, oxygen is given off and the heat should be kept constant to insure a steady flow. In the presence of the oxygen, the caked carbon can easily be ignited and will burn from the surfaces in a minimum of time. Care should be taken not to apply too much heat. For cleaning multiple cylinder motors, the quantities of chemicals can be increased. Since the manganese dioxide acts merely to stimulate the decomposition of the potassium salt, it is evident that the proportions are not all important. Both chemicals can be obtained from any chemist in small quantities, and at low cost. Care should be exercised to keep foreign substances from contact with the chlorate of potash.



Oxygen generator for removing carbon from pistons and cylinder.

ICE EXPERIMENT

IF a small lump of ice is placed on a plate and light allowed to fall on it through an ordinary reading glass so that the burning focus comes within the ice, a very interesting thing may be seen. The ice will begin to melt inside at the point of focus. As ice shrinks on melting, a space will be left on account of the melted ice not taking up so much room as it did when it was ice. This space is almost a vacuum, and is filled with water vapor of very small pressure.

If the piece of ice be left in the sun to melt from the outside in, as it usually does, the walls of the previously made hole get thinner and thinner. As the pressure of the atmosphere is fifteen pounds to the square inch, and as the pressure inside the hole is very slight, there will come a time when the outside air pressure will collapse the ice with an explosive sound.

Seen by Invisible Light

TAGE lighting with invisible light is not so absurd as it sounds and has been own to give some novel and attractive fects, though its use, of course, is very mited. Ultra-violet rays are the invisible ght; and, though they cannot be seen by ne eye, certain substances may be caused o glow or become fluorescent if they are laced in these rays. Clothes, scenery and tage decorations of various kinds, when hey are coated with the proper substance, vill glow if ultra-violet rays are directed t them.

In the experimental tests a spotlight imilar to that usually used in a theater allery was directed at the stage, but all he light except the invisible ultra-violet rays was blocked by filters. The spotlight thus thrown on the stage did not give the cone of light usually so easily detected between the lamp and the stage; for, though the cone of rays was there, these rays were invisible.

Objects on the stage coated with paraffine gave a violet or skyblue glow. A chemical called rhodamine gave a yellowish red glow, vhile articles coated with a combination of araffine and rhodamine gave a Burgundy ed. Another chemical gave a green effect, d various colors could be obtained with mbinations of these three.

Porous Metal.

It is a well-known fact that the alloys of certain metals in a molten condition solidify very slowly and pass through a wide range of temperature in the act of assuming the solid state. Thus with a fused mixture in equal proportions of lead and antimony the alloy begins to become solid when the temperature sinks to 450° C., but it does not become solid throughout until the mass is cooled down to half that temperature. At the higher temperature minute crystals of antimony are formed, which gradually increase in size, and when at last the metal has cooled down to 225° C. the alloy, which will then consist of about 87 per cent of lead and 13 per cent of antimony, crystallizes, forming a network of fine crystals of both metals. Between the formation of the first crystals and the point of complete solidification the alloy remains in a more or less plastic condition. Bessemer made use of this property of semisolid alloys in order to obtain very sharp impressions of medals and coins under heavy pressure. Mr. Hannover, a Danish savant, has devised a new process, based on this property of alloys, which may prove of value in the industrial arts. He expels by centrifugal force or other means the molten part of the residual metal, filling up the spaces between the crystals after they are first formed, and he thus obtains an extremely porous crystalline mass of any required metal, useful for making plates for storage batteries, for filling pipe joints, and other purposes.

"Antikamnia"
"Orangine"
Bromo Seltzer
Royal Pain powder
Muraline 1 "
Mergrimin
&c &c
depend for effect
on acetanilid
a deadly poison
Catarrh powders
Cocaine

Headache powders

Painless Extraction of Teeth.—D. Frohmann (Med. Week., iv, p. 312) recommends the following solution:

Cocaine hydrochlorate	10—20 ctg.
Morphine hydrochlorate	25 mg.
Sterilized sodium chloride	20 ctg.
Antipyrine	1—2 gm.
Guaiacol	2 drops
Distilled water	100 gm.
For external use.	

A few drops of this solution are injected into the gum at various points around the teeth to be extracted, and at a certain distance therefrom, until it appears pale, when the tooth may be extracted without pain. The object of adding morphine and antipyrine is to prevent the pain that frequently supervenes when a tooth has been extracted under cocaine anæsthesia as soon as the analgesic effect of this alkaloid has passed off.—Merck's Report.

To Color Benzine Red.—Benzine may be colored red by dissolving in it a sufficient amount of red aniline hydrochlorate, the depth of color depending of course upon the quantity of the coloring agent used. Alkanet may also be used for this purpose, but has the disadvantage that it fades on long exposure to light.

Diamond Cement.—The following formula will be found useful in repairing china, glass, wood, leather, etc.:

Isinglass	240 grains.
Mastic	120 "
Gum ammoniac or galbanum	60 "
Alcohol	4 fluid ounces.
Water	4 " "

Soak the isinglass in the water for twenty-four hours; evaporate on a water bath to 2 fluid ounces; then add 2 fluid ounces alcohol; strain; add the mastic dissolved in the remaining alcohol; and add the ammoniac by trituration, avoiding loss of alcohol as much as possible.—Bulletin of Pharmacy.

A Remedy for Thirst.—Thirst and great dryness of the mouth in sickness is often relieved by a teaspoonful of powdered gum arabic, beaten thoroughly with two teaspoonfuls of glycerin, to which is added a glass of cold water and enough lemon juice to make the mixture palatable. The mixture may be taken freely, with great relief to the dryness of the mouth and thirst.—Medical Times.

Cement for Leather.—

Strong glue	50 parts.
Water	q. s.
Turpentine	2 parts.
Starch paste	100 "

Dissolve the glue over the fire in the water; add the turpentine, stir up well and mix with the starch paste while hot.—British and Colonial Druggist.

A house or a room may be cleared of mosquitoes by burning pyrethrum powder and allowing the smoke, which is not at all offensive to most people, thoroughly to fill the room that is under treatment. This smoke kills or so stupefies the insects that they will not bite. Pyrethrum powder is a preparation of the plant *Pyrethrum roseum*, and is sometimes sold as Persian Insect Powder or Dalmatian Powder; it can be bought at any drug store for about thirty-five cents a pound. It is a very fine, light powder; and a pound of it will go a long way, making a large volume of smoke. A pyrethrum smudge or smoke may be started by covering a live coal, taken from the kitchen stove, with the powder, first placing the coal upon a small shovel, so that it may be moved about conveniently without danger of setting anything on fire. The pyrethrum will quickly begin to smoulder and give off a dense smoke. All that is now necessary is to add from time to time a pinch of powder as occasion requires, merely keeping the smouldering ashes covered so that they will give off a smoke. People are frequently annoyed and sometimes driven into their houses on summer evenings by the persistent attacks of mosquitoes. On such occasions, pyrethrum powder can often be used to advantage; and the smoke from a small quantity of the powder kept smouldering upon the piazza will drive away most, if not all, of the pests, thus making it possible to enjoy an evening out of doors in comfort, when otherwise life would be unbearable except behind the protection of screens.

Ink Eraser (2) Solutions
Saturated Solution chloride lime
and Citric Acid

Bricks Made of Sand

THE Israelites of old need not have worried about the item of straw as a material for brickmaking if they had only made acquaintance, accidentally or otherwise, with what is to-day the newest invention in this line of industry—namely, the so-called "sand brick," composed of sand and lime. First importations of these bricks are now reaching this country from Germany, and they possess such advantages in respect of cheapness and durability that they are sure before long to come into widespread use.

The recipe for making them is simple enough. They are ninety-four per cent. sand and six per cent. lime, and these ingredients, being thoroughly mixed together by a puddling process, are thereby combined into a semi-fluid material, which is poured into moulds. After hardening and coming out of the moulds the bricks thus formed are exposed for four hours to live steam, which completes the process of manufacture.

The bricks are exceedingly hard, and so tough that it is scarcely possible to hammer them to pieces.

Remedy for Typhoid and Diphtheria.

R. P. HANSON, M. D., Oshkosh, Wis.

LET me give you a remedy, introduced to the eclectics of this State, in 1897, by Dr. H. M. Ludwig, as a specific for typhoid fever and diphtheria, and I have found it equally reliable in pneumonia. Use it from start to finish, and allowing a temperature of 104 Fahrenheit on the fourth day, when typhoid symptoms are fully established, it will take eight to fourteen days to reduce the temperature to normal to stay. A gradual reduction will take place from the start, and if properly used, the drumbelly, or tympanites, will be kept down while kramaria fluid extract, or pulverized cinnamon, can be used to control the bowels in case of diarrhea.

If used in diphtheria, internally, and by swab and gargle, no membrane will form. In pneumonia use it as in typhoid fever and diphtheria, internally, but apply a thin poultice, made of grease and fried onions, over the chest. This last is not considered an ethical or professional remedy, but I have not found anything equal to it. Antiphlogistine does not compete with it in pneumonia.

Following is the prescription:

Carbonate of ammonia, two drams; salicylic acid, two drams, and water (hot is best) to make four ounces. Dose, one or two teaspoonfuls every two to four hours. In typhoid, larger doses are given at times, to control tympanites.

This combination, or chemical compound, is a powerful antiseptic in the stomach and bowels. The carbonate of ammonia is a simple heart tonic, offsetting the slight depressing effect of the salicylic acid, and the compound will keep the system relaxed.

Furniture Polish
1/2 lb beeswax
1 oz rosin
2 oz turpentine

...periments.

Take a large bouquet of purple flowers. You can make roses of them, some white and some green.

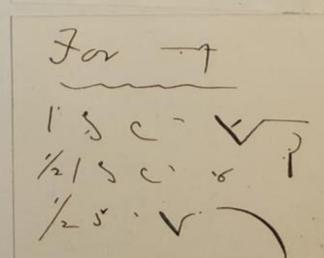
First, put aside a quarter of your flowers. Burn your sulphur in an old iron plate, and you will find that it gives off sulphurous acid. Cover the dish with a paper cone having a hole at the top, through which the acid will rise (Fig 2). Hold your remaining flowers over the opening, and, in an instant, all will be discolored, turning white.

Take a third of these white flowers and put them aside with the first.

Immerse half of the remainder in a glass of water in which you have put a few drops of sulphuric acid, and these will turn red.

And, for the second half, pour a spoonful of ammonia into a glass of water and place the flowers in the glass; they will take a dark green shade.

Then put your four bunches together and you will have a very curious bouquet.



Science

To Chemically Cause Paper to Become Transparent
use the following solution on the paper: White wax, two ounces; absolute alcohol, fifteen ounces; and ether, one ounce. The solution will be muddy at first, but after a few minutes pour off the clear solution, which is the one to save and use. (Contributed by Loren Ward, Des Moines, Iowa.)

(60) What degree of temperature results from the compression of air, per hundred pounds pressure, the compression being so rapid as to avoid loss of heat by radiation?

C. F. J., Washington, D. C.

ANS.—The temperature does not increase in direct proportion to the increase of pressure. The relation of pressure to temperature of air compressed [illegible]iabatically, or without loss of heat, is [illegible]d by the formula,

$$\left(\frac{P_1}{P_2}\right)^{[illegible]}$$

in which P_1 and P_2 are [illegible]d final absolute pressures, respect[illegible]d T_1 and T_2 the initial and final absolute temperatures, respectively. The initial and final pressures and the initial temperature must be known in order to calculate the final temperature. Assume $P_1 = 14.7$ pounds; $P_2 = 114.7$ pounds; and $T_1 = 520°$, corresponding to 60° F. Then

$$\left(\frac{14.7}{114.7}\right)^{.29078} = \frac{520}{T_2}$$

Or, using logarithms, $\log T_2 = \log 520 + .29078 (\log 114.7 - \log 14.7) = 2.716003 + .29078(2.059563 - 1.167317) = 2.972542$. Therefore $T_2 = 938.75°$, and $t_2 = T_2 - 460° = 478.75°$ F. If the final pressure is 200 pounds gauge, or 214.7 pounds absolute, the final temperature will be about 682° F. And by using the formula given, the temperature for any given pressure may be calculated.

The efficiency of compressed air can be greatly increased by using air-heating stoves. The efficiency of fuel consumed in heating compressed air is more than six times greater than burning the same fuel under a boiler. The efficiency of the motors is also considerably increased owing to better lubrication and to less danger from freezing up.

Testing the Freshness of Eggs.

A new and precise means is recommended by the Societe D'Ariculture of Saxony. According to the evaporation of air through the egg-shell, day by day the egg takes a different position when floated in water, because the air space in the egg at one end gradually increases. The fresh egg remains horizontal; from three to five days old it inclines at an angle of 20 degrees; at eight days, 45 degrees; at fourteen, 60 degrees; at three weeks, 75 degrees; at a month, it rests vertical; when older it floats.

The novel recommendation is to inscribe on a glass vessel radii at various angles of a quadrant, marking the degrees, and by this means the age of the egg can be read at a glance, almost to a day.

One lb. Coal tar; 1 lb. Cotton seed oil; 1 lb Sulphur, mixed, with stirring, at 260° and upwards for an hour produces a soft elastic composition like rubber.

A recently invented device for attracting attention to store windows, etc., is an automatic soap bubble blower. The apparatus is provided with a little pump like a bicycle pump and a few strokes of this will furnish air enough to keep it blowing bubbles for half an hour.

Professor William Wood, of Johns Hopkins University, has announced a discovery in light that is of great value in science. In his lecture, when it was announced, he described Tyndall's experiments with a screen that cut out all of the visible rays of the spectrum as well as the ultra-violet rays and let through only heat rays. For thirty or forty years eminent physicists all over the world have been trying to find a similar screen that would cut out all of the heat and all of the visible rays, and let through only the ultra-violet rays. Dr. Wood had for some time known that the substance called nitro-dimenthyl-aniline would keep out all the visible and heat rays, except some red and violet, and that it would also permit the passage of the ultra-violet. It has been only very recently, however, that Dr. Wood has discovered the screen sought for. He combined the known substance with cobalt glass and obtained a screen that permits to pass through it only the ultra-violet rays. One striking peculiarity of the nitro-dimenthyl-aniline, and a peculiarity emphasized by Dr. Wood, is the fact that it gives a spectrum about thirty times as broad as that produced by the ordinary glass prism.

The wireless telegraph of Herr Blockmann uses lenses of resin, glass, paraffin, or other delicate material, instead of antennae, and is practically a heliograph employing invisible electromagnetic rays instead of visible light rays. With transmitting and receiving lenses or mirrors of moderate size, signals can be exchanged over an unobstructed path through the air to a distance of several miles. The dark rays are not intercepted by fog or by non-conducting solids, but mountains are an obstacle that must be overcome by relays. Simultaneous messages may be sent out and received in various directions, the direction of arriving waves being easily determined to within one degree.

CURIOUS AND INTERESTING.

A newly patented German process for soldering cast iron is claimed to give a strength equal to that of the iron itself. After first pickling the surfaces with acid, the pieces are fastened together, the joint is covered with a paste of cuprous oxide and borax, and the metal is heated to redness. The melted borax protects against oxidation from the air. Heating causes the cuprous oxide to give up its oxygen, which burns the carbon of the cast iron surfaces, and metallic copper is separated in fine subdivision. Hard solder is finally applied, which in melting forms an alloy with the copper, the alloy combining with the decarburized surfaces of the cast iron.

(9330) W. J. H. asks: Can you give me the names of the ingredients of a light which is confined in a bottle, as used in the powder magazines in France? Not being exposed to the air, it lessens the danger of explosion. When dim it is replenished by a supply of fresh air by removing cork of bottle. A. The light to which you refer is probably produced by phosphureted oil. A piece of dry phosphorus about the size of a pea is placed in a test tube, and a little pure olive oil poured upon it. The tube is held in a water bath till the oil is heated above the melting point of the phosphorus. Now shake the tube till the oil will take up more phosphorus. After the oil is cooled, put it into a glass-stoppered bottle. When the small quantity of oil in the bottle is shaken about so as to coat the sides of the bottle, a good amount of light is given, and when this becomes dim it may be made luminous again by removing the stopper and admitting fresh air. Use care in handling phosphorus.

In proving or testing a problem in addition by casting out the nines the various columns are added and the sum total placed at the bottom. The digits of each number are now added from left to right and the sum of the digits placed in a column to the right. The numbers in this column are divided by nine, and the remainders, if any, are placed in another column to the right—as, for instance,

```
 2375..17..8
 4682..20..2
 3754..19..1
 9630..18..0
 ----  --  -
20441..74..2
```

In this problem it will be noticed that the result after casting out the nines is as shown in the last column. Much of this operation is done mentally, and the first column to the right is unnecessary, being only given to more clearly illustrate the method. It will be seen that the sum of the digits of the numbers to be added when themselves to be added give seventy-four as a result, which is eight times nine and two remainder, and the operation is proven to be correct, because the sum of the digits of the sum total gives the same remainder (after casting out the nines) as the sum of the digits of the various numbers gives, as in the last column to the right.

The way in which billiard playing is simplified by the device of a Munich College professor has astonished those who have witnessed the test. The sides of an ordinary billiard table are provided with six mirrors, one or more of which can be turned down when a play is made, and the advantage rests in the fact that any image is reflected in the same angle in which it falls on the mirror, just as the billiard ball rebounds from the cushion in the same angle as that of striking. The mirror shows at once the different ways in which a shot can be made. Even the tyro is said to make difficult indirect shots as readily as direct ones, and the intricacies of the game are quickly conquered by anybody.

Briquettes made with such cements as dextrin molasses, lixiviated cellulose, or resinate of ammonia have the fault of dissolving in water. A plan of making them waterproof has been devised by Richard Bock, a Saxon engineer, who simply heats the finished briquettes until carbonized, when they become quite insoluble. If the cement is liable to ignite, the heating must take place in an airtight case or by means of hot gases.

According to a German patent the toughness and durability of aluminum can be much increased by the addition of phosphorus. The addition of 7 to 15 per cent. makes the metal extremely hard and tough, and well adapted for forgings. Three per cent. produces a good horseshoe metal, and with a 2 per cent. addition it can be easily rolled.

M. Maiche, a French inventor, has made some experiments with wireless telephony in the forests of St. Germain. The transmitter was placed on the top of a house, but connected to the ground in the manner of a lightning rod. A thousand yards distant two iron poles ninety feet apart were connected together by wire, and had a telephone receiver in circuit. Sounds from the transmitter were plainly heard in it. Receivers off the line of transmission do not catch the message.

Anti-Rust Paper for Needles, etc.—This is paper covered with logwood, and prepared from a material to which fine graphite powder has been added, and which has been sized with glue and alum. It is used for wrapping round steel goods, such as sewing needles, etc., and protecting them against rust. According to Lake, the paper is treated with sulphuric acid, like vegetable parchment, the graphite being sprinkled on before the paper is put into the water.—Metallarbeiter.

[illegible] writing & exposing every [illegible] to get a clear impression: The erased portion will show, & also where acid has been used.

you refer to. However, a mixture of dry bicarbonate of soda, 80 parts and dry Sal Ammoniac, 50 parts, with enough inert mineral matter to prevent caking, will give about the best possible dry powder fire extinguisher.

Sci. Am. letter 2/2[illegible] 03

TO MAKE FIREPROOF MATERIAL.

Philadelphia Chemist Uses Combination of Sulphur and Aluminum.

CHICAGO, January 21.—Joseph L. Ferrel of Philadelphia threw handfuls of excelsior on a hot gas fire in the rooms of the Western Society of Engineers. It smoked, but it did not blaze.

Then he placed pine shavings on top of the excelsior, pine splinters on top of them and piled pine shingles and slats of pine on the supposedly inflammable material below until he should have had a good-sized bonfire started. There were no flames, however, except the blue ones from the gas.

Mr. Ferrel, who is a chemist and the holder of the Cresson gold medal, the highest award given by the Franklin Institute of Philadelphia for chemical discoveries, had been asked to address the engineers on the subject of fireproofing wood and combustible fabrics. He told them it could be done cheaply, and then he made the practical demonstration desired. To show that theater scenery could be made as impervious as wood the chemist held a piece of canvas in the flame, and, while it smoked a little around the edges, there was no flame.

Sulphate of aluminum is the composition Mr. Ferrel used to fireproof the wood and cotton. His plan is to saturate the material under a pressure.

From a commercial viewpoint, Mr. Ferrel said there was nothing in the way of making any theater safe from spreading flames. While sulphate of ammonia, which has been used, is expensive, sulphate of aluminum is cheap, costing 75 cents a hundred weight, and the expense comparatively is small.

different colors. Printers' rollers are diverse in their composition, each maker having his own formula. The following is a typical formula:

Best glue	10½ pounds
Black molasses or honey	2½ gallons
India rubber, dissolved in oil of turpentine	1 pound
Venice turpentine	2 ounces
Glycerine	12 ounces
Vinegar	4 ounces

The above formula is given for the mysterious black composition, so durable and elastic. Purified and unvulcanized India rubber only is used.

To Make Putty for Repair Work.

A quick, hard drying putty is best made of dry white lead mixed to the right consistency with equal parts of coach japan and quick drying rubbing varnish, says The Hub.

The putty that is elastic, and at the same time hard drying, contradictory as these terms would seem to be, is often badly needed in repair work, and to make which use: Whiting, four parts; dry white lead, one part; litharge, one-fourth part; these ingredients to be mixed in boiled linseed oil to the proper consistency.

For a white putty, when needed, eight parts of dry white lead, five parts soapstone, one part oxide of zinc, three parts dry silica, offer good pigment ingredients. Mix in two parts pale rubbing varnish, one part light coach japan and one-half part each of bleached linseed oil and turpentine.

The glazing putty to be used upon repair work can be made by reducing the common quick putty with turpentine to a free working condition with turpentine, coloring, of course, to meet requirements. Advice is often given to hammer putty to give it firmness and toughness. But in the light of later day experience it is best not to hammer putty that is to be sandpapered. Hammering makes a putty tough and adds to the cost of sanding. If kept in water, mix the putty over in the hands before using to free it from moisture. In puttying repair work, or, for that matter, any kind of work, lay the putty on smooth and cover only the defects. Keep the cost of sanding down to the lowest possible point.

Fly Paper Surface

To melted rosin add, while ~~hot~~ soft, sufficient sweet oil, lard or lamp oil, to make it, when cold, about the consistency of honey.

Another Boiled linseed oil and rosin.

Another Rosin 9 parts — Rape seed oil 4 parts

[Pr]inted matter & pictures [ca]n be copied on absorbent [p]aper by dampening [th]e surface with a weak [s]olution of acetate of iron [&] pressing in copy press.

Cure for Motor Grime.

Editor The Automobile:

Sir:—About the most serious drawback to touring without taking along a mechanic to do the work is the awful state one's hands must always be in, even though there be no breakdowns or serious derangements.

As mineral oil is now generally used, common soap makes no impression upon the grime that seems to sink in deeper the harder you wash. The usual practice is to wash the hands first with gasoline or with some powerful washing powder, which destroy the oil in the skin and make it harsh and raw.

I have hit upon the plan of first rubbing the hands well with a soft cold cream, which seems to enter the pores and replace the dirt, so that with a little soap the hands may be washed as clean and as readily as though they had never been in the grime.

The cold cream of the corner drug store is too stiff and waxy, and that which I use is of the consistency of soft butter and has the following ingredients: 4 ounces imported sweet almond oil, 1 ounce rose water, 1 ounce extract witch hazel, 1-2 ounce white wax, 3 drams spermaceti, 2 drams benzoin.

All of the ingredients are slowly melted together and then the benzoin is added and the mixture is well stirred together.

It is surprising how this compound will bring the dirt to the surface and how smooth and natural it leaves the skin. The same mixture applied to the face protects it from the wind and heat in summer. I carry a good-sized can in the tool box and use it liberally, and no longer am ashamed of my "motor paws."

S. W. Rushmore.

Jersey City, N. J.

Here is an instance. A Southern farmer read the following advertisement in a Western paper: "Send five dollars and learn how to get a pound of butter out of a quart of milk." He sent the money and received his recipe: "Take a pan and pour a quart of milk into it; having first placed a pound of butter in the centre of the pan. Lift the butter out." As clear a case of "gold brick" as this seems to be, it has been outdone by a Canadian who came to the United States in 1892 and copyrighted an "expander" or "increaser," which, where the bunco man only got a pound of butter out of a quart of milk, takes butter, milk and all out in the form of butter. It even does more. It takes six pounds of butter, six pounds of rich cream and gets thirteen and one-half pounds of butter out of the mass. The little emulsifying joker in the case is a mixture of pepsin, salt and color matter. Another is composed of eighty-three per cent. of salt, fifteen per cent. of annatto and two per cent. of rennet and organic matter. In 1901 the Iowa Agricultural College found the "expander" doing business in that State. A farmer who saw the professor take six pounds of good butter, six pounds of good ripe cream, churn them together and, after washing the result in water, letting it stand a while, get thirteen and one-half pounds of butter, exclaimed: "B'Gosh! It collars the hull outfit, milk, butter, water and all." A Wisconsin cheesemaker, who was present, observed that "while the butter man only gets the fat out of milk, the cheese man the fat and the casein, the 'expander' gobbles up fat, casein, sugar, water and all for butter."

Glue or Paste for Making Paper Boxes.—The following comes highly recommended:

Chloral hydrate	5 parts
Gelatin, white	8 parts
Gum arabic	2 parts
Boiling water	30 parts

Mix the chloral, gelatin, and gum arabic in a porcelain container, pour the boiling water over the mixture and let stand for one day, giving it a vigorous stirring several times during the day. In cold weather this is apt to get hard and stiff, but this may be obviated by standing the container in warm water for a few minutes. This paste adheres to any surface whatever.—Nat. Drug.

Make printing stamps out of Roller composition

(8818) G. P. O. wishes a process for galvanizing such as is done on the base boards for stoves. A. The article to be galvanized is first thoroughly cleaned by dipping in weak muriatic or sulphuric acid, and is then thoroughly dried. After this it is plunged in a bath of molten zinc, wherein it becomes coated with a layer of zinc, being what is known as galvanized. The surface of the molten zinc must be kept clean by sprinkling with powdered sal ammoniac and skimming off the dross from time to time.

(8814) J. W. M. says: I would like to know how calcium chloride may be used for extracting moisture. A. Calcium chloride has such a strong affinity for moisture that on simple exposure of the dry substance for a minute, it will become quite wet. Exposed long enough, it will completely dissolve in the water it absorbs. The air is simply passed through tubes or chambers containing the loosely packed chloride. Zinc chloride acts similarly. Oil of vitriol will remove the moisture from air that is bubbled through it. When it is necessary to remove the last traces of moisture from air, phosphorus pentoxide is used.

(8808) J. B. R. wants one or two good formulas for making a strong and absolutely waterproof cement, suitable for use on leather and other similar substances where a flexible joint is needed. A. Gutta-percha and rubber cements are practically the only ones that fully answer the requirement of absolutely waterproof, and if carefully applied are very strong. Either of the following formulæ is serviceable: 1. Dissolve sufficient gutta-percha in 10 parts of carbon disulphide to form a thick solution, then add one part of turpentine. 2. Dissolve gutta-percha as in No. 1, but thin down with petroleum in place of turpentine. 3. Marine glue: Dissolve one part of India rubber in crude benzine and then mix into this solution 2 parts of shellac, heating on a water bath. 4. Marine glue: Dissolve 1 part India rubber and 2 parts asphalt in benzol or naphtha to about the consistency of molasses. In mixing any of these formulæ all the heating must be done in a water bath, as it would be dangerous to use a direct flame on account of the inflammable nature of carbon disulphide, benzine, and benzole.

(8810) O. B. F. says: I wish to etch recorded sound waves on polished zinc or copper plates; these plates being first covered with a film of wax, on which the record is engraved. Please give me the proper acid, or combination of acids, strength of same, and possibly length of time required. A. A liquid which is well recommended for etching copper is the following: Water 880 parts, chlorate of potash 20 parts, hydrochloric acid 100 parts. All chemicals should be chemically pure. Dissolve the chlorate of potash in the water and add the acid. From three to six hours will be required according to the depth of the cutting.

(8804) W. M. B. gives the following information in reference to query 8726: If ammonia is applied to a nitric acid stain to the point of neutralization, even though a few minutes have elapsed, the color of the cloth if dark may be relieved; if not relieved, apply a saturated solution of ferrous sulphate, following with a saturated solution of pyrogallic acid.

(8806) J. P. says: Please give a recipe for a cement that will fasten unglazed porcelain to iron. A. 1. Melt carpenter's glue in wine vinegar, add a little Venice turpentine and boil up for half a day over a slow fire. 2. Mix 15 parts copal varnish, 5 parts drying oil, 5 parts turpentine, and 5 parts liquefied glue, and set in boiling water until all are melted together. Then stir in 10 parts of slaked lime. Use immediately.

(8802) C. C. A. says: I have a gas engine cylinder that leaks water through fine holes in the cylinder wall near a boss, the holes evidently being caused by the "draw" of the iron in cooling. Can you suggest any method of closing these pores solidly enough to stand the heat and pressure of explosion? A. The application of a saturated solution of sal ammoniac in water to the spongy surface will soon rust up the leaky places.

2½ ℥ Benzoic Acid
75 grs Sulphate Morphia
5 ℥ Oxid Zinc
20 ℥ Oil Scecimen

5 ℥ Bee's Wax
5 " Spermaceti
30 " Oil Scecimen
35 gtts (drops) Roses Ottar
50 " " Ottar Rose Geranium
Medicated [illegible] Salve.

Inhalent.
xx

100 oz.	Asetic Semetica
6 "	Red Sanders
32 "	Wild Cherry
34 qts	Alchohol
6 oz.	Oil Bitter Ammonds
16 "	Glycerine
16 "	Chloroform
12 "	Carbolic Acid
20 "	Alchohol
1 "	Oil Anise
1 "	Oil Pepermint
42 oz.	Alchohol
14 "	Gum Benzoin

German Substitute for Celluloid.

The extensive commercial use of celluloid has caused a great many people to try to find substitutes for, or imitations of, it. In Coburg, a popular imitation has been made by dissolving in 16 parts—by weight—of glacial acetic acid, 1.8 parts of nitro-cellulose, and adding 5 parts of gelatin. Gentle heating and stirring are necessary. After the mass has swollen, it is mixed with 7.5 parts of alcohol (96 per cent), and stirring is continued. The resulting product is poured into molds, or, after further dilution, may be spread in thin layers on glass. As an underlay for sensitive photographic films, the material has important advantages, not the least being that it remains flat in developing.

Printer's roller Compositions:
10½ lb. glue
2½ gal. molasses or honey
12 oz glycerine
another:
2 lbs glue
6 lbs molasses

(8677) W. L. J. asks for an acid-proof cement; preferably one which will stand a reasonably high temperature. A. Try a putty made of litharge and glycerin.

(8678) L. A. D. writes: I am a stereotyper. What will I put in paste to make the matrix hard after it is dry? Give me a recipe for backing powder. What is the cause of blow holes in plate and cure for it? A. Paper matrices for making stereotype plates from type forms, used in newspaper offices, are prepared as follows: Make a jelly paste of flour, starch and whiting. Dampen a sheet of soft blotting paper, cover its surface with the paste, lay thereon a sheet of fine tissue paper, cover the surface with paste, and so on until four to six sheets of the tissue paper have been laid on. The combined sheets thus made is then placed, tissue face down, upon the form of types, which are previously dusted with whiting, and with a brush driven down upon the types and thereon allowed to dry. The operation of drying is facilitated by having the types warmed by placing them upon a steam heated table. A blanket is placed over the paper during the drying operation. Probably thorough drying will avoid the difficulty you mention.

(8679) W. S. S. asks for a recipe for a soap to clean woodwork that will not injure the finish or varnish or paint, but at the same time remove the dirt. Also if such a soap will do the work should like it for cleaning carpets or rugs so that same will not be left sticky and stiff. Understand there are receipts for such soaps. A. To clean paint, provide a plate with some of the best whiting to be had; have ready some clean warm water and a piece of flannel, which dip into the water and squeeze nearly dry; then take as much whiting as will adhere to it, and apply it to the painted surface, when a little rubbing will instantly remove any dirt or grease. After which, wash the part well with clean water, rubbing it dry with a soft chamois. Paint thus cleaned looks as well as when first laid on, without any injury to the most delicate colors. It is far better than using soap, and does not require more than half the time and labor. To clean paint, take 1 ounce pulverized borax, 1 pound small pieces best brown soap, and 3 quarts water; let simmer till the soap is dissolved, stirring frequently. Do not let it boil. Use with a piece of old flannel, and rinse off as soon as the paint is clean. This mixture is also good for washing clothes. This would probably answer for cleaning rugs.

(8673) G. R. R. asks: 1. How to preserve eggs, so as to keep them good, a length of time. A. A good method of storing eggs is the following: Having selected perfectly fresh eggs, put them, a dozen or more at a time, into a small willow basket, and immerse this for five seconds in boiling water containing about 5 pounds of common brown sugar per gallon of water. Place the eggs immediately after on trays to dry. The scalding water causes the formation of a thin skin of hard albumen next the inner surface of the shell, the sugar effectually closing all the pores of the latter. The cool eggs are then packed, small end down, in an intimate mixture of one measure of good charcoal, finely powdered, and two measures of dry bran. Eggs thus stored have been found perfectly fresh and unaltered after six months. 2. Can you give a recipe for a cheap and modern stove polish? A. Stove Polish.—Mix 2 parts copperas, 1 part powdered bone black, and 1 part black lead with enough water to give proper consistency, like thick cream. Two applications are to be recommended.

Uses of Turpentine.

From the Woman's Home Companion.

Turpentine, either in resinous form or in spirits, has a household value. A child suffering with the croup or any throat or lung difficulty will be quickly relieved by inhaling the vapor and having the chest rubbed until the skin is red, and then being wrapped about with flannel moistened with fiery spirits. Afterward sweet oil will sa[illegible] the skin from irritation. In the ca[illegible] burns and scalds turpentine has n[illegible] It is the best dressing for patent [illegible] it will remove paint from artists' [illegible] and workmen's garments; it will driv[illegible] moths if a few drops are put into [illegible] and chests; it will persuade mice to [illegible] other quarters if a little is poured int[illegible] mouse holes; one tablespoonful added [illegible] water in which linens are boiled will [illegible] the goods wonderfully white; a few [illegible] will prevent starch from sticking; m[illegible] with beeswax it makes the best floor pol[illegible] and mixed with sweet oil it is unrivaled [illegible] a polish for fine furniture—the latt[illegible] ture should be two parts of sweet oil [illegible] part of turpentine. Some physicia[illegible] [illegible] spirits of turpentine, an[illegible]

The Heavens in April, 1916

Remarkable Surface Features of the Planet Mars

By Prof. Henry Norris Russell, Ph.D.

WHILE Mars is still conspicuous in the evening sky, we may well continue the discussion of the planet's remarkable surface features. Reasons were given last month for believing that the great differences between the drawings of the planet by different observers arise from what is technically called "personal equation"—that is, from differences in their visual and mental perceptive apparatus, operating unconsciously; and that, while a multiple of faint and difficult details undoubtedly exist on the planet's surface, the only way of deciding which of the various types of drawings are probably most like the reality is by means of test observations on "artificial planets," which have never yet been made with sufficient comprehensiveness to answer the question.

We may now consider the principal explanations which have been suggested for the observed details, or, rather, for the changes to which they are subject, for the mere existence of permanent markings of various shapes, sizes and colors on Mars would be no more surprising than on the Moon's surface or anywhere else.

The most conspicuous of all the changes—those of the polar caps—are the easiest to understand. From the way in which they shrink in spring and summer, and reappear again in late autumn, it seems practically certain that they must be deposits of snow or frost of some kind—deposited on the surface as the winter's cold approaches and melting away or evaporating as the warmth returns.

Since the material which disappears from one cap evidently goes, in part at least, to form the other, the planet must have an atmosphere, through which the vapor of the material forming the caps is carried from pole to pole. The existence of an atmosphere is confirmed by several other lines of observation, notably by measures which show that there is a certain amount of twilight on Mars after the sun has set, just as there is on the Earth.

The composition of the atmosphere and of the polar caps is harder to find out, and the existing data are puzzling. The most obvious suggestion is that the white stuff at the poles is actual snow, or hoar frost—frozen water, in some of its familiar forms. The only difficulty about this view is that, so far as can be determined from existing data, it is very hard to see how the surface of Mars can get hot enough, even in summer, to melt snow—or even reach the temperature, perhaps not far above zero Fahrenheit, at which snow begins to evaporate slowly into perfectly dry air, just as camphor does in a warm room.

An alternative idea is that the caps consist of "carbon dioxide snow"—the white flocculent solid into which this gas condenses at a temperature of about 80 degrees Centigrade, or 112 degrees below zero Fahrenheit. But here the difficulty is the other way, for it is equally hard, or harder, to see how the surface of the planet can be cold enough to permit the existence of solid carbon dioxide through the summer, or to allow it to form again as early in the Martian autumn as the white deposit actually does.

In the opinion of the present writer, after a careful examination of the data, the question must be left unsolved for the present.

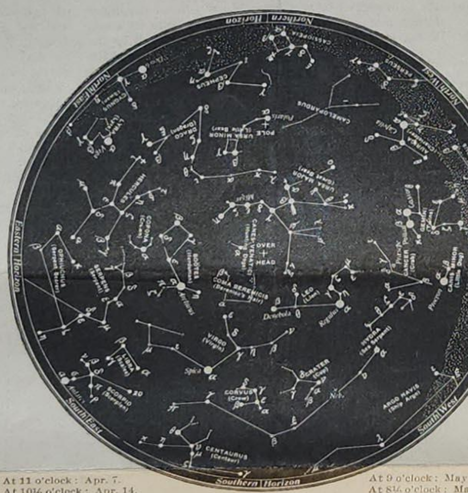
Only one thing seems certain: the polar caps must be very thin, for they sometimes disappear completely in summer. Now the whole amount of heat received during a Martian summer would suffice to melt and evaporate a layer of snow (or of solid carbon dioxide, for that matter) only a few feet in thickness. Since most of the heat actually received must be lost again by reflection or radiation into space, the thickness of the polar caps must be very small, probably averaging only a foot or so.

All the evidence goes to show that the planet's atmosphere, also, is far less extensive than the earth's. It is hardly safe to make a numerical estimate, but the assumption that there is one tenth as much atmosphere above a square mile of the surface of Mars as above an equal area on earth seems a rather liberal one. Regarding the composition of this atmosphere, there are indications, from certain difficult and delicate spectroscopic measures, of the presence of water vapor and oxygen; but other measures by fully as trustworthy methods show no perceptible signs of them. And the quantity present must at most be very small.

We may now take up the most interesting problem—the nature of the dark areas and of the "canals." The former are certainly not seas, as was once supposed—a sufficient proof being that the brilliant reflection of the sun from the surface of the water, which in that case would be conspicuous, has never been observed.

A widely held opinion—and one which is entirely plausible, if the planet's temperature gets above the freezing point of water, and the polar caps are composed of ordinary snow—is that these dark areas are regions of vegetation scattered over the otherwise desert surface of the planet.

The enlargement and darkening of these areas in the local summer, when the moisture from the melting polar snows reaches them (whether by streams, rain or dew) is just what might be expected, while their shrinkage in autumn and winter (when the air becomes very dry again) and the change of color in some places from green to brown, are equally easy to explain.



At 11 o'clock: Apr. 7.
At 10½ o'clock: Apr. 14.
At 10 o'clock: Apr. 22.
At 9½ o'clock: April 30.
At 9 o'clock: May 7.
At 8½ o'clock: May 15.
At 8 o'clock: May 22.

NIGHT SKY: APRIL AND MAY

This is a very attractive theory, but is by no means the only one which can explain the observed changes. For example, Arrhenius, guided by the behavior of certain desert regions in Persia and elsewhere, has suggested that the dark areas may be alkali flats, where the sand is full of hygroscopic salts. Whenever there is much moisture in the atmosphere, these salts will absorb it from the air, and form a brine which will moisten the sand and make it look dark; but when the atmosphere becomes very dry (all the available water being locked up in the growing polar cap) the water will evaporate again, and the dissolved salts will effloresce, leaving the dry surface covered with a whitish or yellowish deposit.

Other explanations, not involving the presence of life, could doubtless be devised; and in all probability some of these chemical explanations could be adapted to the hypotheses that the substance whose vapor diffused from the polar caps into the atmosphere was not water, but something else of lower melting point.

On the vegetation theory, the canals are explained as fertile strips of land bounding watercourses which cross the deserts. This does not prove them to be artificial; for, as Professor W. A. Pickering, the originator of this idea, has pointed out, the valley of the Nile, seen from the moon, would appear as a green streak crossing the great yellow area of the African desert.

As in this terrestrial case, the watered region may be many times wider than the watercourse itself.

The progressive darkening of the canals after the polar cap shrinks, beginning nearest it and extending gradually outward to the equator and beyond it, can then be explained as the result of the progress down them of floods of water from the melting snow, and the subsequent growth of vegetation—as happens, indeed, in the case of the Nile.

Dr. Lowell, starting with this explanation, argues further that the canals form so remarkable a geometric network of fine, sharp straight lines that they cannot have arisen from the casual operation of natural forces, but must be artificial, and the products of great engineering skill. He reasons also that, since the water flows away from the polar cap in all directions along different canals at about the same rate, and goes a long way beyond the equator (as indicated by the darkening of the canals), while six months later, by the Martian calendar, it flows along these same equatorial canals in the opposite direction, it cannot flow under the mere force of gravity, but must be artificially conducted, in a word, *pumped*—which shows that the designers of the canals have not become extinct, but are still using them for irrigation.

To develop arguments which show that it would be possible to get evidence of the existence of intelligent inhabitants upon a planet fifty millions of miles away is an admirable piece of constructive reasoning. There is moreover, nothing in our present conclusively established knowledge of Mars which is irreconcilable with Dr. Lowell's theory; but it should nevertheless be borne in mind that some of the most important bases upon which it is established are not to be counted as conclusively settled by observation, and that it is in any case not the only possible explanation of the phenomena.

It has already been shown that the exact geometrical character of the canal system is very far from being proven, and with this, the argument for the artificial character of the system loses its cogency. Again, and more fundamentally, it is not certainly established that vegetation exists on Mars, or even that the polar caps are of frozen water, and that it ever gets hot enough to melt them.

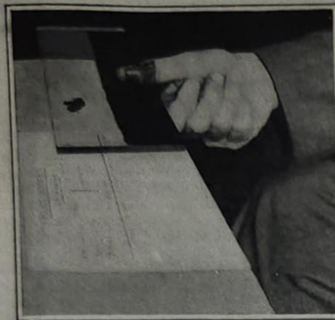
If they do supply the planet with water, the alkali-mud theory will account for changes in the color and visibility of canals as well as of larger areas, and, as Law has suggested, the progressive appearance, first of the canals nearest the pole and then of those farther away, may be explained without invoking intelligent action by assuming that, as the polar caps melt a thin haze spreads over the surface, concealing the full details, which finally clears, starting at the pole, so that the canals, which have all darkened, invisibly to us, under the hazy covering, come into view successively, as reported by the observers.

When all these possibilities are considered, the writer, for his part, is loath to make dogmatic statements concerning Martian problems. The explanations here very briefly outlined have been suggested to their advocates very largely by analogy with features of the Earth's surface. If we could be equally familiar with the conditions prevailing on other bodies, we might well be led to still different, and equally possible, theories concerning Mars, and find ourselves more embarrassed than ever to choose between them, until more distinctive observational data became available.

The Heavens

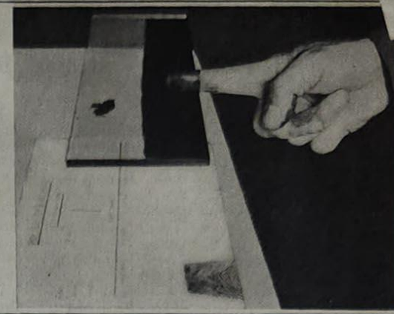
The appearance of the sky in the latter part of an April evening is shown in our map. Almost overhead, but a little to the north, is the Great Bear. The "Pointers" in the bowl of the Dipper point downward to the Pole-Star, and beyond it to the zigzag line of Cassiopeia, low on the horizon. To the right of these, in the northeast, is Draco, coiled about the Little Bear. Low in the northeast is the bright star Vega. Above this are the quadrilateral in Hercules, the semicircle of Corona, and the resplendent Arcturus. Virgo is well up in the south. Its brightest star, Spica, makes a fine triangle with Arcturus and Denebola in Leo.

(Concluded on page 362)



Inking the thumb before making a print

Taking the impression of a finger



Rolling the index finger upon the ink slab

The Origin, Classification and Uses of Finger Prints*

An Ideal System of Identification for the General Public

By Sergeant Frederick Kuhne, Bureau of Criminal Identification, Police Department, City of New York

DURING the last few years numerous articles have appeared in various magazines and newspapers relative to the identification of individuals (principally criminals) by the method known as the "Finger Print System," with no intention of the writers of such articles to convey to the public the information as to the manner in which finger prints are classified and identifications made, nor as to the value of finger prints in cases other than criminal.

When finger prints were first adopted as a means of identification, under a system of classification whereby a print could be filed and readily found, the subject was treated as a science and made to appear technical and difficult. This was done perhaps to keep it confidential for police purposes, no thought having been given to its future possibilities or to the fact that a system, the use of which is indispensable to the Departments of Justice all over the world, would make an ideal system for any institution, department, bureau, firm, corporation, etc., desiring to prove identity or prevent impersonation.

In order to interest the public in this comparatively new system, an endeavor will be made to cover the omissions of previous articles, by explaining the finger print system as concisely as the subject and space will permit by showing that there is nothing difficult or mysterious about the system and how valuable it would be, not only for the police, but for themselves, if everybody had their prints taken and filed for future use.

The only requirements for proficiency in the knowledge of finger prints are ordinary intelligence and practical experience.

Origin

According to the record of researches by prominent criminologists, the individuality of the finger print, or better known as the thumb print, and its value in proving identity was discovered by the Chinese over 200 years B. C., an impression of the thumb being used by them in lieu of their signature in all legal and business transactions; later this method was also adopted in India, and while from time to time various systems for the classification of impressions were advanced, they were not considered until the English government, realizing its value, adopted the "Henry System" in 1901. Since then finger prints under some system have been installed by the police of all the principal cities throughout the world.

A Finger Impression

Before entering upon the explanation of classification, I wish to instill into the minds of those not familiar with the finger print work, the real meaning of a finger print or impression.

The dictionary defines the word impression as being the mark, or a mark of anything, such as a stamp, mold, etc.; but as a mark made with the finger is not necessarily an impression and valueless to experts unless it shows the peculiarities of the ridge formation upon which the classifications and identifications are based, it fails to convey the real meaning.

The term finger print or impression, as used by experts, means the reproduction of the ridge formation on the bulb surface of the outer or nail joint of the finger in any manner whatever, whether it be made with ink, blood, or the greasy substance which is emitted by the sweat glands, the outlets of which are situated on the summits of the ridges; whether it be a photographic reproduction or printed by means of what is known as a line cut; or whether impressed in clay, wax, putty, etc. All are impressions within the full meaning and can be used by experts in making identifications. A smudge made with the finger would be a mark but no impression in accordance with the finger print system.

Classification

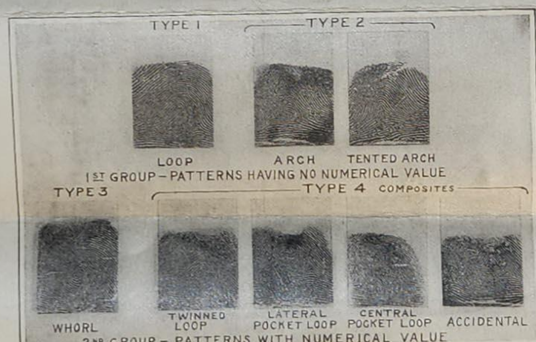
Although there are various systems for the classification of finger prints, such as the "Conley," the "Flak-Conley" (an improvement on the Conley) and the "French System," the system I am about to explain is the "Henry System," which is the one most universally adopted. Any person who acquires experience enough to be recognized as an expert can create a system of his own, which accounts for the variety of systems.

All systems are based upon the peculiarities of the ridges, such as their formation into various patterns (by which the primary classification is determined), and by the formation of two fixed points (known as core or inner terminus and delta or outer terminus), together with the ridges intervening and surrounding these two points (by which the sub-classification, and in some cases the final classification, is determined).

All impressions are divisible into one of two groups, of four types and eight distinct patterns, the first group being patterns to which no numerical value is assigned (except as explained later), consisting of two types and three patterns, such as loops, arches and tented arches (tented arches being included under the type of arches), the second group being those patterns to which a numerical value is assigned in accordance with their position in a set of prints and consisting of two types and five patterns, such as whorls, twinned loops, lateral pocket loops, central pocket loops and accidentals, the last four patterns being classed as composite.

A set of finger prints (ten fingers), consisting wholly of patterns to which no numerical value has been assigned (first group), is given a primary classification of 1 over 1, expressed in the form of a fraction, as ½, ¼, ¾, etc.; for impressions consisting wholly or partly of patterns with a numerical value (second group), the primary classification is determined in the following manner:

The ten fingers are divided into five pairs (the first finger of each pair representing the denominator of the fraction and the second of each pair the numerator), the *first pair* being the right thumb and right index finger, with a value of 16 for denominator if appearing in thumb and 16 for numerator in index; *second pair*, the right middle and right ring finger, with a value of 8 for denominator in middle and 8 for numerator in ring finger; *third pair*, the right little finger and left thumb, with a value of 4 for denominator in right little finger and 4 for numerator in right thumb; *fourth pair*, the left index and middle fingers, with a value of 2 for denominator in index and 2 for numerator in middle finger; *fifth pair*, the left ring and left little fingers, with a value of 1 for denominator in ring finger and 1 for numerator in little finger; the value of 1 which, as previously stated, is assigned to prints consisting of patterns having no value, is always added to the result obtained by the addition of the values as assigned to patterns of the second group, so as to account for the 1 which is borrowed for such prints. The following examples will show how the values are applied and the primary classifications determined.



The "Henry System" of classifying finger prints

If the right and left thumbs were both patterns of the second group and the other eight fingers of the first group, irrespective as to which pattern, the result would be 16 plus 1, giving 17 for the denominator, and 4 plus 1, giving 5 for the numerator; thus we have the primary classification of 5 over 17 for impressions in which both thumbs are represented either by a whorl, a twinned loop, a lateral pocket loop, a central pocket loop or an accidental; if the right thumb, right ring, right little, left index and left little fingers were represented by patterns of the second group, the primary classification would be 10 over 23. When the ten fingers are considered under the same conditions, the classification is the result in addition of 16, 8, 4, 2, 1 plus 1 for both numerator and denominator, or 32 over 32. By this arrangement of values we have the square of 32 or 1,024 primary classifications, running from 1 to 32 over 1; 1 to 32 over 2; 1 to 32 over 3, and so on, up to 1 to 32 over 32.

The primary classifications are further subdivided by the use of letters, as A for arch, T for tented arch, R for radial loop, U for ulnar loop, for patterns of the first group in the index fingers and I for inner, M for meet, O for outer, determined by tracing the ridges of patterns of the second group; but as this part of the system is very lengthy, I will not attempt to explain it in detail owing to limited space.

Prints with a loop appearing in the right little finger would have what is termed a final count or classification in the form of a numeral representing the number

(*Concluded on page 365*)

* Finger Print Instructor, by Frederick Kuhne. Munn & Co., Inc., Publishers.

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STENOTELEGRAPHY.

RAPIDITY of communication is undoubtedly one of the greatest necessities of our epoch. When any important event occurs in any place whatever, it is immediately signaled in every direction; it is for any one to first make the news known. In this order of ideas the telegraph is daily rendering great services. Every one will agree with us, however, that the performance of the most improved apparatus is relatively very limited, and that the cost of transmission is very high. It is with press dispatches that these two inconveniences make themselves particularly felt.

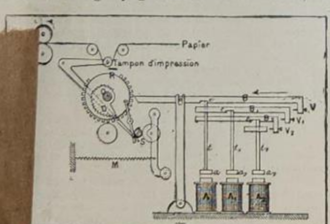
Mr. Cassagnes' stenotelegraph, which we propose to give a brief description of, is designed to remedy, in a large measure, the inconveniences just mentioned.

As its name indicates, this new apparatus transmits with the rapidity of speech and transcribes the stenograph at a distance by the processes of multiple telegraphy. We may add that the stenograph obtained is printed upon a paper band in typographical characters that any one can read.

The stenotelegraph consists essentially of a transmitter and a receiver (Figs. 1 and 2). In the case of a short distance of one or two miles, in the same city, for example, the transmitter and receiver are connected by a cable of twenty wires. In long distances, between two cities, for example, the transmission and transcription are effected by means of the same apparatus connected by a single ordinary telegraph wire. In the latter case, a few intermediate apparatus of which we shall speak are used in the transmitting.

We shall now examine in succession the various elements of the whole affair. As a transmitter, Mr. Cassagnes employs the keyboard of the Michela stenographic apparatus, about which it is well to say a few words in order that what follows may be understood. The Michela keyboard comprises twenty piano keys, each actuating, through the intermedium of a horizontal lever, a vertical rod carrying a conventional character at one of its extremities. The vertical rods, twenty in number, one for each key, are united under a band of paper 1½ inch in width, upon which they print the signs corresponding to the depressed keys, as shown in Fig. 4.*

Things are so arranged that a line represents a syllable formed as follows: One of the first six keys to the left of the keyboard, or a combination of two or three keys, gives the first consonant of the syllable; the four following keys give the second consonant; the



...2.—DIAGRAM OF THE MECHANISM OF THE RECEIVER.

... give the vowel; finally, the last six keys ...onsonant of the syllable.

...lations of this apparatus, employed by ...te, is extremely simple. The words ... orator are decompounded by the ...h prints them syllable by syllable ...per with the rapidity of speech. ...yboard and alphabet that Mr. C... ...th the difference that in the ste... ...t of depressing the keys is simp... circuit, which acts, as we shall ... ceiving ... other ha... ready said, ... binations of ... in the transm... formed in the re... a way as not to ... ventional signs, b... responding typogra... ters.

The receiver, a genera... of which is given in Fig. ... explained in Fig. 2. It co...sists essentially of the following parts: (1) Twenty electro-magnets, A, each connected, through a wire of the cable (in case of a transmission to a short distance) with a key of the keyboard. These electros are arranged in four groups of 6, 4, 4, and 6, corresponding to the groups of keys of which we have above spoken.

(2) Twenty horizontal slide bars, B, arranged above the electros, grouped themselves in four series. Each slide bar is normally held by a rod, *t*, forming part of the armature, *a*, of the corresponding electro, and which enters a notch, *e*, in the slide bar.

(3) Four type wheels, R, held by friction upon an arbor, O, opposite the four groups of slides. The first of these wheels carries 26 typographic characters upon its periphery, and prints the first consonant of the syllable. The following wheels carry respectively 11, 11, and 26 characters for the printing of the second consonant, the vowel and the last consonant of the syllable. Each wheel is combined with a toothed spiral, D, which carries a number of teeth equal to the number of the types of the corresponding wheel.

The operation of this entire affair is as follows:

When, in transmitting, a key is depressed, the circuit of the corresponding electro (A, for example) of the receiver is closed; the armature, *a*, is attracted, and, with it, the rod, *t*, which frees the slide bar, B. This latter, under the action of a spiral spring, M, moves in the direction shown by the arrow. The screw, V, then abuts against the right extremity of the slide bar, B', and the left extremity of the first, B, is arrested at a definite distance in advance of the axis, O. If, at the same time, we free the arbor, O, which is revolved by a small electric motor, the type wheel will be carried along. The one situated opposite the slide bar, B, will be stopped when the tooth of the spiral, D, which is at the same distance from the axis of rotation, O, as the extremity of the slide bar, abuts against the latter.

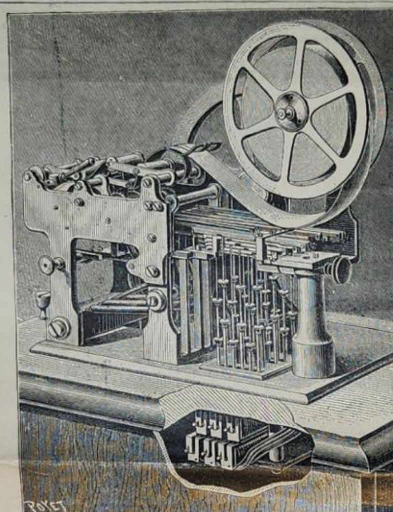


FIG. 1.—RECEIVING AND PRINTING APPARATUS OF THE STENOTELEGRAPH.

The apparatus is so regulated that at the moment of stoppage, the corresponding letter in the advancement of the slide bar is beneath the impression cushion. Suppose, now, that in order to obtain a letter, we must depress, for example, two keys that close the circuit of the electros, A and A'. It is easily seen that the slide bar, B, advancing toward the left to a distance regulated by the screw, V_1, the arrest of the screw, V, will be retarded to an equal degree. The displacement of the first slide bar, B, is therefore the sum of the individual displacements of the two slide bars considered. The tooth of the spiral arrested corresponds in this case to the combination of the two keys depressed. The receiver is completed by a few arrangements of detail. Thus, a series of cams, S, produce the impression, the advance of the paper, and the recoil to the right of the slide bars, B, which the rods, *t*, hold anew in their initial position.

What we have just said in regard to one of the type wheels is applicable to all the others, and the printing of the syllables is effected as shown in Fig. 5, which reproduces a stenographic translation of the conventional signs in Fig. 4.

As may be seen, the bands obtained are perfectly legible. They can be used by compositors either without being written out, or be revised by a corrector.

From the standpoint of stenography, properly so called, this apparatus, which permits of the transmission of two hundred words per minute, offers serious advantages over stenography by hand, by reducing the time necessary for transcription.

Let us now examine the case of transmission to a great distance. As in all multiple transmission telegraphs, a distributer is used in this case, the principle of which we shall make known. Let us suppose a copper circle, D (Fig. 3), divided into a certain number of sectors isolated from each other, over which moves the extremity of a rubber, F, mounted upon the axis of a Paul la Cour phonic wheel, A, and let us admit for an instant that the sectors, twenty in number, are each connected through a wire with the electros of the printing receiver. Finally, let us suppose that the two rubbers, F and F', connected by a wire of the line, L, turn at the same speed and pass at the same instant over the sectors of the same row.

If a key be depressed (the one numbered 4, for example), the current will pass into the line wire and will actuate the electro No. 4 when the rubbers pass over the sectors No. 4, and at that moment only.

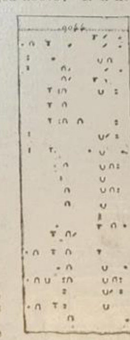


FIG. 4.

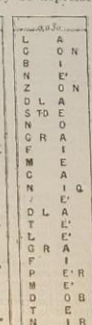


FIG. 5.

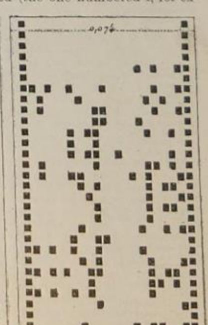
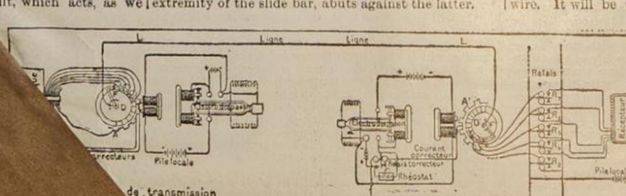


FIG. 6.

The electromagnet attracts its armature, and the effects that we have before described in connection with the twenty-wire cable are here reproduced with a single wire. It will be understood, however, that for great distances, it is necessary to use, at a receiving station, relays, R, that close the circuit of a local current which actuates the electros of the receiver.

On another hand, in order that the transmission might be effected without loss of contacts, it would be necessary, in transmitting, for the keyboard to be actuated in cadence at the rate of one syllable per revolution of the rubber of their sending station. Now, such a condition cannot be realized, since the rapidity of manipulation of the keyboard is subordinated

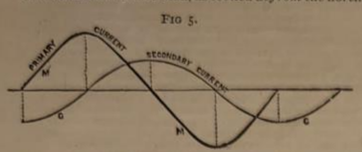


...IAGRAM OF TWO STATIONS IN COMMUNICATION.

* Translation: La combinaison de la stenographie mecanique et de la telegraphie, permet d'obtenir une rapidite de transmission inconnue jusqu'a ce jour.

Let the magnet be an electromagnet, and let the pole be suddenly made a north or marked pole. Lines of magnetic force are thrust into the aperture of the ring. This magnetic flux, in accordance with a well known law, generates an inductive electromotive force which causes a transient current to flow round the ring in a counter clockwise direction, as looked at *from* the north

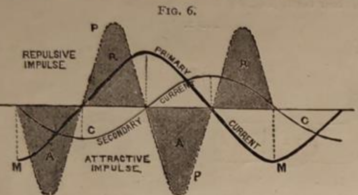
FIG. 5.



magnetic pole. The ring becomes virtually a *magnetic shell*, having a north pole facing the north pole of the exciting magnet. By the fundamental laws of action between currents and magnets established by Ampere, the ring experiences a slight repulsive force, due to the electrodynamic action between the current in the ring and the magnetic pole. The generation of the momentary induced current in the ring is accompanied by an electrodynamic impulse tending to thrust it away from the pole.

Suppose, next, that the electromagnet is demagnetized. The ring has generated in it a reverse induced

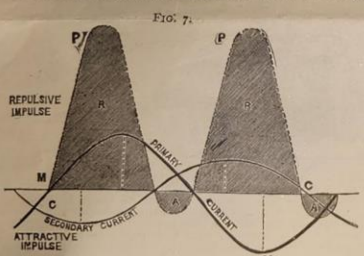
FIG. 6.



current flowing in the same direction as the hands of a clock move when looked at from the magnetic pole. This is also accompanied by an electrodynamic attraction of the ring toward the pole, but which is much more feeble than the previous repulsion. These attractions and repulsions are well seen when small disks of copper or aluminum are suspended in front of the poles of a powerful electromagnet which is alternately "made" and "broken." They have been particularly investigated by Mr. C. V. Boys.*

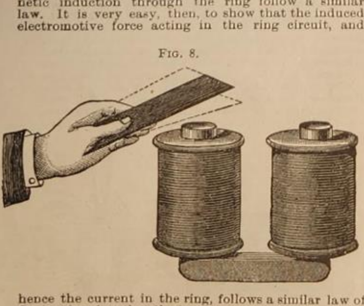
I will now ask you to consider what would happen if the coils of the electro-magnet were traversed by an

FIG. 7.



alternating current. Furthermore, we shall first suppose that the copper ring has a zero time constant; that is to say, the induced currents in the ring rise up and sink down in strength in exact synchronism with the changes in the inductive electromotive force acting on the ring. If the current, flowing in the coils of the electro-magnet, is represented as to changes in strength by a simple periodic curve, we may suppose that the magnetism of the core and the magnetic induction through the ring follow a similar law. It is very easy, then, to show that the induced electromotive force acting in the ring circuit, and

FIG. 8.



hence the current in the ring, follows a similar law of fluctuation, but that the instant of maximum current in the ring coincides with the instant of reversal of magnetism in the electro-magnet. Under these circumstances we can represent the changing strength of the magnetic field in which the ring is immersed by a simple periodic curve, M, and the changes of current strength in the ring circuit by another simple periodic curve, C, shifted backward relatively to the first by a quarter of a wave length (Fig. 5).

By Ampere's law, the force acting on the ring at any instant is proportional to the product of the instantaneous value of the surrounding field and this current strength. If we multiply together the ordinates of these two curves, M and C, and form a third curve, P, whose ordinate at every point is proportional to the product of the ordinates of the other curves (Fig. 6) at those points, we obtain a curve which represents the fluctuation of force at every instant acting upon the ring. This curve, P, is also a wave-like curve, lying symmetrically above and below the horizontal line. The positive and negative areas of this curve included between the curve and the horizontal line represent the impulses or time integrals of the forces which act upon the ring. These impulses are alternately positive and negative. This is equivalent to saying that under the circumstances assumed, the ring gets a series of small pushes and pulls, or repulsions and attractions, which succeed each other at the same rate as the changes of magnetic polarity of the magnet. The series of rapidly alternating and equal impulses would result in leaving the ring apparently unmoved. No real conducting ring can, however, behave in this fashion, because every ring has a sensible "time constant." Let us next see how the above statements will be modified if the ring has such a sensible self-induction that the current induced in the ring lags behind the inducing electromotive force in phase. Repeating the above construction for a force curve, on the assumption that the instant of maximum of the current in the ring occurs later than the instant of reversal of magnetism in the magnet, it is easy to see that the force curve consists now of two very unequal parts. It is not symmetrically situated with respect to the horizontal lines (see Fig. 7). The area of the hummocks (shaded portions) which lie above the datum line, and which represent the repulsive impulses on the ring, are much larger than the area of the hummocks below the datum line, and which represent the attractive impulses acting on the ring. This means to say, that the ring when possessing self-induction experiences on the whole a repulsive force, or a series of repulsive impulses, when immersed in such an alternating magnetic field radiated from a magnetic pole; and this repulsive force will be, within certain limits, more pronounced, other things being equal, the greater the time constant of the circuit. You see clearly, therefore, that a ring or disk of copper in which the induced currents lag behind the inducing electromotive force in phase must experience a repulsive force when this inducing electromotive force is caused by a rapid flux backward and forward of lines of magnetic forces perforating through the ring or disk. The realization of this inference in a striking manner is the first of a series of remarkable experiments on this subject due to Prof. Elihu Thomson. We have on the table an electro-magnet suitable for these experiments, which consists of a core of divided iron, surrounded by a coil in which I can cause to circulate a powerful alternating current of 40 to 50 ampères. Let us, however, begin with an experiment in which we employ a continuous current to energize the core. I give you, in Prof. Elihu Thomson's own words,* an account of this preliminary experiment:

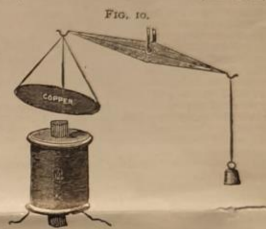
"In 1884, while preparing for the International Electrical Exhibition at Philadelphia, we had occasion to construct a large electromagnet, the cores of which were about 6 in. in diameter and about 20 in. long. They were made of bundles of iron rod about 5-16ths of an inch in diameter. When complete, the magnet was energized by a current from a continuous current dynamo, and it exhibited the usual powerful magnetic effects. It was found also that a disk of sheet copper of about 1-16th of an inch in thickness, and 10 in. in diameter, if dropped flat against a pole of the magnet, would settle down softly upon it, being retarded by the development of currents in the disk, due to its movement in a strong magnetic field, and which currents were of opposite direction to those in the coils of the magnet. In fact, it was impossible to strike the magnet pole a sharp blow with the disk, even when the attempt was made by holding one edge of the disk in the hand and bringing it down forcibly toward the magnet. In attempting to raise the disk quickly off the pole, a similar but opposite action of resistance to movement took place, showing the development of currents in the same direction as those in the coils of the magnet, and which currents, of course, would cause attraction as a result. The experiment could be tried in another way. Holding the sheet of copper by one edge, just over the magnet pole (Fig. 8), the current in the magnet coils was cut off by shunting them. There was felt an attraction of the disk, or a dip toward the pole. The current was then put on by opening the shunting switch, and a repulsive action or lift of the disk was felt. The actions just described are what would be expected in such a case, for when attraction took place currents had been induced in the disk in the same direction as those in the magnet coils beneath it, and when repulsion took place the induced current in the disk was of opposite character or direction to that in the coils. Now let us imagine the current in the magnet coils to be not only cut off, but reversed back and forth. For the reasons just given, we find that the disk is attracted and repelled alternately; for whenever the currents induced in it are of the same direction with those in the inducing or magnet coil, attraction will ensue, and when they are opposite in direction repulsion will be produced. Moreover, the repulsion will be produced when the current in the magnet coil is rising to a maximum in either direction, and attraction will be the result when the current of either direction is falling to zero, since in the former case opposite currents are induced in the disk, in accordance with well-known laws; and in the latter case currents of the same direction will exist in the disk and the magnet coil. The disk might, of course, be replaced by a ring of copper or other good conductor, or by a closed coil of bare or insulated wire, or by a series of disks, rings, or coils superposed, and the results would be the same."

We have already seen that in an alternating field the electrodynamic impulses so experienced by the disk or ring are alternately attractive and impulsive, and that when the circuit possesses a sensible self-induction, the repulsive impulses overpower the attractive ones, and their repetition constitutes a repulsive force. Before adding a few more words of explanation, permit me to show you some of these electrodynamic repulsions produced by an alternating electromagnet. Here is a copper ring, and I lay it upon the top of this electromagnet, having a divided iron core and excited by a powerful alternating current. On energizing the magnet, the ring jumps up in the air (Fig. 9). If a copper plate is hung like

FIG. 9.

a scale pan from a balanced beam, and placed over the magnetic pole, it gives evidence of being strongly repelled the moment we pass the current through the coils of the magnet (Fig. 10). Instead of employing copper rings or copper plates, we can use closed coils of thick wire, either insulated or not. If, however, our

FIG. 10.



plates or rings have a radial slit made in them, or if our coils of wire are not closed circuit coils, all the effects vanish.

So strong is this repulsion, with proper appliances, that light copper rings tethered by strings may be held suspended in the air against the force of gravity, the upward electromagnet repulsion overcoming their weight, and holding them, like Mahomet's fabled coffin, floating in the air (Fig. 11). In cases where we are

FIG. 11.

dealing only with impulsive effects, aluminum rings or disks give most marked results, because aluminum has the highest conductivity per unit of mass; but in the cases like those just considered, where what is required is the greatest force effect, copper or silver gives a better result than aluminum, because they have the highest conductivity per unit of volume. In Mr. Boys' experiments, if I remember rightly, he found aluminum the best to employ. In these cases of electrodynamic repulsion, the force effect depends essentially upon the lag of the induced current, or it is retardation in phase behind that of the inducing field, and, other things being equal, this is proportional to the conductivity of the circuit. I will pass before your view a series of diagrams intended to represent various cases and modes of production of these repulsive effects, giving you descriptions of them in Prof. Elihu Thomson's own words. He says:

"This preponderating repulsive effect may be utilized or may show its presence in a given direction by producing angular deflection as of a pivoted body, or by producing continuous rotation in a properly organized structure.

"In Fig. 12, C, is a coil traversed by alternating currents, B is a copper case or tube surrounding it, but not exactly over its center. The copper tube, B, is fairly massive, and is the seat of heavy induced currents. There is a preponderance of repulsive action tending to force the two conductors apart in an axial line. The part, B, may be replaced by concentric tubes slid one in the other, or by a pile of flat rings, or by a closed coil of coarse or fine wire, insulated or not. If the coil, C, or primary coil, is provided with an iron core, such as a bundle of fine iron wires, the effects are greatly increased in intensity, and the repulsion with a strong primary current may become quite vigorous, many pounds of thrust being producible by apparatus of quite moderate size.

* On a "Magneto-Electric Phenomenon." By C. V. Boys, F.R.S. Proc. Phys. Soc., London, vol. vi., p. 218.

* See the *Electrical World*, May, 1887, p. 258; or the *Electrical Engineer* (American), June, 1887, p. 211: "Novel Phenomena of Alternating Currents," by Elihu Thomson.

to the rapidity of speech. In order to remedy this inconvenience, Mr. Cassagnes employs two small apparatus whose principle we shall describe.

Upon a transmission, the keyboard actuates a perforator, which consists essentially of twenty punches that act vertically upon a band of paper.

This latter on making its exit from the apparatus is therefore perforated with a series of square apertures at the place that would be occupied by the conventional signs, if printing were done.

The band thus obtained (Fig. 6) with the rapidity of speech is placed in another apparatus, which carries it along automatically, and by impulses, and makes it move forward by one line at a time. Twenty spring levers tend constantly to enter the apertures in the band in order to establish a series of contacts and close the circuits of the corresponding relays at the receiving station.

The paper, where it is not perforated, therefore forms an insulator. The motion of the apparatus that carries along the paper is regulated by the distributer of the transmitting station.

In practice, it is not with the keys (as we have above supposed, in order to make the system understood), but with the spring levers of the transmitting station that the sectors of the distributer of this station are connected.

The bands obtained at the other end of the line are identical with those represented in Fig. 5.

Fig. 3 gives the general arrangement of the two stations in the case of transmissions to great distances. The important point to remember is the necessity of the previous perforation and the use of perforated bands with the rapidity of speech for the sending of currents to the receiving station.

The theoretical performance of the apparatus is as follows:

For very great distances, from Paris to Marseilles, for example, the experiments made here demonstrated that it is possible to make use of distributers with two series of sectors. The rubbers making three revolutions per second, and the ratio of the stenographic lines to the words that they represent being about 80 to 100, it will be seen that on this distance it is possible to transmit $2 \times 3 \times 60 \times 0{\cdot}80 = 288$ words per minute.

For shorter distances, from Paris to Brussels, for example, distributers with three series of sectors may be used. The result in this case is $3 \times 3 \times 60 \times 0{\cdot}80 = 432$ words per minute.

We shall not dwell longer upon this high theoretical performance. We think the margin is sufficient to permit of a practical performance much greater than that of the most rapid telegraph, which gives from 25 to 30 words per minute at a maximum.

It is true that the telegraph transmits orthographized words, though this is not always necessary. The stenotelegraph also is naturally capable of transmitting in the same way, but with a diminution of *thirty per cent. in the rendering.—La Nature.*

WELDABLE BY ELECTRICITY.

FOLLOWING is a list of the different materials which have been successfully welded together by the Thomson process, which may be of interest, inasmuch as the term welding is ordinarily used with especial reference to the joining of two pieces of material of the same or closely allied composition:

METALS.

Wrought iron,	Tin,	Aluminum,
Cast iron,	Zinc,	Silver,
Malleable iron,	Antimony,	Platinum,
Wrought copper,	Cobalt,	Gold (pure),
Cast copper,	Nickel,	Manganese,
Lead,	Bismuth,	Magnesium.

ALLOYS.

Stubs steel,	Fuse metal,
Cast brass,	Type metal,
Gun metal,	Coin silver,
Chrome steel,	Solder metal,
Mushet steel,	German silver,
Crescent steel,	Silicon bronze,
Bessemer steel,	Aluminum brass,
Steel castings,	Phosphor bronze,
Brass composition,	Aluminum bronze,
Various grades of tool steel,	Various grades of gold,
Various grades of mild steel,	Aluminum alloyed with iron.

COMBINATIONS.

Copper to brass,	Wrought iron to mild steel,
Copper to wrought iron,	Wrought iron to tool steel,
Copper to German silver,	Gold to German silver,
Copper to gold,	Gold to silver,
Copper to silver,	Gold to platinum,
Brass to wrought iron,	Silver to platinum,
Brass to cast iron,	Wrought iron to Mushet steel,
Tin to zinc,	Wrought iron to Stubs steel,
Tin to brass,	Wrought iron to Crescent steel,
Brass to German silver,	Wrought iron to cast brass,
Brass to tin,	Wrought iron to German silver,
Brass to mild steel,	Wrought iron to nickel,
Wrought iron to cast iron,	Tin to lead.
Wrought iron to cast steel,	

It will be seen from the foregoing that materials heretofore impossible to weld to pieces of similar composition have been welded, and not only this, but different combinations have been made, which are entirely impossible by ordinary methods.

BRONZE COVERED PROPELLER BLADE.—A propeller blade consisting of a sheathing of bronze or delta metal cast on a steel core has recently been produced by Mr. John List, M. Inst. C.E., and Mr. Alexander Dick, of the Delta Metal Company, Limited. The advantages of bronze propeller blades have long been recognized. Such blades can be cast with finer edges, which will, moreover, last the whole life of the blade, and have a very much smoother surface than steel or cast iron blades. In spite of this, however, their adoption is still limited to war vessels and fast passenger steamships, as the ordinary shipowner does not care to face the heavy first cost of the bronze, in spite of the fact that it is worth a considerable percentage of its original cost as scrap at the end of its useful life. The new compound propeller will considerably reduce this first cost, as the steel core makes up a large part of the total weight of the blade. The union between the two metals is very perfect, actual test showing that a tensile stress of 15 tons per square inch was required to separate the metals. The new blade would seem to possess all the advantages of the bronze blades at a considerable reduction in the cost of these.

[Continued from SUPPLEMENT, No. 762, page 12177.]

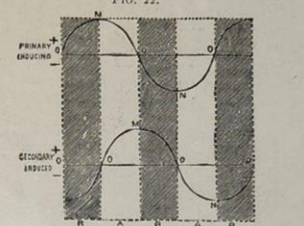
PROFESSOR ELIHU THOMSON'S ELECTROMAGNETIC INDUCTION EXPERIMENTS.*

By J. A. FLEMING, M.A., D.Sc., M.I.E.E., Professor of Electrical Engineering in University College, London.

RETURNING for a moment to the theory of these repulsive and deflective actions, it will repay us to consider it in the form placed before us by Prof. Thomson, in his first paper on the subject, read before the American Institute of Electrical Engineers, May 18, 1887. He says: "It may be stated as certainly true that, were the induced currents in the closed conductor unaffected by any self-induction, the only phenomena exhibited would be alternate equal attractions and repulsions, because currents would be induced in opposite directions to that of the primary current when the latter current was changing from zero to maximum positive or negative current, so producing repulsion; and would be induced in the same direction when changing from maximum positive or negative value to zero, so producing attraction.

"This condition can be illustrated by a diagram, Fig. 22. Here the lines of zero current are the horizontal straight lines. The wavy lines represent the variations of current strength in each conductor, the current in one direction being indicated by that portion of the curve above the zero line, and in the other direction by that portion below it. The vertical dotted lines simply mark off corresponding portions of phase or succession of times.

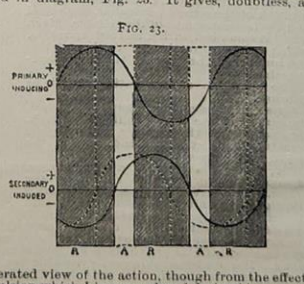
FIG. 22.



"Here it will be seen that in the positive primary current descending from M, its maximum, to the [illegible] line, the secondary current has risen from its ze[illegible] M', its maximum. Attraction will therefore ensu[illegible] the currents are in the same direction in the two conductors. When the primary current increases from zero to its negative maximum, N, the positive current in the secondary closed circuit will be decreasing from M', its positive maximum, to zero; but, as the currents are in opposite directions, repulsion will occur. These actions of attraction and repulsion will be reproduced continually, there being a repulsion, then an attraction, then a repulsion, and again an attraction, during one complete wave of the primary current. The letters, R, A, at the foot of the diagram, Fig. 22, indicate this succession. (The shaded portions in the diagrams represent the time during which the force between the primary and secondary circuits is a repulsive force.)

"In reality, however, the effects of self induction in causing a lag, shift, or retardation of phase in the secondary current will considerably modify the results, and especially so when the secondary conductor is constructed so as to give to such self-induction a large value. In other words, the maxima of the primary or inducing current will no longer be found coincident with the zero points of the secondary currents. The effect will be the same as if the line representing the wave of the secondary current in Fig. 22 had been shifted forward to a greater or less extent. This is indicated in diagram, Fig. 23. It gives, doubtless, an exaggerated view of the action, though from the effects of repulsion which I have produced I should say it is by no means an unrealizable condition.

FIG. 23.



"It will be noticed that the period during which the currents are opposite, and during which repulsion can take place, is lengthened at the expense of the period during which the currents are in the right direction for attractive action. These differing periods are marked *r*, *a*, etc., or the period during which repulsion exists is from the zero of the primary or inducing current to the succeeding zero of the secondary or induced current; and the period during which attraction exists is from the zero of the induced current to the zero of inducing current. (It will be seen that the shaded portions in diagram 23 have been widened out at the expense of the unshaded parts.)

"But far more important still in giving prominence to the repulsive effect than this difference of effective period is the fact that during the period of repulsion both the inducing and induced currents have their greatest values, while during the period of attraction the currents are of small amounts comparatively. This condition may be otherwise expressed by saying that the period during which repulsion occurs includes all the maxima of current, while the period of attraction includes no maxima. There is then a repulsion due to the summative effects of strong opposite currents for a lengthened period against an attraction due to the summative effects of weak currents of the same direction during a shortened period, the resultant effect being a greatly preponderating repulsion

"It is now not difficult to understand all the actions before described, as obtained with the varied relations of coils, magnetic fields, and closed circuits. It will be easily understood, also, that an alternating magnetic field is in all respects the same as an alternating current coil in producing repulsion on the closed conductor, because the repulsions between the two conductors are the result of magnetic repulsions arising from opposing fields produced by the coils when the currents are of opposite directions in them."

One of the most beautiful of Prof. Thomson's experiments illustrating this repulsion can, I think, be shown to you now.

An incandescent lamp is attached to the terminals of a coil of wire, and the coil and lamp floated in water or hung from a scale beam (Fig. 24) over the pole of an

FIG. 24.

[illegible] magnet. The coil and lamp form, as it [illegible], a balloon and car floating in space, and placed in a magnetic field. When that magnetic field is rapidly alternated by exciting the magnet, the induced currents created in the coil make themselves evident by illuminating the lamp, and the repulsive electrodynamic action shows itself by lifting the lamp and coil upward through the water or the air.

The same experiment renders it possible to show the effect of magnetic screening very prettily. If I introduce a plate of copper between the magnet pole and the induction coil attached to the lamp, the copper "screens" the coil from the inductive action of the pole, and the light of the lamp disappears. I must next direct your attention to some curious effects which are found to exist when two conducting circuits are exposed to the magnetic flux from an alternating magnetic pole, and which depend upon the interaction of the currents induced in each respectively. Professor Thomson embodies these facts now to be considered in four laws, which may be briefly stated as follows:

1. If two or more closed circuits are similarly affected inductively by an alternating magnetic field, they will attract one another, and tend to move into parallelism.

2. Iron or steel masses placed in an alternating field give rise to shifting magnetism or lines of force moving laterally, and may, therefore, act to move closed circuits in the path of such shifting lines.

3. Closed circuits in alternating magnetic fields or fields of varying intensity give rise to shifting magnetism, or lines of force moving laterally to their own direction, and may, therefore, act to move other closed circuits in the path of such lines.

4. Iron or steel masses may, when placed in an alternating magnetic field, interact with other such masses, or with closed electric circuits, so as to produce movement of such masses or circuits relatively, or give rise to tendencies to so move, the effects depending on continual adaptations of shifting magnetism and retained magnetism relatively.

It is a simple matter to illustrate these principles; and the experiments, which are designed so to do, bring before us some striking peculiarities of the action of magnetic force upon closed circuits, and upon masses of conducting and magnetizable matter.

Returning, first, to the simple experiment of a copper ring repelled by an alternating pole, we find that if we add a second ring under the first, they both attract one another, and the two rings are supported and repelled as if they were one ring. It is obvious that at any instant the induced currents in both rings are in the same direction, and hence they attract one another.

Such an attractive action can be made to produce continuous rotation. We have only to place a copper ring or plate over the alternating current coil or pole, and then bring a copper disk, free to revolve on pivots, into proper position relatively thereto. This can best be done by placing the ring or plate so as to be somewhat to one side of the pole, so as to "shade" part of it, as it were, while a part of the pivoted disk is placed under or over it, in front of the alternating pole. The disk then begins to revolve rapidly on its pivot (Fig. 25). A little consideration shows that in this case the fixed copper plate shields a portion of the pivoted plate. The currents induced in the fixed plate attract the non-symmetrically placed induced currents in the other disk, and exert a tangential action or couple upon it tending to pull it round. The continual repetition of this action as each portion of the plate becomes in turn the seat of maximum inductive action results in a continual revolution of the plate. Two pivoted disks may be used in-

* A paper recently read before the Society of Arts, London.

to give the best results. Perhaps the best plan of all is that occasionally adopted of passing the water from each vessel into the steam chamber of the next, the pipe connections being of progressive area to accommodate the increasing volumes to be passed. The combination flow from the last vessel may go either to the condenser or a small separate pump, the latter plan allowing the distilled water to be kept separate. This is sometimes necessary, to allow this water to be used for boiler feeding or other purposes; though, as a rule, excepting that from the first vessel, it is far from pure, containing ferments which render it unsuited for boilers without some previous corrective treatment. The method of passing the water drained from each vessel through all the successive ones effects a small but perceptible economy of heat, as on each transfer to the succeeding cooler vessel the water parts with heat which does useful work. As the difference between the pressures in two adjacent vessels is but small, the water pipes in place of cocks might have simple diaphragms, pierced with orifices of perhaps twice the area needed to pass at this head the volume of water corresponding with the expected duty. Calculation and experience would easily determine the best area for each case, and the theory of the efflux of gases goes to show that the area of the orifice might probably be made sufficiently liberal to insure a pretty complete voiding of any air, without wasting any considerable proportion of the heating vapor, the volumes of which at the low tensions employed are very great. Further, any heat so carried away would be partially utilized in the succeeding vessels. A refinement in heat economy, frequently practiced by Continental makers, is the heating of the cold juice immediately on its expression by the vapor passing from the last vessel to the condenser. By means of a tubular heater of ample surface a temperature of about 130 deg. is reached, that of the vapor being about 140 deg., more or less, according to the quality of the vacuum.

For multiple effet apparatus of the usual construction, with either vertical or horizontal vessels, the stated duty is generally based by the maker on a total evaporation of from 1·0 to 1·5 gals. per square foot of heating surface in one vessel, but is commonly stated with reference to the gross surface of all the vessels, becoming 0·5 to 0·75 gal. for a double, 0·33 to 0·5 gal. for a triple, and 0·25 to 0·375 gal. for a quadruple effet. This amount of duty should be obtained from any apparatus of fair design, with a very moderate amount of skill on the part of the attendant, and many carefully worked apparatus of ordinary design regularly give results exceeding this by from 50 per cent. to 100 per cent. Continuous night and day working conduces greatly to efficiency, and avoids the loss of time spent in starting and stopping.

Mr. Hagermann, experimenting with a large vertical triple effet, found that an exceptionally large evaporation could be effected by the simple expedient of allowing the liquor level to fall, while working, to [illegible] tube height, the circulation being still maintained by the ebullition with more than common activity—of course, at stopping or starting, the liquor must cover the upper tube plate. This method of using only partially filled tubes, and trusting to the circulation caused by ebullition to bathe their upper parts, is the same as that adopted by Mr. Thornycroft in his water tube boilers. Referring again to the ideal example of triple effet working, an apparatus to do the assumed duty would be liberally provided with 700 square feet of surface in each vessel, and the heat transmission in that case would be 91, 98, and 100 units per degree respectively. In the ordinary types of multiple effet apparatus which have been so far considered, a considerable quantity of liquor, commonly amounting to from 0·33 to 0·5 gal. per square foot of heating surface, is needed to charge the vessels, and this quantity is subjected to the injurious action of the heat for the whole time of working. From the same cause the apparatus cannot be promptly set to work, stopped or changed over from one class of liquor to another. During the past few years, in which the use of multiple effet apparatus has greatly extended, inventors have been busy devising and patenting apparatus which should be free from these objections, and two new designs in particular have attracted attention, viz., the "Yaryan" and the "Lillie" apparatus, both of American origin. In both of these the leading idea is the same, viz., in place of filling the heating tubes with liquor, to pass only a small stream through a considerable length of steam-heated tube, and as far as practicable to cause this liquor to form a thin film over the surface of the tube. The manner of attaining this end is not, however, the same for both.

In the Yaryan the tubes are horizontal, and divided into sections each of as many tubes as required to give about 60 ft. total length, the ends being connected, so as to make each section virtually a tube of this length. Each of these sections receives, as nearly as practicable, its proper proportion of the total feed of liquor, which, propelled principally by the pressure of the vapor rising from it, rapidly performs its 60 ft. journey, and discharges into a chamber common to all the sections, where the juice and vapor separate prior to passing on to the next vessel. The feed of liquor is so adjusted that the degree of concentration desired from each vessel is effected during a single passage through the tubes. In this apparatus the transfer of the partially concentrated liquor from one vessel to the next is in most cases effected by the difference of pressure, as in the ordinary apparatus. Doubtless on account of the definite and rapid flow over the heating surface, this apparatus is claimed to give a high evaporative duty per square foot, reaching from 2·0 to 4·0 gallons per square foot of surface in one pan, or about twice the duty of an apparatus of the ordinary type.

The following results, obtained from a quadruple effet Yaryan apparatus working on esparto liquor in a paper mill, are extracted from particulars published by the Yaryan Company:

Heating surface in each vessel	540 sq. feet
Steam pressure in shell of first vessel	17 lb. = 254°
" " separator of first vessel	2 lb. = 219°
Inches vacuum in separator of second vessel	6 in. = 201°
Inches vacuum in separator of third vessel	14½ in. = 180°
Inches vacuum in separator of fourth vessel	23 in. = 147°
Feed liquor per hour 1020 S. G. at 90 deg. Fah.	= 1537½ gallons
Concentrated liquor per hour 1080 S. G. at 138 deg. Fah.	= 176½ "
Water evaporated per hour	1361 "
" " " per square foot heating surface in one vessel	2·52 "
Steam used in heating entering liquor	2119 lb.
" evaporating "	3346 lb.
Evaporation per 1 lb. of total steam	2·5 lb.
" " " evaporating steam	4·07 lb.

The Lillie has vertical tubes of a moderate length, surrounded by the steam. Through each of these the liquor falls in the form of an annular film covering its inner surface, and being returned to the upper end by a pump, traverses the tubes as often as necessary to produce the degree of concentration desired in each vessel, after which it is allowed to pass on to the next one. It seems probable that the evaporative duty of this apparatus per unit of surface will be very similar to that obtained in the Yaryan. Both of these new designs are to a great extent free from the objections already mentioned as belonging to the ordinary types, and although in each case the advantages are accompanied by some loss of simplicity and ease of working, some such improved type bids fair to supersede the older forms. Of course, no advantage as to steam economy can be claimed for any such improved designs, unless they should be found to permit the economical use of a larger number of vessels working in series; as the vessels at present employed utilize all the available heat, less the unavoidable losses by radiation, etc., which are practically equal for all forms. The directions in which improvement may be looked for are reduced weight, cost, and time required for a given duty.—*The Engineer.*

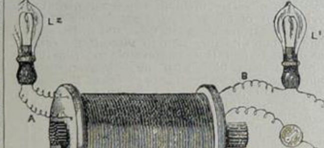
PROFESSOR ELIHU THOMSON'S ELECTRO-MAGNETIC INDUCTION EXPERIMENTS.*

By J. A. FLEMING, M.A., D.Sc., M.I.E.E., Professor of Electrical Engineering in University College, London.

I. IN the Paris exhibition of 1889, and in the United States court, many present will, perhaps, recollect to have seen a collection of electrical apparatus, contributed by Prof. Elihu Thomson as his private exhibit. These pieces of experimental apparatus constituted the appliances for illustrating some highly remarkable and interesting facts in electro-magnetic induction. It is more than probable that very many persons interested in electrical discovery either did not find or did not happen to see in action these instruments, or perhaps had not the opportunity to see them at all. By the kindness of Prof. Elihu Thomson, to whom I am indebted for the loan of the apparatus, it is in my power to repeat some of these experiments before you to-night; and my obligations are likewise especially due to Mr. Ernst Thurnauer, the engineer of the European Thomson-Houston Electric Light Company, for affording me his valuable aid in bringing them before you, and to Mr. Garfield, of the Thomson Electric Welding Company, for assistance in preparing the experiments. A few introductory remarks will be essential, in order that I may carry the whole of my audience with me in subsequent explanations; and these remarks will refer to that which is so very familiar a subject to every electrician, viz., the mutual induction of electric circuits.

Before me lies a very large bobbin or spool, wound over with two insulated copper wires. These wires were wound on the spool together, and for convenience sake we will distinguish them by calling them A and B (Fig. 1). Bear in mind that the wires or circuits are

FIG. 1.



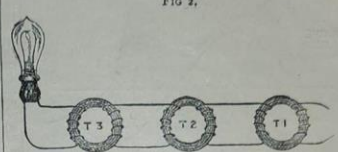
insulated from each other throughout their entire length, but lie closely adjacent on the bobbin. I can at pleasure insert a large bundle of soft iron wires tied up together into the hollow split brass tube which forms the body or the spool. The ends of one wire, say A, are connected to the terminals of a glow lamp, and I can pass or interrupt an electric current which traverses the other circuit, B, and a second glow lamp in series with it. You will note at once what happens when I start or stop the electric current in the circuit, B. The lamp connected to circuit A flashes up momentarily at the instant when the current begins to flow in circuit B, and also when it ceases to flow; but while the current flows steadily in the circuit, B, and illuminates the lamp in series with it, the lamp in series with circuit A is not illuminated at all.

We have here a lecture experiment illustrating the familiar classical discovery of Faraday of the mutual induction of two electric circuits, viz., that the starting or stopping of an electric current in one circuit induces at the instant of commencement or cessation a brief secondary current in another closed adjacent circuit. I shall not take up time by dwelling on the historical details of this fundamental fact. You know them well. If instead of starting and stopping a continuously flowing electric current through the circuit, B, and observing at each "make" or "break" a brief secondary current in circuit A, we supply the circuit, B, with an alternating electric current, one of which the direction is rapidly reversed many times in a second, and connect as before a glow lamp in series with circuit A, we find that this lamp glows continuously while the alternating current flows in circuit B. This also is familiar to us all.

If in our first experiment we had employed, as a current detector in the secondary circuit, not an incandescent lamp, but some kind of galvanometer capable of indicating the direction of the induced electric current, we could easily have established for ourselves the fact that at the instant when the continuous electric current begins to flow in the circuit, B, it generates an oppositely directed induced secondary current in the circuit, A, which is merely a transient current. At the instant when the continuous current is interrupted in circuit B, it gives rise to a similarly directed transient induced electric current in the circuit, A. The momentary currents in A are called the *inverse* and *direct* secondary currents, induced by the commencement or cessation of the continuous primary current in circuit B. If the primary current is rapidly reversed, as in the case of an alternating current, then the secondary current consists likewise of a rapid succession of currents alternating in direction.

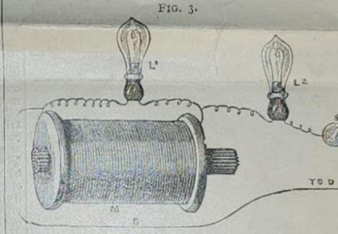
In most of our experiments this evening we shall employ an alternating current, having a "frequency" of 90 per second, that is to say, changed in direction in the circuit 180 times in a second, and provided for us by the kindness of the London Electric Supply Company. If such an alternating current traverses a primary circuit, it induces a secondary alternating current of the same frequency in an adjacent secondary circuit, and this secondary periodic current may be made to induce in another circuit a tertiary current of like frequency, and this, again, a quaternary current, and so on; these successive orders of induced currents being, as it were, the children, grandchildren, and great-grandchildren of the primary parent current to which they owe their birth (Fig. 2.)

FIG 2.



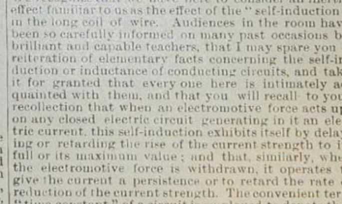
The same large spool of insulated wire will provide us with the means of illustrating another important fact. I join up the two wires, A and B, into one length, so as to form one continuous bobbin of wire, and connect this great spiral of wire with a couple of glow lamps, one being in series with the wire spiral, and the other being in parallel with it (Fig. 3). On sending

FIG. 3.



a steady current through the system, it divides between the wire spiral, S, and the lamp, L¹, and I adjust the strength of this current so that the lamp, L¹, is barely visibly red hot. On interrupting suddenly this electric current, the lamp, L¹, flashes up for a moment. We recognize that we have here to consider an inertia effect familiar to us as the effect of the "self-induction" in the long coil of wire. Audiences in the room have been so carefully informed on many past occasions by brilliant and capable teachers, that I may spare you a reiteration of elementary facts concerning the self-induction or inductance of conducting circuits, and take it for granted that every one here is intimately acquainted with them, and that you will recall to your recollection that when an electromotive force acts upon any closed electric circuit generating in it an electric current, this self-induction exhibits itself by delaying or retarding the rise of the current strength to its full or its maximum value; and that, similarly, when the electromotive force is withdrawn, it operates to give the current a persistence or to retard the rate of reduction of the current strength. The convenient term "time-constant" of a circuit is employed to denote that time, expressed in fractions of a second or any other unit, which must elapse before a current rises to a certain definite fraction of its full value, when a steady electromotive force acts upon the circuit. I will next beg you to turn a moment's attention to the electro-dynamic actions or forces which are brought into play

FIG. 4.



when a circuit of any kind is subjected to electro-magnetic induction in a magnetic field.

Consider, for instance, a ring of copper hanging in front of the pole of an electro-magnet (Fig 4), having the plane of the ring perpendicular to the lines of magnetic force proceeding out from the pole.

* A paper recently read before the Society of Arts, London.

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Going down through the ice of Toronto Bay to saw off a propeller blade.

THE DIVER IN WINTER.—[See page 158.]

FIG. 11.

Air whirl produced near a spinning ball—air everywhere at rest except in so far as it is affected by the spinning ball.

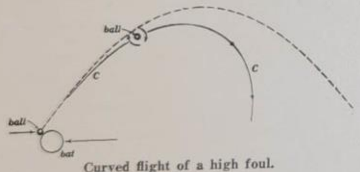
through gases: statistical physics. All correlations in this branch of physics must be sought for on the basis of statistical studies; the same thing never happens twice; and the old-fashioned idea of *cause and effect*, or the idea of *one-to-one correspondence*, or the idea of *law, in the sense of functional relationship* (as one may prefer to call it), gives place to chance and the laws of probability.

The older physics is sometimes called *macro-physics*, and the newer *micro-physics*, but this is distinctly misleading, because the largest-scale phenomena with which we deal in this world of ours belong to statistical physics—namely, weather phenomena. And the essential method in meteorology is the statistical method. Some little insight into atmospheric phenomena can be obtained by studying functional relationships, such as are expressed by Boyle's law of gases, the law of constant circulation in the vortex theory of fluid motion, the functional laws of radiation and absorption, and the functional relations of long-time and wide-space averages; but the thing which is now most needed in meteorology is the study and classification of storm types, the establishment of norms and probable departures therefrom, and, above all, the study of incipient stages of storm movements where very small variations may produce very large ultimate departures. If weather control is ever to be realized it must be by studying the possibilities of big consequences from small beginnings! Our Weather Bureau should employ, say, twenty of the most talented young men of highly-developed and rigorously-trained imaginative faculty, and set them to work studying storm data, averaging in time and space to discover norms, studying individual departures, and, above all, visualizing storm movements on a basis of the most minute study of details. No other method can ever lead to important results in meteorology.[2]

Consider a very smooth ball which is moving through still water without spinning. There is certainly no more

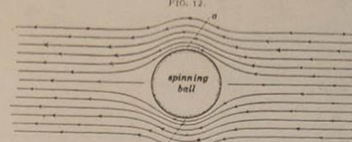
[2]See a very brief article by W. S. Franklin in *Science*, vol. xiv, pp. 496, 497, September 27, 1901.

FIG. 15.



Curved flight of a high foul.

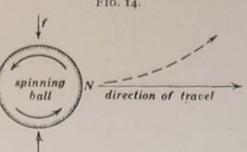
FIG. 12.



Air stream flowing past a ball which is not spinning.

reason why the ball should jump to the right than to the left. Therefore it must continue to move straight forward! That is good logic; but such a ball is no more subject to logic than is a sharp stick! The fact is that the ball does jump sidewise, and in a most irregular manner. This may be shown by dropping a smooth marble in a jar of still water. The marble goes nearly straight for several inches, and then suddenly jumps sidewise, as shown in Fig. 16. Similarly a smooth baseball jumps

FIG. 14.



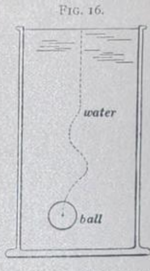
Unequal side forces "f" and "F" exerted on a spinning ball which is moving through the air.

sidewise irregularly as it moves through the air, if the ball is not spinning.

Fig. 17 shows how a rapidly moving stream of air splits when it flows past a ball, and the dividing lines, or *vortex sheets*, *aa* and *bb* between moving and still air are unstable. The result is that the stream of air *aa* (or *bb*) spurts upward and downward in irregular succession. When the stream *aa* spurts downward it produces an upward force or reaction on the ball, and *vice versa*. That is to say, the irregularities of the streams *aa* and *bb* cause a series of irregular side forces to be exerted on the ball.

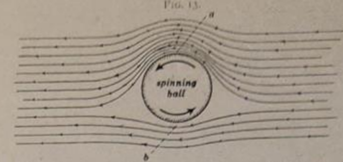
The dynamic effects associated with a ball standing in a stream of air as shown in Fig. 17 exist also when a

FIG. 16.



Irregular path of smooth ball (not spinning) as it sinks in water.

FIG. 13.



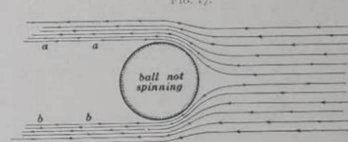
Air stream flowing past a spinning ball. The velocity is high at "a" and low at "b"; consequently the air pressure is high at "b" and low at "a," thus producing the unequal forces "F" and "f" in Fig. 14.

ball moves through still air. Therefore if a ball moves fast enough through still air to produce unstable vortex sheets, the irregular sidewise spurts of the air as it flows around behind the ball will cause the ball to travel in an irregular zigzag path.

The instability and consequent irregularity of a stream of rapidly-moving fluid is exemplified by the sensitive fluid. Every one knows how an ordinary gas flame suddenly becomes turbulent and produces a roaring sound when it is turned up too high (velocity of gas too great), and when a gas flame is on the verge of becoming turbulent the least disturbance is sometimes sufficient to throw the flame over into the turbulent form. A sensitive flame can easily be made by drawing out a glass tube to give a smooth nozzle about a millimeter in diameter, and burning a jet of ordinary illuminating gas at this nozzle. When properly adjusted, the flame responds to a hissing sound across a large room.

The hissing sound of a high-pressure steam jet is due primarily to an unstable condition of the jet near the nozzle, *an unstable condition which is somewhat similar to the instability of the vortex sheets aa and bb in Fig. 17*; and this instability leads to an excessively irregular and complicated whirling and eddying motion in the jet. Indeed, a jet of gas or steam is infinitely complicated! Everyone concedes the idea of infinity which is based on abstract numerals—one, two, three, four and so on *ad finitum*—and the idea of infinity which is based on the notion of a straight line; but most men are concerned with more or less persistent or steady phases of the material world, their perception does not penetrate into the substratum of utterly confused and erratic action which underlies every physical phenomenon, and they balk at the suggestion that the phenomena of fluid motion, for example, are infinitely complicated and erratic. Surely the abstract idea of infinity is nothing as compared with the dreadful intimation of infinity that comes from things that are seen and felt. We are immersed in an illimitable sea of phenomena every element of which is infinitely complex, and every minute detail is essentially erratic.

FIG. 17.



Showing how a rapid stream splits when it flows past a ball.

German Radiotelegraphic Stations in the Pacific

THE first German radiotelegraph station in the Pacific was opened in November, 1909, on Yap (or Uap) Island, in the Carolines, situated about 10 deg. N. and to the north of New Guinea. The station was built by the Telefunken Gesellschaft on behalf of the Deutsche Südsee Phosphat Gesellschaft, which has phosphate mines there, and about 500 kilometers west on Angaur, which belongs to the Palau Archipelago. Yap is connected with the cable system of the Deutsch-Niederländische Telegraphen-Gesellschaft (of Cologne) by three cables to Shanghai, in China, to Guam (in the Marianne Islands, belonging to the United States), and to Menado (on Celebes, Dutch East India). For this reason Yap was selected as a radiotelegraphic center, and further stations have now been erected at Rabaul (seat of the Governor of German New Guinea, who is also Governor of the large Bismarck Archipelago), at Nauru (in the Marshall Archipelago, which extends far to the north of the Equator, while Nauru itself is on the Equator), and at Apia, in Samoa (14 deg. south); a station on the already-mentioned Angaur Island had been built at the same time as that on Yap. The distances worked are considerable. Yap-Rabaul is 2,200 kilometers, Yap-Nauru 3,400 kilometers, Nauru-Samoa 2,700 kilometers, and New Guinea-Samoa 4,000 kilometers. The distance Yap-Tsingtau (in Shantung, also known under the name of Kiaochow; but Kiaochow itself is Chinese, while Tsingtau is German, and possesses a radiotelegraphy station and an observatory, and is joined to the Asiatic railway and telegraph system) is 3,650 kilometers, almost exactly as far as from Clifden, in the west of Ireland, to Glace Bay, in Newfoundland. The station at Apia is to be opened this Spring, the other stations are already working. The stations are equipped with 60 horse-power oil engines, and with umbrella antennæ 120 meters in height, to work with an energy of 25 kilowatts or 30 kilowatts, and with waves ranging from 300 meters up to 2,000 meters; the ordinary wave-length for signaling to ships is 600 meters. Smaller coastal stations for T antennæ and energy of 5 kilowatts are being added. The German Telegraph Department has not proceeded directly in this enterprise. A concession has been granted to the two companies already referred to, the Telefunken-Gesellschaft and Deutsch-Niederländische Telegraphen-Gesellschaft, which, for building and working these stations, have combined with the Deutsch Südsee-Gesellschaft für Drahtlose Telegraphie. The combination was effected in August, 1912, and the service is under the control of an Imperial commissioner. The co-operation of a cable company with a radiotelegraphy company will forestall rivalry between these two telegraph systems. We may supplement this note by a few statements on other radiotelegraphy stations in German colonies, almost all of which are now equipped. In German East Africa there is a coastal station at Dar-es-Salaam, and two stations are at Nuansa and Bukoba, on the Victoria Nyanza. Cameroon has a station at Duala; Togo, one at Toblekohve, near Lome (not yet open); and German Southwest Africa, stations at Swakopmund and Lüderitz Bay. Further stations are contemplated, and an agreement will probably be made with the Netherlands government as to the question of a station at Sumatra, in the East Indies, to serve as intermediate station between East Africa (Dar-es-Salaam) and the Pacific islands (Yap). The distance between East Africa and Sumatra would be 8,000 kilometers, while the farthest distance, so far covered experimentally at night-time, is Nauen-New York, 6,500 kilometers. Nauen and Togo, 5,500 kilometers, have communicated with one another at daytime.—*Engineering.*

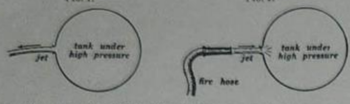
Some Phenomena of Fluid Motion*

The Curved Flight of a Baseball

By W. S. Franklin, Sc.D., Professor of Physics, Lehigh University, Member of the Institute

The steady curvature of path of a rapidly spinning baseball in flight is explained on the basis of a principle which was first enunciated by Daniel Bernoulli several hundred years ago. Bernoulli's principle is illustrated in Figs. 1 and 2. In a stream of water or air the pressure is high where the velocity is low, and the pressure is low where the velocity is high. In the following discussion it is not desired to take account of gravity, and therefore Bernoulli's principle is stated for the case of a horizontal stream. Also the effects of friction are ignored; as here stated, therefore, Bernoulli's principle applies only to approximately frictionless fluids, and indeed the principle applies only to cases of steady flow.[1]

Fig. 1. Fig. 2.

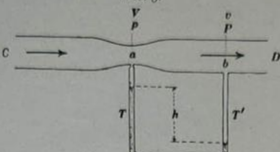


In the tank the water has high pressure and low velocity; in the jet the water has low pressure and high velocity.

A fancy method for pumping water into a steam boiler. In the jet the water has high velocity and low pressure.

Diagram showing Bernoulli's principle of pressure and velocity.

Fig. 3.



The Venturi tube.

The Venturi Tube.—Air is blown through a tube CD (Fig. 3). The velocity of the air is larger at a than at b, therefore, according to Bernoulli's principle, the pressure of the air is larger at b than at a. This excess of pressure at b is shown by the difference in level of the liquid in the two tubes T and T^1. If one blows hard enough through CD the liquid in T will be drawn up into the throat at a, where it will be broken up into spray.

The Disk Paradox.—A brass disk DD (Fig. 4) is soldered to the end of a tube T, and a light metal disk dd is held against DD by blowing strongly through T. The region between the two disks is a region of high velocity, and as the stream comes out at the edge of the disks its velocity falls and its pressure rises, according to Bernoulli's principle. Therefore the pressure of the air in the region between the two disks is less than the pressure of the outside air, and consequently the outside air pressure holds the two disks together.

Fig. 4. Fig. 5.

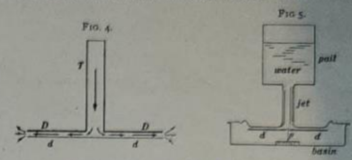


Diagram showing the disk paradox.

A complete hydraulic analogue of Fig. 4 is shown in Fig 5. A thin metal disk dd is kept from moving sidewise by a pin p which projects through a small hole in the disk, and the disk is held up by the jet of water. The jet spreads out over the disk as a thin layer of rapidly moving water, and when this flowing water reaches the edge of the disk it loses its velocity and raises itself to the higher level of the still water in the basin.

The Ball and Air Jet.—A small ball floats steadily in an air or steam jet, as shown in Fig. 6. The impact of the jet against the ball holds the ball up, and when the ball starts to fall out of the jet, as shown in Fig. 6, it is pushed back into the jet because the pressure of the surrounding still air is greater than the pressure of the rapidly moving air in the jet (Bernoulli's principle).

An ordinary file handle may be supported by an air jet, as shown in Fig. 7.

Attraction of Two Ships Steaming Along Side by Side.—As a ship steams along through a body of still water, the water at a given point moves as the ship approaches, and comes to rest again when the ship is past. That is, the motion of the water is not what is called steady motion, and, therefore, Bernoulli's principle does not apply. But the dynamic effects associated with a ship steaming through a body of still water are exactly the same as the dynamic effects associated with a steady stream of water flowing past a ship which is standing still, and in the latter case the fluid motion is steady and Bernoulli's principle does apply. Thus Fig. 8 represents a stream of water flowing past two ships. The velocity of the water is greatest between the two boats where the stream lines are most crowded. Indeed, the velocity of the water is greater between the boats than it is on the outer sides of the boats; therefore the level (pressure) of the water is greater on the outer sides than it is between the boats; and consequently the two ships are pushed toward each other by the high-level water on the outer sides.

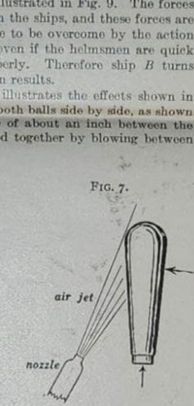
The most serious situation arising from the attraction of two moving ships is illustrated in Fig. 9. The forces FF in Fig. 9 tend to turn the ships, and these forces are apt to be much too large to be overcome by the action of either ship's rudder, even if the helmsmen are quick to set the rudders properly. Therefore ship B turns towards A and a collision results.

An experiment which illustrates the effects shown in Fig. 8 is to hang two smooth balls side by side, as shown in Fig. 10, with a space of about an inch between the balls; the balls are pulled together by blowing between them.

Fig. 6.

Ball and air jet.

Fig. 7.



Handle and air jet.

The Curved Flight of a Spinning Ball.—To analyze the effect of the air upon a moving ball, it is best to think of the ball as standing still with the air blowing past it, as shown in Fig. 12.

Fig. 11 shows the air whirl near a spinning ball; and Fig. 12 shows a blast of air streaming past a ball that is not spinning. Let us consider a combination of Figs. 11 and 12—that is, let us consider how a blast of air streams past a spinning ball. At a the stream and the whirl both give a velocity from right to left—that is, two causes are acting together at a to produce velocity from right to left. At b, on the other hand, the stream tends to produce a velocity from right to left, whereas the whirl tends to produce velocity from left to right—that is, two causes act in opposition to each other at b to produce velocity. Therefore the velocity at a is much greater than the velocity at b, as shown in Fig. 13. Therefore, according to Bernoulli's principle, the pressure of the air at b is greater than the pressure of the air at a, and consequently the spinning ball is pushed upward by the air stream or blast.

The dynamic effects in Fig. 13, where a blast of air blows from right to left past a spinning ball, are exactly the same as the dynamic effects in Fig. 14, where a spinning ball moves from left to right through a body of still air. That is to say, the spinning ball in Fig. 14 is pushed upward by the air, and therefore the ball travels in an upward curve, as indicated by the dotted curved arrow.

Let us call the foremost point N of the traveling ball the *nose* of the ball. *The traveling ball curves in the direction in which the nose of the ball is moving because of the spin.* Thus, if the nose of the ball moves toward the right with respect to a pitcher, the ball will curve to the right; if the nose of the ball moves upward (as shown in Fig. 14), the ball will curve upward, and so on.

Perhaps the best way to throw a curved ball for purposes of demonstration is to use a light ball of cork or pith, and throw it from a pasteboard tube, moving the tube somewhat as one would move a bat. The inside walls of the tube should be rough so that the ball will roll along the inside of the tube, and come out of the end of the tube with a rapid spinning motion.

Fig. 15 shows the curved flight of a high foul. The ball is set spinning rapidly as it glances off the bat, and instead of following the symmetrical dotted curve (which it would follow if it were not spinning) it actually follows the curve CC.

This curved flight of a high foul may be beautifully demonstrated by means of a light ping-pong ball or by means of an oak-gall. Throw the ball or oak-gall upward by the thumb as in shotting a marble, and as it falls it will curve in toward one's feet. This experiment must be performed in a closed room where there is no wind.

The Spit-Ball.—There is no reason why a sharp-pointed stick standing exactly vertical on a hard floor in a quiet room should fall one way more than another. Therefore the stick will not fall either way! That is good logic, but it is bad physics. The stick always does fall. The fact of the matter is that such a stick is unstable; and in the case of an ideally sharp stick standing perfectly vertical, an infinitesimal initial distrubance would be enough to start the fall in some direction, and then away she goes! We are here dealing with a kind of physical phenomenon in which the much-talked-of philosophical principle of cause and effect does not hold. When infinitesimal causes can determine finite differences in the ultimate trend of a phenomenon, then surely the principle of cause and effect is no more! Indeed, an infinitesimal cause is (in the limit) non-physical!

We here stand face to face with an entirely new branch of physical science, a branch which has existed for some years in the minds of some of our most advanced physicists, and a branch which is just beginning to be realized in researches concerning the discharge of electricity

*Reprinted from the Journal of the Franklin Institute.

[1]A further limitation of Bernoulli's principle is exemplified by the motion of the fluid in a cream separator. The pressure is greatest near the outer walls of the rotating bowl where the velocity is greatest. Bernoulli's principle does not apply to rotational fluid motion.

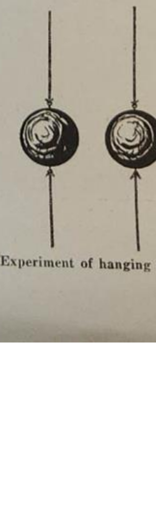
Fig. 8.

A stream of water flowing past two ships.

Fig. 9.

Attraction of two moving ships.

Fig. 10.



Experiment of hanging balls.

Interior of a grotto of the ming-ui or "thousand houses" (seventh century).

Terra-cotta bas-relief of Touen-houang (ninth century).

Buddha on his throne in grotto of Touen-houang. Side statues recently renewed.

Buddhist Art in Eastern Turkestan

The Pelliot Archæological Expedition

By the Paris Correspondent of the Scientific American

Orientalists consider that the recent finds which have been made in the sands of Turkestan, consisting of numerous vestiges of a civilization antedating the conquest of this country by Islam, form one of the leading epochs in this branch of archæology. The specimens belong to the period lying mainly between the seventh and the ninth century of our era, the conquest having taken place about the year 1000. This part of Asia was the center for the spread of Buddhism into China, and at the beginning of our era, the Hindoo religion started from the upper Indus and by way of the Pamirs and Karakorum it reached the limits of the Celestial Empire. Following this, there was a corresponding spread of the forms of art which existed in northwest India, this being a Hellenistic art of which numerous specimens are now extant. We illustrated this form, which is characterized by the influence of Greek upon Hindoo art, in a preceding article, and typical works of the kind have been found at Gandhara.

In the specimens which the French expedition found in Turkestan, and which are the subject of the present description, it is noticed that the style is closely related to the above-mentioned Græco-Buddhist art. As M. Foucher states, the originality and interest of these specimens consist in an intimate union of the antique and the Oriental spirit, in the fusion as it were of the Buddhic legend in Occidental molds. Thus we see the combination of a classic form and a Buddhist foundation idea, or the adaptation of Greek or Hellenistic technique to strictly Hindoo subjects. As we examine these remains, we observe that as to execution and handling, the ideas taken from India bear but a small proportion, but if the *motifs* are not strictly native they are not, on the other hand, purely Greek. It might be said that they occupy a position midway between Mediterranean classicism and Hindoo inspiration, and these two tendencies are about equal.

Owing to the attention which archæologists have been giving to this subject for the last twenty years, as well as the numerous excavations which are made, it is possible to trace the transmission path of Mediterranean art into the extreme regions of Asia by way of Assyria, Persia, Bactriana, Gandhara, eastern Turkestan and northern China. In 1889 Capt. Bower, an Englishman, purchased at Kutchar a manuscript which was recognized as a medical text in Sanskrit, of Buddhic origin, and this appears to be the first specimen showing Hindoo influence in Turkestan brought to the knowledge of European archæologists. As the greater part of the Buddhist manuscripts had disappeared from India proper, the discovery of the Bower manuscript led to the hope that the originals would be found in the sands of Turkestan. The Russian consul and the English agent at Kachgar thereupon lent themselves to the task of collecting all the manuscripts and objects which treasure-seekers had found in the sands, and they sent these to St. Petersburg and Calcutta. In 1897, the Academy of Sciences, of St. Petersburg, sent Dr. Klementz into the Tourfan region, and following this a German expedition set out under the direction of Dr. Grünwedel. On the other hand, the well-known Swedish explorer, Sven Hedin, had discovered a certain number of "dead cities" in the southern part of the desert. In 1900, the government of India sent an expedition to the Khotan region under Dr. Stein, and it brought back numerous Hindoo and Thibetan manuscripts as well as works of art of an Iranian and Græco-Buddhist character.

Bas-relief of Toumchoug (eighth century), showing some destruction in parts.

Nirvana of Buddha (ninth century); statues of deciples, recently renewed.

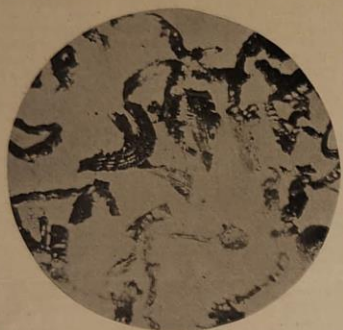
These important discoveries awakened the interest of Orientalists over the entire world, and as the result of the movement, the Hamburg Congress founded, in 1902, an international association for historical, archæologic, lingnistic and ethnographic exploration of central Asia and the extreme Orient. France was among the last countries to enter actively into the work, but finally a scientific expedition was sent out in 1905 under M. Paul Pelliot, a leading archæologist and professor of Chinese language and literature at the French School of Extreme Orient, at Paris. The object of the expedition was mainly to carry on researches concerning vestiges of pre-Islamic Buddhism, but measures were taken to make other scientific observations as well, such as natural history, astronomy and cartography, and in this he was aided by Dr. Louis Vaillant for observational research, and also by M. Ch. Nouette for the photographic work, to whom we are indebted for the originals of the accompanying illustrations.

The first important archæological labor of the expedition was carried on at Tumchong between Kachgar and Kutchar, where Sven Hedin had observed some ruins, and these proved to be the remains of a Buddhist monas-

Altar of Buddha in Touen-houang, about the year 700.

Statue in a grotto of Touen-houang (ninth century).

Fresco of a grotto in Touen-houang (seventh century). Monk added (ninth century).



Microphotograph of Chips Made by Wheel Cutting Properly.

Grinding Wheel Sparks*

How They Indicate the Character of Steel

By R. G. Williams†

Microphotograph of Particles Showing Effect of Heat.

When certain kinds of metal, namely, iron and steels, are pressed against a rapidly revolving grinding wheel, sparks are produced. Sparks are pieces of metal which are torn away from the mass being ground, and during this tearing process are heated to such a high temperature that they become molten. In this highly heated condition they give out light, the amount of light produced being proportional to the temperature to which the metal is heated.

It is one of the natural laws of physics that when a liquid drops, or is thrown through the air, it takes a spherical form. Ordinary rain drops are an illustration of this fact. Consequently, we would expect the solidified sparks to be in the form of little solid globules. In a general way this is true, but not exactly. When these sparks first cool they do take on the form of globules, but as they get colder, the outside and solid shell contracts on the liquid interior until a point is reached where the pressure of the liquid interior is great enough to rupture the outside shell, and the phenomena, which we refer to as spurting or forking, then takes place. All that is left is part of a hollow spherical shell.

As far back as 1804, a Frenchman made some spark experiments with an old-fashioned grindstone, but it was probably not until the introduction of high speed steel that grinding wheel sparks became of interest to the ordinary shop-man. It was noticed that high speed steel did not spurt in the same manner as ordinary carbon steel, and this led to the question of what it was that produced different kinds of sparks. It is common knowledge that the air contains oxygen, and it is the combination at high temperatures of oxygen in the air and the constituents of the metal being ground that produces spark characteristics peculiar to different metals. Carbon is the most influential constituent, the volume and brightness of sparks being roughly proportional to the amount of carbon present in the steel. In other words, a high carbon steel gives a large volume of sparks; a medium carbon steel gives a moderate volume; and a very low carbon steel, or wrought iron, gives a still smaller volume. High speed, or self-hardening steel, as it is sometimes called, is in a class by itself, and the characteristics peculiar to this class of steels will be taken up later in this article.

Chips is the name used for these sparks when they have become solidified, and by an examination of these chips through a magnifying glass it is possible to tell whether or not the wheel was cutting properly. A good many kinds of material, notably high carbon steel tools, require a very cool cutting wheel; that is, one which will generate very little heat during the grinding operation. This is necessary, for, if the wheel generated considerable heat, there would be great danger of drawing the temper of the tool and its usefulness being destroyed. If upon examining chips through a magnifying glass, we see a predominance of curls over globules, we say that the wheel is cutting properly and generating a very small amount of heat, but if the sample of chips shows a predominance of globules over curls, we then know that the wheel is generating more heat than it should.

Whether or not a wheel is cutting properly can also be judged by the volume of sparks produced during the grinding operation. If two wheels are working on the same kind of steel, and one wheel is only producing a small volume of sparks, while the other wheel is producing a large volume, it is an indication that the first wheel is not cutting satisfactorily. The most common cause of a wheel not cutting satisfactorily is being in a state which those initiated into grinding wheel language know as glazed. When the minute cutting particles of a wheel, which should stick out far enough to penetrate the material being held against the wheel, have worn down flat, have lost their sharpness, and no longer penetrate as they should, the wheel is then in a glazed condition.

It has been shown that sparks will be produced from a cylindrical piece of work when the depth of cut is only five-millionths of an inch. This will give you a good idea of why the volume of sparks is a correct indication of how the wheel is cutting. For instance, if owing to improper supply of cooling liquid, or for some other reason, a shaft being ground is expanding just a little more on one side than the other, which would cause the shaft to be out of round when finished, the volume of sparks produced will be greater from the side which is expanding than from the other side.

The cut shown is a reproduction of a chart used in Purdue University by John F. Keller, instructor in forging, to bring to the pupils' attention the spark characteristics of different iron and steels, as a means of roughly determining what kind of iron or steel they are working with. While not strictly accurate, in that the sparks shown are free-hand drawings, nevertheless, it is both interesting and instructive.

Fig. 1 gives an idea of the characteristics of sparks from wrought iron. Wrought iron is free from carbon and the sparks follow straight lines which become broader and more luminous until they reach their maximum size, then gradually diminish until they grow dark. Wrought iron is easily distinguished from iron which contains carbon, that is, steel, in that there are practically no sparks which spurt or fork. The sparks from wrought iron present an analogy to meteors, or shooting stars. Meteors are masses of iron practically free from carbon which have been traveling about in space and come in contact with the air which surrounds the earth. They are traveling at an enormous rate of speed and sufficient friction is set up between the meteor and the air to heat the meteor to a temperature where the iron it contains combines with the oxygen in the air. In other words, the iron burns and this burning produces light.

Fig. 2 shows the sparks from mild steel. This contains a low percentage of carbon which is evidenced by the appearance of a few sparks which spurt, otherwise the sparks are similar to those from wrought iron.

Fig. 3 represents the sparks from tool steel, and it will be noticed that the number of sparks which spurt are greater than from mild steel. Also, the number of sparks characteristic of wrought iron have diminished. The color of the sparks has also changed from a light straw to nearly white.

Fig. 4 gives an idea of the sparks from high carbon steel. The characteristic iron spark is no longer present and practically all the sparks spurt, a great many respurting a number of times. It will be noticed that the distance the sparks travel away from the grinding wheel has also diminished. In high carbon steels, the iron and carbon are in such form that they most readily combine with the oxygen in the air.

Fig. 5 represents high speed steel sparks. Although high speed steels contain a fairly high percentage of

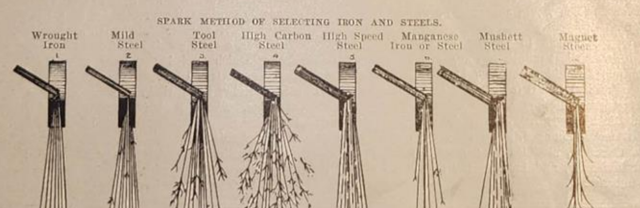


Chart Prepared by John F. Keller to Show Spark Characteristics.

* Reproduced from *Grits and Grinds*.

† The writer acknowledges his indebtedness to Mr. John F. Keller, instructor in forging and heat treatment of metals, Purdue University, for the inspiration that led to the selection of this subject, for the spark diagram shown herewith and for much of the text used in describing the diagram.

said, let there be lights in the firmament of heaven to divide the day from the night, and let them be for signs and for seasons, and for days and years. . . . And God made two great lights; the greater light to rule the day, and the lesser light to rule the night. He made the stars also."

Where new moons were sacred, it became a matter of much importance to note the time of their appearance. A dweller in ancient Israel learned the time from signal fires upon the hills, or from runners who carried the news out from the large cities over the surrounding country. If there was any doubt of the day on which the thin crescent of the new moon appeared, it was necessary to keep two days, that the right one should be observed at all hazards.

A new moon was never to be observed on a Sunday, a Wednesday, or a Friday. If a dweller in Zebulon, for instance, went out at night and saw the signal-fire burning on Tabor's summit, he immediately proceeded to keep the feast of the new moon. If, however, the day was the first, the third, or the fifth, he kept the following day. If a runner came to his house, and told him that the silver crescent had been seen after noon and before sunset, the following day, which began at sunset, was the "new-moon" day, unless it was one of those on which a new moon was not to be observed, in which case the day following it was kept.

The embolismic month of the Jewish year is intercalated before the month Adhar, the last month of the sacred year, the month immediately before Nisan. The Jewish common year had three forms.

1. The ordinary or regular common year of 354 days.
2. The imperfect or defective common year in which the third month, Kislev, had only 29 instead of 30 days, and the year had 353 days.
3. The perfect or abundant common year of 355 days, in which the second month, Marheshwan, had 30 instead of the usual 29 days. Similarly, there were three embolismic years corresponding to these, and consisting of 384, 383, and 385 days, respectively.

The Jewish calendar, like all religious institutions with features peculiar to themselves, is assured of perpetuity as long as the religious system endures which gave it its origin. When all separating walls are broken down, when the races and their institutions are all thrown into the melting-pot, and the pure gold of humanity issues refined and unified into one homogeneous expression of life and its highest uses, who can tell *whether there will be more of the Jewish or of the* Gentile institutions in the new regime?

The ancient Arabian calendar was purely lunar. Its year consisted of 12 lunar months, with no intercalation to keep them in constant seasonal relation. Their year retrogressed through the four seasons in about 32½ years. Arabian or Mohammedan years are arranged in cycles of thirty, nineteen of which are common years of 354 days each, and eleven are intercalary years with an additional day appended to the last month. This brings the average duration of the Mohammedan month to within 2.8 seconds of an astronomical mean lunation, an error which would amount to a day in about 2,400 years.

The pilgrimage to the Kaaba took place in early times in the last month of the year. Necessarily, this pilgrimage would take place 11 days earlier at every recurrence. When it fell so early as to come before the harvest, the pilgrims had difficulty in getting enough food for their journey. The date of the pilgrimage could not be changed, being too sacred. The calendar was, therefore, modified by a process which made the year luni-solar, and brought the pilgrimage always in the autumn.

Four of the Mohammedan months were sacred. They were the first, second, seventh, and twelfth. Three of the sacred months being consecutive, the fiery-hearted Arabs could do no fighting for the whole period of three months, till Mohammed came to the rescue and interpreted this restriction as meaning that they could only fight with Mussulmans in these months. He then led an expedition against the heathen himself, and the situation was no longer intolerable.

China, like nearly all the Eastern nations, has a lunar calendar. The months are alternately 29 and 30 days in duration, and begin when the moon is between the sun and the earth. The year begins and ends when these three bodies are in the same relation. The Chinese add a thirteenth month to the year after every thirty lunations. Such a plan does not keep the year in consonance with the seasons, therefore instructions have to be issued relating to planting, reaping, fishing, and hunting. This accounts for the great bulk of the Chinese almanac, which is said to have the largest circulation of any book in the world.

The almanac for the year which closed February 9th, 1910, shows that year to have had 13 months; a first month, a second month, an intercalary second month, then a third, fourth, fifth, etc., to the last, which is considered as a twelfth, but is in reality a thirteenth month. As the intercalary second month of that year contained only 29 days, the whole year contained 383 days. The common twelve-month year contains necessarily 354 days.

In ancient times, the Chinese years were named after certain animals. Even the hours were so named. A Chinaman will sometimes even yet tell you he was born in the dragon year or in the dog year. Clocks are still running which strike the hour of the rat or the horse. Expressions such as "before horse," or "after horse," meaning before or after noon, were in use. Noon was "full horse" in the old days.

The Chinese have devised a most ingenious clock, which is so explicit that the observer may see, for instance, on its dial that he is looking at a Chinese clock in the first hour of the first day of the first month, which consists of 29 days, of the 48th year of the 76th cycle of 60 years, which is also the 2462nd year of Confucius, the third year of the Emperor Hsaun Tung, the 4548th year by the sexagenary system, the 4608th from the time when Hwang Ti ascended the throne, and which corresponds most nearly with our year 1911.

The Chinese hour has 120 minutes, the noon hour being the period between 11 A. M. and 1 P. M. of our time. This is the horse hour of the ancient calendar. The time from 11 P. M. to 1 A. M. is the rat hour. Half of these hours was A. M., and the other half was P. M.

A notable contribution to the calendar was made when the Athenian astronomer, Meton, observed that 235 lunations correspond in duration almost to an hour with the period of 19 solar years. In fact, there is only 1.5 hours of difference between 235 lunations and 19 Julian years. It may help us to understand how some of the ancients arrived so near to final truth respecting heavenly motions, if we remember that, long before the time of Meton, some Babylonian sage had discovered the *Saros*, a cycle consisting of 6,585 days and 8 hours, during which period there are 223 lunations. The period consists of 18 Julian years, 10 days, and 18 hours. At the end of this period all eclipses are repeated nearly as before. The computation of eclipses and all recurrent luni-solar phenomena was much simplified by the discovery of this cycle.

The practice of intercalation is common to all calendars and is necessary in order to make the year solar and seasonal. The Aryans have always been more disposed to favor the solar, the Semites the lunar, division of time. The moon loses sway over intelligent people, while the uninstructed still tend to regulate their times and seasons under the guidance of the lunar phases. The Hebrews are immensely clever, but the progress of a race is sometimes inhibited by its traditionalism.

A few words as to our own calendar. Our day names were derived from the Scandinavians. The week came to us from the Jews, the month and the year from the Romans. No institution was ever more subject to whim and caprice than the Roman calendar. The ten months of Romulus became twelve under Numa, who added January and February. The year was now one of 354 days, having 12 months of 29 and 30 days alternately. Then a day was added to make the number odd because odd numbers were accounted more propitious. A month of 22 and 23 days alternately was intercalated between the 23rd and 24th of February in every second year. The average number of days in the year was now 366½. Later the intercalary month was omitted in every 24th year. This transaction made the year average almost solar.

After this, the priests seem to have had power to increase or diminish the days of any year at will under any plausible pretext. Their plan was to postpone an event or hasten it without changing its date. They intercalated days at will. No one knew just when a year would begin or end. This continued till Julius Cæsar found the year A.U.C. 707 so disordered that it was necessary to add two months, though it was already a year of thirteen months. He thus made it a year of fifteen months, being 455 days.

The average year was now fixed at 365¼ days by giving the odd months 31 days, and the even ones 30 days. The exceptions to this rule were the common years when February had only 29 days. Even now the priests seemed not to have enough intelligence to carry out Cæsar's orders, and their mistakes had to be corrected in the next reign. But Augustus, wishing to be accounted a patron of science, imitated Julius Cæsar by having August named in his honor, as July had been named after his predecessor. But August had only 30 days, and July had 31. Why should the month of Augustus be briefer than the month of Julius? This was an indignity not to be suffered, so another day was taken from the already long-suffering February and added to August. Then, that there should not be three 31-day months in one quarter, one day of September was pushed on into October, and the 31st day of November was pushed on into December, and, lo! we had our calendar. It has always been called the Julian calendar, but if the great Cæsar had known what anomalies his successor had introduced, he would have disowned it, and the least the world should have done was to have restored the Julian calendar to the state in which Julius Cæsar intended it to remain. This should be done now, and without the least delay. The Julian calendar is clumsy enough with all the improvements of the Gregorian reforms, without the silly meddlings which have made it a curio for all time.

The Gregorian amendments to the calendar are described in a thousand books, almanacs, and cyclopædias, and though a worthy and helpful reform, need not be explained here. Just this observation, however, may be made. We speak of the Julian and Gregorian calendars. Cæsar and Gregory were the instruments by which these were adopted, and are to be commended. Perhaps it is well to remember, however, that the astronomer Sosigenes was the author of the Julian calendar, and that the Italian physician, Aloysius Lilius, devised the Gregorian reform, but died before its introduction.

The Cost of Success

The time-worn aphorism of the candle lighted at both ends lasting only half its natural span, has never applied more accurately or more intensely to the average American city man than it does to-day. The higher cost of living, the desire for social recognition, and the luring attractions of the city are all contributing causes of an inexorable desire for success, that, hydra-headed though it may be in the multiplicity of its forms, still means, when reduced to its ultimate factor, only a firmer grip on the elusive god Mammon.

The indomitable driving force of American enterprise has, it is true, made itself felt in all parts of the civilized world. That fact in itself has, consciously or unconsciously to us, plastered an immense amount of comfort on our collective vanity. For American success does stand out unique and gigantic when viewed *in toto*, and without further analysis. But sooner or later we shall see that we are paying the price with a vengeance and that the law of compensation is asserting itself, surreptitiously but none the less surely. Thoughtful men are daily becoming more and more aware of the fact that the hundreds of thousands of Americans, we might say the millions, who make possible the abstract fact of our success, are individually traveling at a terrific pace to give us this so called supremacy. The intensity of their efforts may wear them out, but new recruits are ever ready to fill up the gap and keep the mighty ball rolling.

When we are constantly geared up to a high speed, physiological laws raise a warning that read aright means, "Thus far shalt thou go and no farther." The very pleasures and recreations of the city man are unphysiological and exaggerated. Late hours with loss of sleep, dining at a time when repose is indicated, and violations of hygienic and dietetic laws in the matter of proper exercise and regular nourishment are all diminishing a vitality that can only be fleeting under such abnormal stress and strain.

Of what value is success if we spend ourselves untimely in its attainment? It is not hard to see that the unnatural demands of business and pleasure in our life are causing an ever increasing drain on the physical resources of the city individual. The mad scramble for success with its accompanying ability to indulge in dubious pleasures, would be ludicrous were it not tragic.

It is a terrible fact that cardiac diseases, cancer, and arteriosclerosis are eating more and more into the vitals of a nation that should be robust and virile. Insanity has increased enormously in the last half century. Sudden deaths are so common-place that they pass unnoticed. And if we were to dwell upon the subject in detail, it could be shown that the intensity and single purposeness of the average American in the gratification of his lust for success, as well as for the enjoyment of exaggerated pleasures, play no small part in the increase of disease, insanity, and shortened lives.

Preventive medicine has, it is true, diminished the mortality of infectious diseases; it has mostly done away with the dangers of scourges and plagues; it is making such rapid progress that miraculous discoveries soon appear commonplace in the light of new discoveries. But preventive medicine has a still greater sociological mission to perform. It must teach the lesson that a normal life, in which sufficient leisure and repose alternate with bustle and hard work, is far more to be desired than riches and exaggerated pleasures which are abnormal. Such a knowledge of how to live normally, once attained and wisely followed, would go the longest possible way in diminishing the labors of medicine.—*The New York Medical Journal.*

Alternate Forms for the Graphs.—The comparison of the work quantities so far plotted, *viz.*, drag, power and speed, sometimes can be made by suitably plotting functions of them. For example, to find what value of the speed, $V/V_0 = \sqrt{C_L \max/C_L}$, will require the least power, one may either note the minimum point on the graph of (13), or the minimum for (13_1), or the maximum for $C_L/(C_D + n\, C_L \max)$ *versus* $\sqrt{C_L/C_L \max}$. Again, to find what speed will require least thrust, one may either note the minimum point on the graph of (12), or the square of (12), or the maximum on the inverse curve which results from reciprocating the ordinates of (12), or the maximum on the doubly inverse curve, etc. The methods of plotting, being so manifold, can best be chosen to suit the work in hand. The present graphs directly correlate familiar quantities. But to compare the aerodynamic merits of different aerofoils it sometimes may be well to plot simpler expressions, or to compare suitable criteria which can be derived from the foregoing equations.

SUMMARY.

The main doctrines of this report may be summarized as follows:

Wing Forces and Moments.

1. The lift, drag and pitching moment of a wing of fixed size, shape and presentation, moving uniformly, are proportional to the density and square of the speed, no account of Reynold's number being taken.

2. The lift and drag increase as the square, the moment as the cube, of the linear dimensions of the wing.

3. For the more usual angles of attack α, the lift is a linear, the drag a quadratic function of α; hence the drag is a quadratic function of the lift.

4. The lift/drag is a cubic in α; the drag/lift is a hyperbola in α; hence the *drag versus* α is a hyperbola where the lift is constant.

5. The pitching moment is a linear function of the lift; and hence plots against the drag as a parabola.

6. The distance of the centre of wing pressure aft of the leading edge is approximately $l = M/L = cC_m/C_L$, c being the chord length; l plots against L as a hyperbola, against α as a hyperbola, and, with constant loading, plots against speed as a parabola.

Airplane Drag and Power.

7. The drag of an airplane consists of the "useful" or pressural wing drag, the wasteful wing drag which is mainly frictional, and the body drag. The two latter vary closely as the square of the speed; the first varies inversely as the square of the speed, if the wing load is constant. The drag-*versus*-speed graph is therefore a kind of quartic, composed of a parabola and an inverse parabola or kind of hyperbola.

8. The towline power of an airplane therefore consists of the useful part which varies inversely as the speed, and the wasteful part which increases roughly as the cube of the speed. The power-speed graph is compounded of a hyperbola and a cubical parabola.

9. Expressions are given for the minimum drag and towline power in terms of the speed of the airplane.

The Motion of a Sphere in a Rotating Liquid. G. I. Taylor. (*Proc. Royal Soc.*, A 715.)—There are great mathematical difficulties in the way of theoretical investigations of the motion of a sphere in a rotating liquid, but these can be overcome in the case when the sphere moves with uniform velocity along the axis of rotation of the liquid. The equations show that then there is around the sphere a sheath of liquid which does not rotate as the rest of the liquid does. This deduction from theory was confirmed by experiment. It was arranged that a cylinder of liquid was rotated about its axis. A ping-pong ball was supported by a thread passing up along the axis of the vertical cylinder. The ball took up the rotation of the liquid. Then a uniform vertical velocity was given to the ball by means of the thread. "It was found that the ball stopped rotating directly it started moving along the axis. As soon as the reel was released, so that the ball stopped moving along the axis, it quickly picked up the rotation of the rest of the system once more. To ensure success, it was found necessary also to make the ball move at a rate greater than about one diameter per revolution of the system. If the ball travelled more slowly than this it was found that it did not stop rotating and investigation of the stream-lines, with colored water, showed that a column of liquid of the same diameter as the sphere was apparently pushed along in front of the sphere.

"In the course of these experiments, it was noticed that if the sphere was stopped suddenly when half-way up the cylinder, and if there was some coloring matter present to show up the motion, a mass of liquid appeared to detach itself from the sphere, and to continue moving along the axis of rotation with the same velocity as that with which the sphere had been moving." G. F. S.

A Boat Which Sails into the Teeth of the Wind by Using the Wind Itself as Motive Power. CONSTANTIN, JOESSEL and DALOZ. (*Comptes Rendus,* Oct. 23, 1922.)—Sails will not suffice for this. The solution was found by using an air turbine geared to a screw in the water. The combination was mounted on a fishing boat. The air turbine, with two blades and devised for minimum weight, was 9 m. in diameter. The screw had four blades and was 1.05 m. in diameter. In both the inclination of the blades was variable. The setting of the turbine perpendicular to the wind was made by the steersman through an endless screw gearing. "The boat thus equipped showed itself very manageable. One man was enough to bring it from Sevres to Saint-Cloud in the midst of the active shipping of the Seine and in spite of the current of the river. It could be handled in just the same way as a boat with a thermal motor." The boat could progress in any direction to the wind.

The wind acting on the turbine located a considerable distance above the water produced a force tipping the boat over. This was counteracted by a deeper keel.

It might seem that the forward thrust of the screw could not be greater than the backward push of the wind on the turbine. With suitable dimensions of the turbine and screw and with a proper transmission with multiplication of the angular velocity of the former to the screw, the forward thrust may, however, be made the greater.

G. F. S.

The Electric Arc as Rectifier. STANISLAW BOROWIK. (*Physikal. Z.,* Sept. 15, 1922.)—In studying the alternating current arc it was found that an arc, one of whose electrodes was covered with iron oxide while the other was carbon, allows only that phase of the alternating current to pass for which the oxide is positive. This phenomenon regularly manifested itself for current strengths ranging from 2 to 30 amperes and for voltages from 100 to 1500. Somewhat similar results were obtained for the current from an induction coil.

It is interesting to note that this paper comes from a laboratory in Petrograd.

G. F. S.

Distribution of Methyl Anthranilate in Grapes.—Power and Chesnut showed some years ago the existence of this ester in many samples of grape-juice and devised methods for its detection. They have extended their researches in order to determine whether the ester occurs in all forms. Their results have just been published in *Jour. Agric. Res.* (1923, v. 23, 47). Although the cultivation of the vine and the utilization of its juice for the manufacture of an intoxicating beverage dates from the earliest period of which we have written history, the genus *Vitis* is more developed in the New than in the Old World. The Old World vine is *V. vinifera* L, and even at this day, this species, developed into many varieties, is exclusively cultivated. The most commonly cultivated American species is

V. labrusca L, a typical representative of which is the Concord grape. Another form much esteemed is *V. riparia Michx,* which is the original of the Clinton grape. In the South, *V. rotundifolia Michx,* best represented by the Scuppernong or Muscadine, and *V. æstivalis Michx,* represented by the Norton grape, are principally in use.

Authentic samples of grapes from many sources were tested, and it was found that when the plant was derived from *V. labrusca* or hybrids in which this predominated, methyl anthranilate was present, but the fruit of *V. vinifera* does not give evidence of it. It appears that this species does not thrive in the United States, east of the Rockies, but is very successfully cultivated in California. The great grape-growing industry of that region is said to depend upon the cultivation of the European species. The literature of grape-culture shows that about 6000 varieties have been described. Even in California, however, many of the vines are growing as grafts on American roots, and it is thought probably that in time all the vines will be thus grafted. A number of samples of commercial grape-juice were tested, most of which contained the ester.

H. L.

Oxidized Kerosenes as Fuel.—This problem has been undertaken at the laboratories of Carnegie Institute of Technology, Pittsburgh, in experiments to determine the relative efficiency of kerosenes and oxidized kerosenes as fuels. According to a report by Dr. J. H. James, Head of the Department conducting the experiments, oxidized kerosenes cause less "knocking" tendencies than the straight when used in a kerosene engine, but have approximately the same power development notwithstanding that the thermal value is one-eighth less. Doctor James attributes this efficiency to the better "clean up" in the combustion of them.

The experimental work at Carnegie gives promise that oxidized kerosene, which is manufactured by catalytic oxidation from low-grade petroleum, may become a useful fuel. H. L.

Studies of Vitamins.—At a recent meeting of the Royal Institution of Great Britain, Dr. Arthur Harden presented a summary of present knowledge on the question of vitamins. Experiments on these substances are difficult and tedious. It seems to be established that vitamins A and C are fairly resistant to moderate increase of temperature provided air is excluded, but deteriorate rapidly when exposed to oxidation. Vitamin B is less affected by heat and aeration. All three vitamins originate in the vegetable kingdom, and in view of this fact, it is interesting to recall the Biblical endorsement of the "green herb for meat" as given to the residents of Gan-Eden. In fats, the vitamin seems to reside entirely in the unsaponifiable portion, and as this usually consists largely of cholesterol, which has no value, it is evident that the amount of the really active substance is very minute. Vitamin A does not appear until the photosynthetic actions occur. Vitamin C is not in seeds, but appears when they

Causes for Variation in the Quality of Distilled-Water Ice*

By Peter Neff

It is apparent to all that there is a great variety in the quality of distilled-water ice, some plants produce a superior grade while others in the same locality do not. This may be due to a multitude of reasons. There are, however, several simple ones which to a greater or less degree affect the quality, and some of these will be considered.

If pure distilled water could be placed in the cans, the ice would be practically clear and of a uniform quality. This condition cannot be realized in practice and all that can be hoped for is to approximate the ideal condition as nearly as possible.

Air in the water is an ever present trouble. If it has not got into the water before, it will do so when the can is being filled. The amount will vary with different tank men, because intentionally or otherwise, one man will so place the can and filler that a minimum amount of water will seal the end of the filler. Where the storage tank is placed so high above the top of the ice tank that there is considerable pressure at the filler, the inrush of the water to the can when the filler is opened will cause a large amount of air to be taken up by the water. This can be avoided by choking the flow to the can-filler hose.

A frequent source of air introduction is produced by draining the storage tank so low that the outlet is exposed, or so nearly so as to cause a suction of the air. There are times when the packing about the stem of the can-filler valve is not tight. When the filler is not in use a small leak may be observed at this point, which usually disappears when the filler is put into service, for the water in passing this opening will cause air to be drawn in.

The most fruitful source of air is the flat cooler, and sometimes the filter as well, when located above the storage tank. In such an arrangement there is a tendency at all times to suck in air through small leaks about the valve stems and joints. By putting water pressure on this part of the apparatus, the leaks may be located. All parts of the distilling system from the reboiler or skimmer to the storage tank should at all times be full of water under pressure.

Where the condition noted prevails, a regulating valve controlled from the reboiler or skimmer should be placed at a point below the bottom of the storage tank. And the opening through this regulator should not be so great as to allow the water to flow through faster than supplied from the reboiler or skimmer, for if it does it will produce a suction on the apparatus between the regulator and the reboiler.

Care must always be exercised to see that the reboiler is not allowed to drain, for when it does enough air is introduced to ruin all the water in the storage tank and in some cases to cause parts of the apparatus to become air-bound. The surest method is to have the flat cooler and filter below the bottom of the storage tank, which will insure their being full of water at all times, but even then it is desirable to have the regulator below the storage tank.

A little care in these particulars, remembering that falling water will suck in air when passing a small opening, will reduce air troubles to a minimum.

Air in the water is manifested in the ice by a white core with radiating needles. But air is not the only cause of white ice. Other gases generated in the boiler from impurities contained in the water used, pass with the steam and are taken up by the water when condensation takes place. Some of these gases have a disagreeable odor, so often noticeable in manufactured ice. A proper venting of the steam condenser will help to get rid of these gases. In other words, allow a small amount of steam to escape from the condenser at all times.

The object of the reboiler is to further eliminate these gases as well as the air, and for that reason the reboiler does better work when the depth of the water is small in comparison with the area of the water surface, so that the gases have a freer exit. In spite of these precautions some gas will remain in the water, and for this reason it is customary to filter the water through charcoal, taking advantage of its peculiar property to retain or occlude them. The capacity of charcoal for this purpose is limited, especially when some oil is passing with the water, as the oil tends to fill up the small interstices in the charcoal. When care is not exercised to thoroughly eliminate these gases in the condenser and reboiler, it is but a short time before the charcoal filter is of no use, although to the eye the charcoal may appear all right.

Of all these gases the principal source is the foreign matter contained in the water used in the boiler. Some gas may come from the oil used, but the greater quantity comes from the water. As the process of concentration goes on in the boiler, more of these gases are driven off, and the higher the temperature of the steam, corresponding to a higher pressure, the more readily will the gases be formed. To obviate this trouble, the boilers should be blown down frequently, and the steam pressure carried no higher than is necessary for the work and supply only the requisite amount of distilled water.

There is another trouble causing white cores and sometimes a white or cloudy appearance of the outside of the cake of ice, with clear ice lying just under it. This trouble also comes from impurities in the water used in the boiler. More or less water is carried along with the steam, and if the boiler is priming the quantity may be considerable. When this raw water contains certain impurities, they crystallize at the same time as the ice crystals are formed, and produce the cloudy appearance referred to, which is easily distinguished from the white ice produced by air. Other impurities concentrate in the center of the ice cake and go to make up the white core. A separator on the main steam line will help eliminate this trouble, which is also lessened by the frequent blowing down of the boiler.

* Reproduced from *Power*.

Cellar Space Made Available by the Use of Prismatic Glass

By James Chittick

In many factory buildings, and other places where productive industry is carried on, there is frequently to be found substantial cellar space which is put to no other use than for storage purpose.

Wherever cellars are to be found, be they under private houses, shops, or other buildings, this is generally the case, and the reason they are not put to more profitable uses is the absence of light.

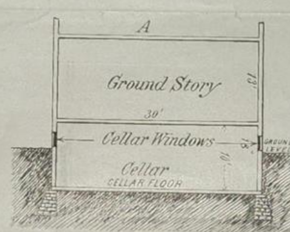


Fig. 1.—The original state of the building, with dark cellar space.

Fig. 2.—After alteration, with the cellar space made available for manufacturing operations.

Usually, the top of the cellar is two or three feet above the ground level, and in this limited space are placed small single windows at infrequent intervals, giving but little light at high noon, and, during most of the day, the place is half dark.

Many such cellars will have good head-room, say 8 to 12 feet, and have well-made floors, and, but for the absence of light, would be just as good manufacturing space as any other part of the mill. In fact, for textiles, the cellar space would be superior, on account of its damper atmosphere which facilitates the work.

It is no uncommon thing to find every other inch of habitable space jammed full, and yet spacious cellar room existing but largely unused.

There is a simple, and not very expensive method, that can in many cases be used to make this basement space fully available.

In the accompanying drawing, *A*, I have sketched part of a building, showing how the cellar was originally arranged, and in the drawing *B* I have shown what changes were actually made.

Along the side walls of the building are dug area-ways of convenient and suitable depths and widths. About 4 inches wide and 4 inches deep will often be found to answer very well.

The retaining wall may properly be made about 12 inches thick, with a good stone or cement coping on the top, reaching a trifle above the ground level.

The floor of the area-way may be laid with single brick, and, if there is a convenient sewer connection, it may be faced with cement and sloped toward the outlet to the sewer. If there is no sewer connection available, the bricks should be laid without mortar, so as to allow seepage between them to pass away rain water, and this will be helped if, here and there between them, holes are worked into the ground with a crowbar, so that the water can soak away faster through these holes. The level of this floor can be a few inches below the window sills, so as to prevent any chance of water entering the basement during heavy rainfall.

It is judicious to put braces across the area-way, at frequent intervals, to prevent the chance of the retaining walls caving in. A convenient form of bracing is to place iron plates on the two walls with lengths of 2-inch steam pipe between them. If these are made in two lengths, joined by a coupling, they can be readily tightened or lossened by turning the coupling.

Then the masons should break holes for windows in the cellar walls, at as frequent intervals as the structure of the building will permit, always taking care to keep on the safe side.

The size of these openings should be arranged to hold some regular stock size of window sash, say 5 to 6 feet high and proportionately wide, being the usual double sash with six panes in each half. Starting about 2 inches from the ceiling they might descend to 2 or 2½ inches from the floor. These sashes are bought unglazed, and, being stock goods, are quite cheap.

In the lights of glass to be used, that sort of prismatic glass that is rolled in large sheets should be procured. The makers of this will cut it to order, and they make them charge by the square foot and at a most reasonable price. Sufficient panes for the sashes are ordered, and are glazed in in the usual way. As the weight of this glass is greater than that of the common window glass, heavier sash weights should be provided.

The panes are cut so that the ribs run horizontally, and are glazed so that the smooth side is inside, and the prismatic face outside, the slope of the prisms being downward. In this position, also, they do not fill up with dust easily, and the rain helps to keep them clean.

A good sky-line is very desirable, that is, other buildings should preferably not be so close as to interfere materially with the light.

With an installation made as here outlined, it will be found that the glasses seize the rays of light and project them promptly across the room, making practically every inch of it available for all ordinary purposes and this also, to a great extent, even if it be only lighted from one side.

When lighted from both sides it may be advantageous to arrange that the new windows be not opposite each other, so as to avoid the conflicting of the beams of light.

This means of turning cellar storage space into good manufacturing space for textile work has been employed by the writer on several occasions, and always with the happiest results. If the rental value of the space thus made of use for manufacturing be compared with its value as storage room, it will be apparent that the sum of money spent in making the necessary changes has been made to yield a very handsome profit.

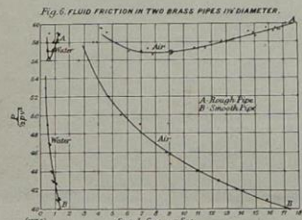
Hardening Steel with Compressed Air

A process whereby steel is hardened by means of compressed air is now in use by a German firm in cases where only certain parts of the metal require hardening. The customary methods of hardening by chilling the steel in water, oil, or special baths is not satisfactory in such cases, owing to the tension created between the hardened and unhardened portions of the treated metal. In the new procedure the compressed air is sprayed over the metal through specially designed nozzles, by means of which, by varying the number and spacing of the openings, the degree of hardening may be accurately graded. The claim is made that a wide range of results can be obtained by adapting the shape of the nozzle to that of the work.—*Journal of Industrial and Engineering Chemistry*.

conclusions.

A simple illustration will show the whole process of reasoning involved from the beginning of an experiment to the development of the law of similitude corresponding to it. Suppose, for in-

Fig. 6. FLUID FRICTION IN TWO BRASS PIPES 1" DIAMETER.



stance, that we have been making experiments on a simple pendulum, an' hat as a result we ·ve found that any alter 'n the length pro- very appreciable e on the time

If the materials are the same from one size to another, *w* is constant, and we see that the bigger the dirigible the bigger the stress, and that doubling the size of an air-ship without altering the drawings or material reduces its factor of safety to half.

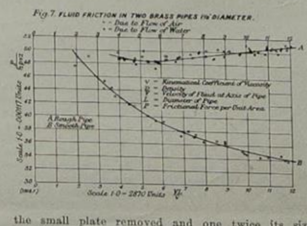
The application to similar aeroplanes which are to travel at the same speed is equally easy, and we find that increase of size does not produce difficulties due to increased stresses.

These rules are not new; engineers have acted on similar rules for a long time. Railway bridges of short span, in which the stresses are mainly due to the train, follow the aeroplane law. Long-span bridges, like the Forth Bridge, in which the stresses are mainly due to the weight of the bridge-girders, and only in a minor degree to the train, follow the dirigible law, and it is recognized that there is an upper limit to the size of cantilever bridges, just as there must be an upper limit to the size of dirigibles.

Interesting as these applications are, they are not so important as the application of the principles of similitude to the motion of fluids, because we have more complete theories available. Theories of hydrodynamics and aerodynamics are, however, very incomplete, and in naval ·ecture are ejected in favor of experiment 'els.

represented in Fig. 4. Instead of a continuous spiral streak, the eddies now come off in definite loops, and there is no resemblance between the new and the old flows. Now, further, imagine

Fig. 7. FLUID FRICTION IN TWO BRASS PIPES 1" DIAMETER.



the small plate removed and one twice its size substituted, and the experiment again repeated to find the velocity at which the flow changes. This has been done at the National Physics Laboratory, and it is shown that as nearly as it can be measured the change occurs in accordance with the friction

A New Process for Coating Surfaces With Metal*

By Means of a Spray of Finely Divided Metal the Most Delicate Objects Can be Coated

By Dr. Lach

THERE are several methods of coating surfaces with metal now in vogue, of which the so-called "galvanizing" of iron (tin plate) and the electroplating of various metals are the chief. But each of these methods has its disadvantages; the latter, for example, is necessarily slow, and cannot be applied to some metals, as for instance aluminium. A new process developed by M. U. Schoop, of Zürich, is not only capable of much wider application than the former methods, but possesses other notable advantages, of which not the least is its extreme simplicity. It consists essentially in spraying the finely divided metal by a powerful blast against the surface to be coated. This surface may consist of almost any material—metal, wood, concrete, celluloid or even paper.

The production of fine metal powders by means of a spray is in itself not new, but has been practised for some thirty years. Thus the apparatus shown in Fig. 2 is employed for the production of powdered lead for accumulators. This apparatus is constructed like an ordinary atomizer, superheated steam being used to produce the blast which draws up the molten lead from a kettle.

But the idea of preparing, not a loose powder, but a coherent coating of metal by such means, must be credited to the Swiss engineer, M. U. Schoop. The first apparatus by means of which this invention was carried out consisted either of a compressor or else of a compressed gas cylinder to furnish the requisite gas under pressure; this was then used much as in an atomizer to spray a stream of finely divided metal. At first a heated compressed gas was used, with the idea that such heated medium kept the drops of liquid molten, and that the molten drops coalesced on impinging against the surface presented to the spray. But it was soon discovered that the spray had a comparatively low temperature, so that it was quite possible to direct it not only against metal surfaces but against wood, paper and even celluloid without any danger of such material catching fire. Apparently then, the particles of metal were not molten at all on reaching the surface to be coated and the fact that they united to homogeneous layers upon the surface presented to the spray must be due to the effect of their impact and a high velocity (from 1,700 to 5,000 feet per second) against the surface presented to the spray. In fact, it was found that the pressure first employed—20 to 30 atmospheres—was altogether excessive, and at the present time a very much smaller pressure of only about 3 [illegible] 4 atmospheres is used. As a matter of fact it was found that the high pressure had the effect of causing the particles of metal to rebound from the surface to be coated, thus entailing an unnecessary and somewhat serious loss of material.

But the inventor did not [illegible] here. The idea occurred to him that it might be preferable to start with the powdered metal and spray this after the manner of a sand blast against the surface to be treated. This was found to be perfectly feasible, and [illegible] the apparatus was greatly simplified by eliminating the melting kettle. It was now possible to construct the apparatus on a comparatively small scale and to make it transportable.

But as yet perfection was far from being attained. The valves of the apparatus had to be very finely made and they were very apt to become stopped up by the metal dust. Besides, it was difficult to regulate the feed of metal and there was consequently considerable waste. It was impossible to work with the rare metals such as silver and gold in this way, as the weight was excessive, and the metals with high melting points could not readily be caused to coalesce in the process.

Moreover, while the apparatus was portable, it was still rather heavy and clumsy. All these disadvantages have now been completely overcome, the apparatus in its present form being no larger than a pistol.

In its latest form the apparatus depends neither upon the use of molten metal nor of metal powder, but makes use of a fine metal wire which is led through the apparatus and atomized. Fig. 1 shows one of the earlier forms of this device. At *a* is seen a spool from which a fine metal wire is unwound by means of a mechanism *b*, which feeds it to the atomizing nozzle *c*. The apparatus is actuated through a transmission gear *e* from an air turbine *d* which is driven through a reinforced flexible pipe *f* by means of compressed air at six to eight atmospheres, making about 15,000 revolutions per minute. The nozzle is provided with connections *h* and *h'* for oxygen and hydrogen, which issue at the nozzle, are there ignited and fuse the metal wire as it is fed through the nozzle. The compressed air after passing through the turbine and there doing its work, passes by a tube (to the nozzle from which it issues as a conical blast surrounding the oxy-hydrogen flame and carrying with it the metal molten by that flame. The working of the apparatus is accurately regulated in such manner that the turbine feeds the wire at just exactly the same rate as it is consumed, atomized and sprayed from the nozzle. This adjustment can be made very accurate, so that in this method of working there is practically no loss of material whatever, and moreover, metals of even the highest melting point such as gold and platinum can be used. In special cases, if the temperature of the oxy-hydrogen blowpipe should prove insufficient, resort may be had to the electric arc.

As the final result of evolution of the apparatus just described, there was finally produced a device, shown in Fig. 3, and no larger than an ordinary revolver, a device which moreover has been found most efficient in practice. It has done duty for eight hours at a stretch without giving any trouble.

In Fig. 3 the front wall is shown broken away, exposing the internal part of the device. Air under pressure passes through a thick tube, which also contains the channels for the oxygen and hydrogen admission, and actuates a turbine (at the right in the center) which rotates at very high velocity (up to 35,000 revolutions per minute). The motion is transmitted to a large disk on the left, and then to a smaller disk above. Between these two the wire passes, being firmly gripped by them and fed to the nozzle. The melting and atomization is effected just as described above.

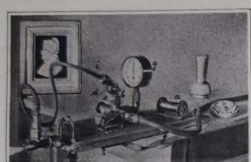


Fig. 1.—An earlier form of the apparatus devised by Mr. Schoop.

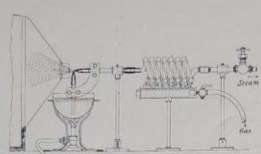


Fig. 2.—Diagram showing essential parts of metal atomizer.

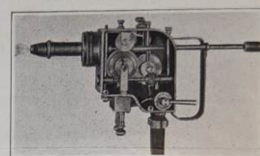


Fig. 3.—The metalizing pistol. The latest stage in the evolution of the Schoop process.

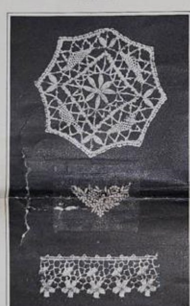


Fig. 4.—Metalized laces and fabric.

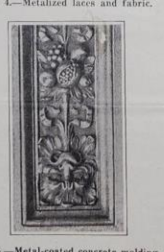


Fig. 5.—Metal-coated concrete molding.

Passing on now to a consideration of the field of application of the new process, we have to distinguish two classes of cases. On the one hand it may be desired to produce a permanent coating to remain attached to the surface on which it is originally projected. Secondly, it may be desired to temporarily coat an object and to then detach the coating thus formed and use it as a mold or cast.

Applications of the first kind are so numerous that one hardly knows where to begin their enumeration.

All containers employed in the industry, in mines, in chemical works, in breweries, etc., are either provided with a resistant coat of paint, or are lined with lead, copper, tin or other metal. In all these cases the atomizing process commends itself highly in place of all the methods hitherto employed. And no small advantage lies in the fact that it is possible by means of the little spray pistol, to gain access to every nook and corner, even where a brush does not readily and thoroughly penetrate.

Moreover, the thickness of the layer can easily be regulated by continuing for a greater or less length of time. In this way layers from 112,500 of an inch to half an inch can be produced, which moreover are extremely uniform and dense. The density of the coating may be adjusted by suitably selecting the gas employed in the atomizer. Thus in the case of lead, when steam was used, a specific gravity of 9.5 was attained, while by using hydrogen a lead coating with a density of 11 to 11.3 was obtained. The possibility of producing a comparatively loose layer will be of particular interest in the production of accumulator lead plates, which should be as porous as possible.

As a rule it will be desirable to produce thin coatings of metals. A particular case of this kind is the manufacture of electrical cooking and heating apparatus, in which it is desirable to produce very thin metallic deposits of a conductor, to act as a "resistance," upon a suitable substratum, such as porcelain or earthenware. Hitherto it has been customary for this purpose to coat the substratum with a layer of the resinates of the noble metals, which are subsequently reduced. It is obvious here that the use of Schoop's method will be a great gain. Again, in copper-plating carbon electrodes and in making all sorts of electrical connections, the metal spray process should prove invaluable. The joining of two metal surfaces, for instance, at the edges of a tank, can be effected by the Schoop process more satisfactorily than in any other manner. In fact a joint so produced is so intimate that it cannot be distinguished with the eye.

Again in coating iron surfaces to protect them against rust, especially in the case of structures presenting a complicated surface, the new process should prove invaluable, as it enables one to gain access to every nook and corner. A metal coating thus applied will give vastly better protection than the usual coat of paint, which has to be renewed at frequent intervals and corresponding expense.

As compared with electroplating the Schoop process possesses the great advantage that the somewhat delicate operation of "pickling" (cleaning) metal before coating becomes unnecessary. Every one conversant with the act of electroplating knows the difficulties which are apt to arise in this pickling operation. In applying Schoop's process a simple cleansing with wire brushes or by the sandblast suffices. But the most serious objection to electroplating is that the rate of deposition of the coating is strictly limited. In Schoop's process vastly greater speeds are readily attainable. Again aluminium, for example, cannot be coated at all by electroplating, while the Schoop process is applicable, of course, not only to all metals whatsoever, but also to the most varied and delicate materials, such as wood, paper, fabric and even lace.

An important application of metal-coated fabrics prepared by the Schoop process is their use for balloon envelopes, which can be rendered almost absolutely im- [illegible] The fact [illegible] make clothing for workmen in electrical installations from metalized fabric, as this would afford them considerable protection against shock by contact with live wires or leads. Metal-coated fabric has also been found to furnish an excellent screen for optical lantern projection, a screen which possesses all the advantage of the aluminium screen, while being much cheaper, and at the same time handier, since it can be rolled up when not in use.

As regards the possible application of the process to coating wood, the field appears practically unlimited. Aside from the production of purely decorative effects, we need only point to such examples as the coating of railway ties, telegraph posts, fence posts, etc., for protection against the weather, against the moisture of the ground, or against insects. Again, the wooden hulls of ships can be copper-coated with greater ease and perfection by Schoop's process than by the usual method of applying the metal in sheets. In packing goods air-tight for transport by land and sea the new process should prove invaluable. Bottles may be sealed, and in some cases (e. g., eggs) food materials themselves given a protective metal coating.

Some idea of the artistic effects attainable by the new process can be gained from the accompanying illustrations. Thus Fig. 4 shows two specimens of metalized lace, and a very fine example of silk "inlaid" by Schoop's process with a metal pattern.

The possibilities of metalized concrete are well brought out in Fig. 5, which shows an artistic design molded in concrete and coated with brass.

[illegible] are those applications in which a detachable coating is produced upon a surface, in order to prepare a mold for casting a copy of the original. In this case the surface is first prepared by giving it a fine coat of graphite, talcum, or fat, from which the metal coat afterward detaches itself readily.

Not only is this method of making casts applicable to all ordinary purposes, but dentists, for example, can by its aid prepare artificial palates by spraying a metal coating over the mold made in the usual manner from a plastic mass. A similar process can be employed for the preparation of artificial limbs. The variety of possible applications is in fact unlimited. Thus the well-known method of identifying criminals by their finger prints can be improved upon by making metal casts of the imprints by Schoop's process. Grammophon plates can also be copied with complete success by this method. This is probably as severe a test as could well be applied as regards the accuracy of the copy. Another important application is in the reproduction of half-tone blocks, which has hitherto been effected electrolytically. Not only is it possible to use any desired metal, such as iron for example, but as many as thirty copies have been prepared in the almost incredible short space of one hour.

And all the possibilities of the new process are far from being exhausted. The inventor is still working on its further development. Among these is its application to spraying glazings and enamels; the production of alloyed coatings by spraying on two or more metals from separate nozzles or from one nozzle (which may for instance be fed with a wire of several strands twisted together).

* Abridged translation prepared for the SCIENTIFIC AMERICAN SUPPLEMENT from *Prometheus*.

The Unsinkable Ship

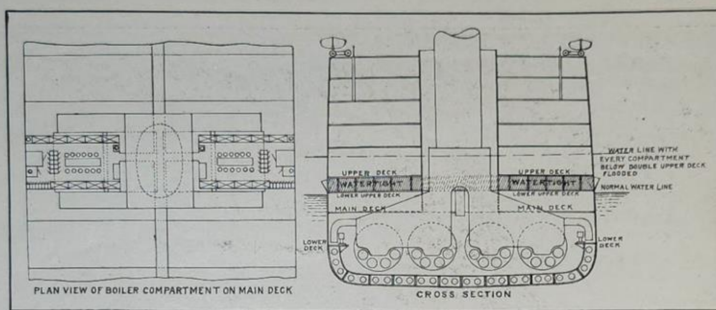
Notable Naval Architect's Design for a Ship That Will Not Sink

TAKING the "Great Eastern" as its text, the SCIENTIFIC AMERICAN at the time of the loss of the "Titanic" stated that it was entirely feasible to so build large passenger ships that they would not founder even under such severe a mishap as befell the "Titanic."

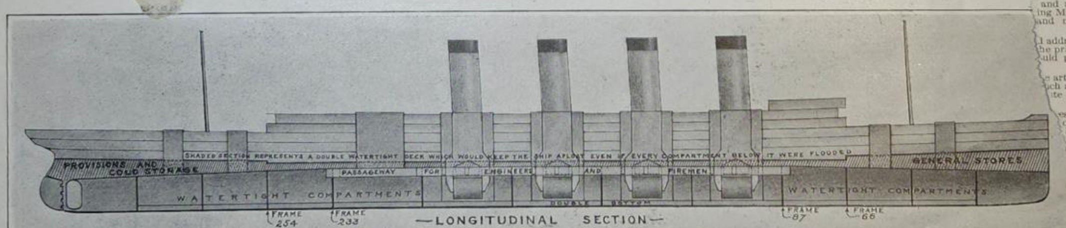
At the last meeting (December 11th and 12th) of the Society of Naval Architects and Marine Engineers, its vice-president, one of America's best known naval architects, gave a paper with plans entitled "On the possibility of building a large passenger liner that would not, under any of the known mishaps at sea, lose her buoyancy or stability and sink."

We present the plans and the following digest of his paper with the conviction that not only would it be unnecessary for such a ship to carry lifeboats; but both in construction and operation it would be an engineering and commercial success.

This paper seeks to point out a possible solution of the problem as applied to a certain type of vessel, viz., the large, modern, passenger liner. New and ever increasing laws concerning life-saving appliances have created a grave problem for the naval architect, both as to carrying heavy top weights and littering a large area of deck space with life boats and rafts. In brief, the suggestions embodied are the fitting of a double upper deck and so arranging the watertight subdivision below the lower member of this deck that the ship would prove both seaworthy and unsinkable under the most aggravated conditions of flooding. The advantages to be considered in this arrangement as opposed to the drawback of wasted space are as follows: The space between the two members of the upper deck would be utilized for cold storage rooms, air ducts, water and steam piping, stores, etc. The fire mains would at all times be under direct control. All horizontal piping and ducts through living spaces would be done away with. Communication to and from engine room, fire rooms, dynamo room, and ventilating and refrigerating rooms would be through a continuous watertight passage fitted with automatic watertight doors which would [illegible] from the influx of the sea.



Section and plan views of an unsinkable ship.



This ship is rendered safe against either sinking or capsizing by the provision of a double cellular watertight deck at the waterline. If the whole bottom of this ship were ripped open she would settle and ride upon this double deck as upon a second double bottom. Such a ship would be her own lifeboat.

General plan for an unsinkable ship.

In a ship so constructed and practically, at least, unsinkable, would it be necessary to carry the great number of lifeboats now deemed necessary which, with the great freeboards of our ocean liners, are utterly useless except in the event of a moderate sea and the speedy arrival of assistance?

The question of designing a ship that cannot be sunk by any of the known accidents which befall vessels at sea cannot be treated in a general way. The conditions are so varying in different types of vessels that the only way to handle the subject is to assume a certain type and work out the problem in its relation to the assumption, which is what I propose doing in this paper. I [illegible] taken a typical large passenger steamer of the [illegible] dimensions:

Len[illegible] perpendiculars .... 800 feet
[illegible] .... 90 feet
[illegible] loaded .... 33 feet

With a coefficient of 0.64 these dimensions would give a load displacement of 42,130 tons. There would be a complete double bottom, the inner shell being 4 feet from the outer skin, extending from the fore peak to the after peak and up the sides to the lower deck, which would be 15 feet above the base line. The main deck would be 9 feet above the lower deck and the upper deck 9 feet above the main deck amidships and would extend parallel to the base line from frame 87 to frame 233. From frame 87 to the stem, this deck would slope down, touching the stem at a height of 26 feet above base, and from frame 233 it would slope downward aft, touching the stern frame at a height of 27 feet. There would be twelve bulkheads extending from the inner bottom to the upper deck. These would be absolutely watertight, without any doors or openings whatever.

I think it will be admitted that this ship could be considered safe from any injury to the bottom below the lower deck and that danger of sinking would arise from rupture of the skin above the lower deck and under the water line, which is at the upper deck line. Such danger would arise from collision with another ship at such an angle as would cause penetration, or through striking some stationary mass between the lower and upper decks, opening up several compartments to the sea as in the case of the "Titanic."

Let us first consider penetration by collision. Here the damage would be vertical and might, if the striking vessel were large and nearly at right angles, penetrate quite a distance into the side of the vessel. I think, however, that such a disaster could not entail more than three adjacent compartments if near amidships, or say 219 feet 6 inches. What would be the condition with three adjacent compartments near the center of this vessel flooded? The capacity of one of these compartments would be 163,345 cubic feet, from which would have to be deducted the displacement of the boilers, less furnaces, tubes and combustion chambers, or 13,120 cubic feet. The coal capacity would also have to be deducted, for if half the coal were used the vessel would be 3,000 tons lighters, and if the coal were all on board it would displace so much water, and for this we must deduct 52,000 cubic feet and also 1,740 cubic feet for a central watertight passage under the upper deck. This leaves 98,225 cubic feet or 2,806 tons for each of the three compartments that we consider may be possibly injured through collision, or 8,418 tons to be carried by new displacement. In order to provide the displacement for the condition described above, I would propose to fit what I would term a double upper deck, the upper member of which would be 5 feet 6 inches above the lower amidships and parallel to the base line between frames 66 and 254, at which frames it would rise 2 feet and follow the sheer line to the stem and stern. In case of a collision cutting into the upper member of the upper deck the local damage would be confined practically to the depth of penetration and the width of the striking ship, as the space between these decks would be divided into very small compartments both transeversely and longitudinally. As it is, we have between these upper decks 9,730 tons of displacement which, in case of three compartments being opened to the sea, would leave the upper member still materially above the water line. If the injury was near the forward end of the ship, the lower member of the upper deck extending downward reduces the size of the flooded compartments and the displacement of the contents of the holds, at least 50 per cent would still further have to be deducted, while the upper member rising at frame 266 and following the sheer line would provide sufficient displacement to trim ship till water could be introduced into the double bottom aft. These same conditions would apply in case of serious injury aft. It will be understood, of course, that all openings through the upper deck, such as boiler and engine casings and hold hatches, would be watertight structures for at least 16 feet above the load water line.

We come now to another form of disaster, the ripping open of the side of a ship for a considerable proportion of her length by striking the projecting edge of some obstruction under the water line. In the case under consideration this might happen between the lower and the upper deck for a great portion of the vessel's length. The five large compartments would add 14[illegible] to the displacement, while the forward holds, [illegible] that the cargo occupied one half the space, w[illegible] 3,800 tons more, and the after compartments, if they had to be flooded to trim ship, would add 3,400 tons, a total of 21,000 tons. This would sink the vessel 11.86 feet, or 6.36 feet above the upper member of the upper deck amidships, and she would then draw 43.86 feet. This assumption is to the very limit of the possibilities, yet, for an unsinkable ship, it should be provided against in the design. Between the upper member of the upper deck and the shelter deck there should be no air pores or side lights or if lights are fitted they should not be arranged to open and the glass should be cast around a wire mesh as a protection against cracking.

The objection that would naturally present itself to this type of vessel is the apparent waste of space between the upper decks. T[illegible]wever, need not be wasted. Forward of [illegible] feet

(Conclud[illegible]

Volendam on the shores of the Zuider Zee.

City fathers of the Isle of Marken.

Fishing fleet in the harbor of Volendam.

supply of fresh water always at hand there can be no harm in letting the water run to a very low level in spring. At present this is hardly possible because summer droughts may cause a scarcity of water. The Ysselmeer will raise the value of hundreds of thousands of acres of grasslands in the surrounding districts by rendering the draining more perfect, preventing want of water and improving the dairy produce. The rise in value will probably amount to from $2 to $4 rent per hectare (2.47 acres). The inclosing will further improve the drainage of some districts because the water level of the Ysselmeer will be less variable, and on an average lower than the Zuider Zee level. The navigation will be rendered safer because the water will be smoother and the Zwolssche Diep will be improved. It will lessen the cost of upkeep of water defenses because long lengths of sea-dyke will no longer be wanted and no damage will be done by floods in Overyssel and the north of Gelderland. Besides all these advantages a railroad connection will be provided between north Holland and Friesland. But the greatest advantage of all will be the acquisition of a great area of fertile land.

The existing shortage of land, as shown by the annual returns is due to the fact that the increase of the population, both rural and urban, goes on at a much quicker rate than the acquisition of tillable land. Assuming that, as in the case of the Waard and Groet Polders and the Y Polders, very little of the clay in the Zuider Zee Polder will make permanent pasture, the cultivation of the land will require at least 40,000 peasants, including the laborers. To this number we must add peasants families and some 50,000 tradesmen, handicraftsmen, etc., to get the total number of 250,000 workers, who will find ample means of support in the new Zuider Zee province. In 1907 the rent of clayey land in the Waard and Groet Polders was $40 to $60; of light clayey land, $28 to $36 per hectare. In the Anna Pawlown Polder the rent of the light sandy soil was $20, and that of heavy sandy soil $36 per hectare.

Supposing the average rent of the Zuider Zee areas, where the soil will be much like that of the Waard and Groet Polders, to be only $30 per hectare, we may estimate the total amount of the rentals at $6,000,000 a year. The value of the fish caught in the Zuider Zee is a little over $8,000,000 annually. The value of the crops grown on the drained Zuider Zee areas will be $28,000,000 a year. Canals for use in navigation and for the regulation of the water-level will be dug along the coasts in north Holland, coast of Gelderland and that of Friesland.

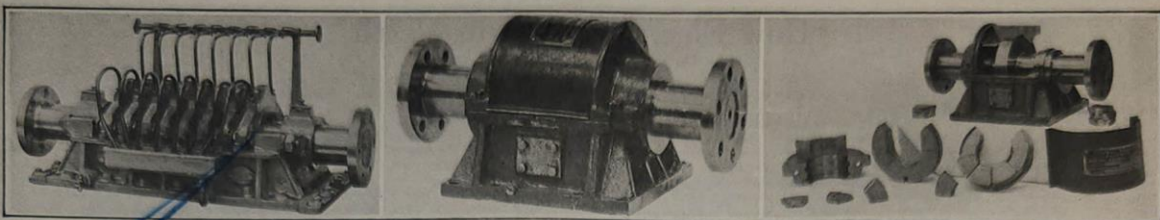
The time needed for the work will be thirty-three years, and the embankment, which is to be built of sand, will take nine years. By the end of the fourteenth year, the first land will have been reclaimed, in the north-west area, and in the seventeenth year, portions fit for cultivation and habitation will be offered for sale. The cost will not be prohibitive, some $2,400,000 or $2,800,000 annually, the whole cost of the undertaking being estimated at $75,600,000, exclusive of interest; inclusive of cost of military defences, improvement of the Zwolsche Diep, accumulation of capital to defray the cost of dredging sand and silt from the Yesselmeer, compensation to the fishermen, etc. The reclaimed land is to be government property, and it will be offered for sale, but no certainty can yet be given about which system is to be followed in apportioning it.

Many economists are of the opinion that this would be a good opportunity to make a commencement with a system of small allotments which is now deemed so necessary by them, for the welfare of the agricultural population, and for the prosperity of the entire country.

The Latest Change in the Map of Africa is the amalgamation of Northern and Southern Nigeria into the single colony of Nigeria, dating from about January 1st, 1914. The new colony has an area of 332,960 square miles and an estimated population of 18,000,000.

The sections in lighter tint show the 530,000 acres of land which are to be reclaimed by building an embankment across the mouth of the Zuider Zee.

Inclosing and partial draining of the Zuider Zee.



Left: The old type multi-collar block for marine thrust-bearings; note the complexity and the elaborate arrangements for cooling. *Center:* The short, simple bearing that is replacing the older one, and that requires no cooling. *Right:* The bearing shown in the center, taken apart to indicate its construction.

Old and new marine bearings, showing the application of a brand new principle

Fighting the Friction Fiend

How Invention Has Taken Advantage of the Peculiarities of the Lubricating Film

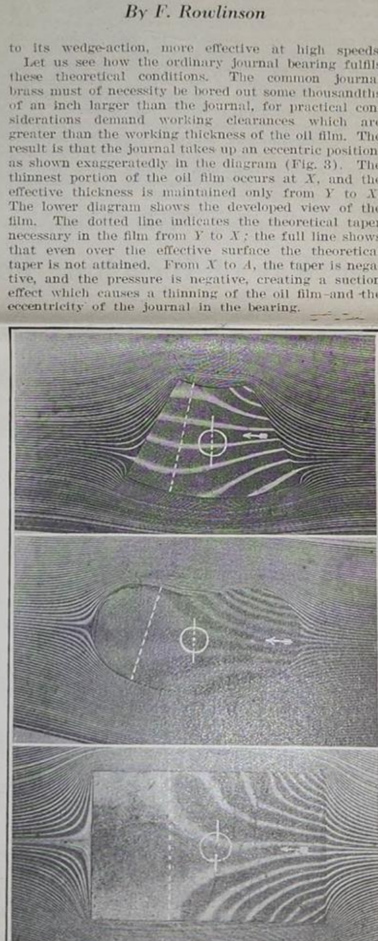
By F. Rowlinson

THE "Man with the Oilcan" is a feature wherever machinery is used. His job is to combat the insidious "friction fiend"—the cause of untold power wastage and energy loss. The absorption of energy in overcoming the friction of a multiplicity of bearings and sliding parts of machinery often amounts to from 30 to 40 per cent of the energy generated, and the only step taken to remedy the evil was, for long enough, the employment of "the man with the oilcan." By a copious and repeated application of lubricant, the friction fiend has thus been kept at bay, and not allowed to make his presence felt by hot and smoking bearings—but he is always there, none the less, continually taking his toll of useful energy. Modern research on lubricants and modern improvements in bearings have now opened up a reasonable prospect of escaping this toll.

The foundation of the science of lubrication was laid about 30 years ago, when Professor Osborne Reynolds evolved an abstract mathematical theory of lubrication which met with approval and coordinated all known facts. This theory may be condensed into the "tapered film law." It is now accepted that no lubricated surfaces can possibly be efficient unless the construction of the bearing is such that the oil between the faces is able to take up a tapered formation under pressure. That is to say, the two surfaces must be parallel and the oil must form a thin wedge between them. The ordinary journal bearing, while in a measure providing for correct film lubrication, labors under certain important disadvantages inherent in its design. These render perfect lubrication under all conditions, impossible.

If a loaded block *W* (Fig. 1) moves over a lubricated surface *A B*, scientific demonstrations show that a two-fold effect will operate to cause it to tilt slightly, so that the leading edge *B* is slightly higher than the trailing edge *A*. The entering oil at *B* may be first considered as inert along the edge *B*, and as leaving at *A* in haste to quit the pressure zone into which it has been introduced. This is the first reason why the oil film is tapered from *B* to *A*. Moreover, if the photographic views be examined, it will be seen that the oil entering along the one edge *BB* leaves along three edges, as shown by the flow lines. These photographs are of a lubricating film between a glass block and a metal surface. The oil, which has been specially colored to show the flow lines, will be seen to spread itself out fanwise. As the oil enters along *one* edge, and leaves along *three* edges, it follows that the thickness of the oil film along *BB* must be materially greater than along *AA*, if it is to be maintained. If the block be unable to lift along *BB*, then the space available for entry is only about one-third that available for leaving, and the oil escapes under the pressure faster than it can enter. The result is an increasingly impoverished film, and ultimately "greasy metallic contact" ensues. The friction absorbed by greasy metallic contact may easily be 10 to 20 times that absorbed by proper oil-film contact. The ideal condition for lubrication then, considered theoretically, is the maintenance at all times of a tapered oil film between the moving surfaces, the latter being kept apart by the wedge-action of the oil as it enters and leaves. Such a film, though microscopically thin, is remarkably strong and cannot be broken by high pressures or very high speeds. In fact, the higher the speed, the better the film, owing to its wedge-action, more effective at high speeds.

Let us see how the ordinary journal bearing fulfils these theoretical conditions. The common journal brass must of necessity be bored out some thousandths of an inch larger than the journal, for practical considerations demand working clearances which are greater than the working thickness of the oil film. The result is that the journal takes up an eccentric position, as shown exaggeratedly in the diagram (Fig. 3). The thinnest portion of the oil film occurs at *X*, and the effective thickness is maintained only from *Y* to *X*. The lower diagram shows the developed view of the film. The dotted line indicates the theoretical taper necessary in the film from *Y* to *X*; the full line shows that even over the effective surface the theoretical taper is not attained. From *X* to *A*, the taper is negative, and the pressure is negative, creating a suction effect which causes a thinning of the oil film and the eccentricity of the journal in the bearing.



Actual stream-line photographs of the flow of colored films across tapered bearing surfaces. The portions of the surfaces beyond the dotted lines are useless, and the blocks must therefore be pivoted non-symmetrically

An ordinary collar thrust bearing, as used in marine and other work, is even worse. The surfaces are necessarily parallel, and no taper can be formed anywhere. The result is a negative pressure in the whole film, and the oil is everywhere squeezed out. The friction is therefore that between greasy metal surfaces, *i. e.*, about ten times the theoretical minimum. The average thrust bearing can for this reason run only at a low pressure per square inch (say 50 pounds) and needs for heavy work a multiplicity of collars. Even at this elaborate means are usually provided for water cooling, to carry off the heat generated by the wasted energy. Mechanical difficulties also arise in distributing the load equally over all the collars.

It remained for Mr. Michell, a well-known British engineer, to provide the practical solution which most nearly fulfilled the theoretical desiderata. Michell divided the bearing surfaces into several segmental pads, each pivoted upon a center at the back. The oil then entering automatically with the rotation of the shaft, causes the pads to take up a *slight inclination* to the plane of rotation, so that the load is supported upon thin wedges of oil. This simple device enables the oil film to support any pressure which the metallic surfaces will carry, and experiments have shown that such a bearing will run cool under a pressure at which the white metal begins to squeeze out. As much as five tons per square inch has been carried successfully on the pads of a Michell under test. No undue heating occurred. The diagram, Fig. 2, shows two methods of pivoting the segmental pads. The point at which they are pivoted corresponds with the point of maximum pressure, and is situated a little off the center of area. No metallic contact takes place between the rubbing pads and the thrust collar, because the oil film is automatically maintained, and the pads may be said to float. The only friction generated is that due to the shearing of oil. With the ordinary thrust bearing friction increases with the load, and heating and wearing troubles are experienced if the load exceeds 50 pounds per square inch. In the Michell, the friction being that of a fluid, is independent of the load, so that 500 or 600 pounds per square inch is carried without any difficulty. These figures demonstrate that a Michell thrust bearing will carry ten times the load of an ordinary thrust bearing and absorb in friction only one-tenth of the power.

The first great application of the Michell principle was to the thrust blocks of marine propeller shafts, and marine practice in large shafts with heavy thrusts has been revolutionized. The most important bearing in a screw-propeller is undoubtedly the thrust block, through which the propeller thrust is transmitted to the hull. Hitherto this bearing has been the most inefficient and troublesome in the ship. The old troublesome multi-collar type of block has now given place in most high-class ships to the single-collar Michell, which requires little more attention than the passing glance of the engineer. No hose-pipe work is needed to keep the Michell cool, because, being scientifically designed, no metallic contact takes place between the faces, and the block does not run hot. In particular, the Michell principle has rendered possible the geared turbine drive now being used with such success. In ordinary marine turbine practice, it is possible to neutralize the propeller thrust at least partially by balancing it against the thrust of the turbine shaft—with geared drive this is impossible. In the British High Court of Justice, in

1919, Mr. Justice Sargeant said of the Michell block: "The result of this invention has been to increase to an extraordinary extent the efficiency of thrust bearings by allowing them to withstand an enormously higher pressure per square inch of surface. The evidence before me is clear and uncontradicted that with the previous type of thrust bearings it was impossible to use shafts carrying more than 3000 or 4000 horsepower at the most, and that, even then, constant attention, repair and renewal was necessary after short intervals of use, and that the use of the gear-driven turbine, as it has been practiced in the Navy throughout the war (including its use in submarines), and as it is being used in fast commercial vessels now, has been rendered possible only by the invention now in question." At the head of this article the photographs show a comparison between an ordinary marine thrust block and between a Michell block for the same service. One of the Michell blocks for "H. M. S. Hood," the largest vessel of the British Navy, carries 36,000 horsepower on a 25-inch shaft at 210 revolutions per minute. Over 10,000,000 horsepower in the British Navy alone is transmitted on Michell blocks. The new thrust block is limited by no considerations of speed. As the speed increases, the angle of the pads adjusts itself automatically to the new speed. For this reason the Michell block is in use for steam and water turbines, in the former at speeds up to 3000 revolutions per minute, with normal load pressure of 400 pounds per square inch. This efficiency is unapproachable by any other method.

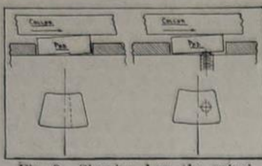


Fig. 2: Showing how the principle of the tapered film is applied practically in the Michell block

For ordinary journals, the Michell principle has been applied in a similar fashion. The author has records of a case reported by a tyre cogging mill, in *which the ordinary bearings* of phosphor bronze lasted only 2 to 3 hours, when they needed grinding up and replacing. With the installation of a bearing on the new principle, the bearing has been free from trouble, and requires no attention whatever beyond a small quantity of oil. Engineer Vice-Admiral Sir George Goodwin, Engineer-in-Chief of the British Navy, has said of the new principle of lubrication of bearings: "To be quite candid, it is probable that the bearing-metal problem has lost a great deal of the importance that formerly belonged to it, owing to the fact that the true principles of lubrication so long known but not utilized have now been applied in a manner which can properly be described as revolutionary. It has long been thought that the nature of the bearing metal itself was a minor matter, provided that the oil film between the rubbing surfaces could be maintained; and the problem before engineers for years has been how to maintain that film, with the ever-increasing direct bearing pressures and rubbing velocities. Following the mathematical investigation of the problem by Professor Osborne Reynolds some years ago, the practical solution of the problem has been effected by Mr. Michell in no uncertain manner. It has been adopted unreservedly in the Navy for the thrust blocks of all descriptions of engines with complete success. Although some difficulties have presented themselves in the application of the principles to marine journal bearings on account of the need of reversibility, they have been overcome."

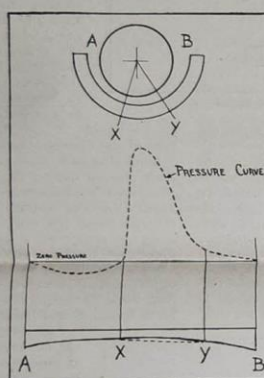


Fig. 3. Showing why the ordinary journal bearing is never fully efficient

Tens of thousands of the new bearings are in use in all parts of the world, and though at first engineers were found skeptical that so great an advance on old-time methods was possible, it is now acknowledged the whole world over that the friction fiend who wastes our time and who robs us of our energy is at last vanquished.

The foregoing method is a mechanical solution of the problem rather than one involving the use of new lubricating compounds or oils. It is well here to recall some of the remarkable strides which have been made in overcoming friction. Ball bearings and roller bearings are too well known to require much explanation. Certain alloys have been introduced which give excellent results when used for bearings. One of the most interesting developments in reducing friction has been the development of graphited metal, such as brass. By an ingenious method it is possible to impregnate brass and certain other metals with graphite that permeates every little pore, so that an absolutely smooth, self-lubricating surface is produced, which requires no oil. Another interesting development is an alloy which indicates by its color if it is properly cooled, by means of ample lubrication, or if it is getting hot. Bearings made of this metal must of course be used in an exposed position, where their indicative properties can be employed to good stead at all times.

Construction of a Steam-Turbine Wheel

By John K. Cochran

TURBINE designers today are tending toward lower wheel-speeds and elimination of the extreme gear-reductions of former practice. But even under these less severe conditions, the demands upon the wheel are heavy. The impact of the steam on the blades tends to wear and pit them; but the buckets must remain clean and "slippery" and must be able to withstand the shock when the steam is turned on.

The wheel proper is turned from a blank of open-hearth steel, and so far as it is concerned itself, can withstand anything in the way of centrifugal strains likely to happen to it. But the buckets provide another problem. If these are cut from the blank itself, their blades are in a horizontal plane, and centrifugal force works on them at an angle of 90 degrees, tending to straighten them out so that they will be along a radius line. If this is to be avoided by placing the bucket the other way, it is necessary to make them separately and fasten them around the wheel. The problem of their composition is not so difficult. Monel metal has been used extensively, and there are other non-corrosive, rust-proof metals on the market that will give satisfactory strength as well. But the problem of attainment is still to be met.

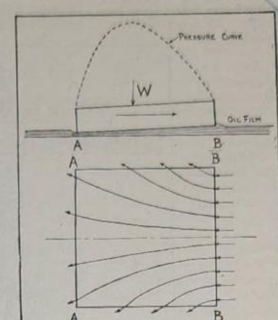
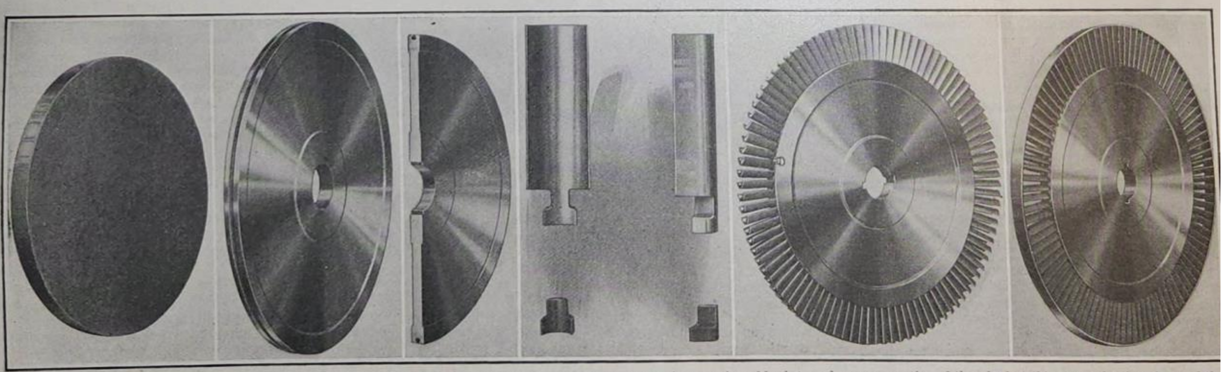


Fig. 1: Showing how the tapered film law of lubrication acts, and the flow of a tapered film under a bearing block

The buckets must be so placed on the periphery of the wheel that there is a permanent lock. Speed must not affect the locking qualities between the bucket and the wheel proper, and there must be no strain placed upon the buckets at the point where they are locked. Our illustrations show one very interesting way in which these demands are met. A slot is cut all around the edge of the wheel, as shown in the second view and, in cross-section, in the third. A circular hole at one side of this slot admits alternately a bucket and a spacer such as are shown in the fourth photograph. When the entire groove has been packed full of buckets and spacers, these constitute in effect almost one solid piece of metal, being forced tight against one another under pressure. When the hole through which they have entered is brazed over, the bladed wheel becomes a unit which can come apart only by breakage.

Around the outer tips of the buckets there is placed a continuous shroud of the same metal as the buckets, spot welded to each bucket and welded together at its ends. The purpose of this shroud is best understood by picturing a slug of condensed steam entering the wheel—a very common thing in practice. There is a violent shock on the wheel and each bucket has to take up that shock. Naturally the steam is most likely to hit at the tip of the bucket, and there is a fulcrum action which, if the bucket were free to yield to torsion, would tend to break it off at its base. But the shroud distributes the strain uniformly through all the buckets, and itself takes up a goodly part of it.

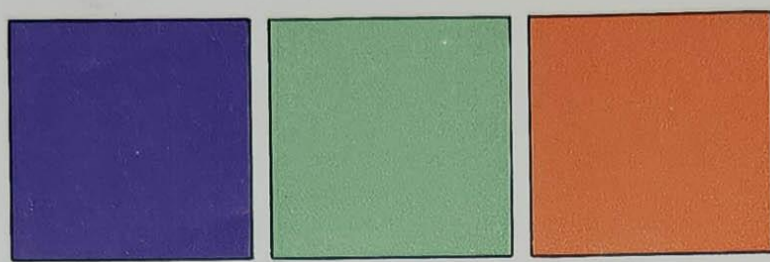
With such a wheel, hot-pressed on to the turbine shaft, there is a big factor of safety for every hazard of turbine operation. The objectionable features of an entirely solid steel wheel are removed, yet strength far superior in every respect is attained, with points of excellence impossible in an all-steel wheel.



In order from left to right, these views show: the steel blank; the latter with the annular groove cut for the reception of buckets and spacers; section of the wheel at this stage, showing shape of the groove; a bucket (above) and a spacer (below), each seen from front and from side; the wheel with the buckets all in place, but with the hole still unbrazed through which they were inserted; and the finished wheel, with shroud welded in place outside the buckets

Six stages in the making of a steam-turbine wheel with buckets separately attached

THE THREE-COLOR PROCESS



Glass Color Screens, Through Each of Which a Separate Negative Is Produced

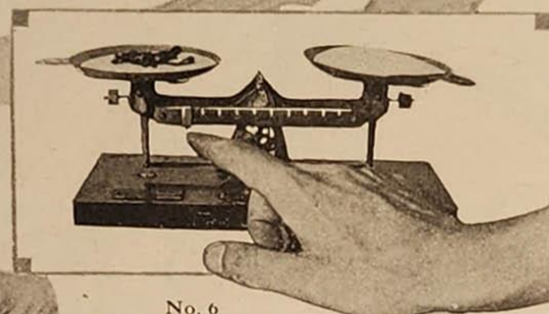
Negatives Produced by Photographing Through the Respective Screens Above

Positive Reproductions of Above Negatives Printed in Colors Complementary to the Respective Screens

The Three Plates Printed Over Each Other

Finding the Cotton in "All Wool" Suits

Every man who wears a suit of clothes cannot *ipso facto* tell whether it is "all wool." Here, at the left, is a piece of goods before passing through a test that will find out for him

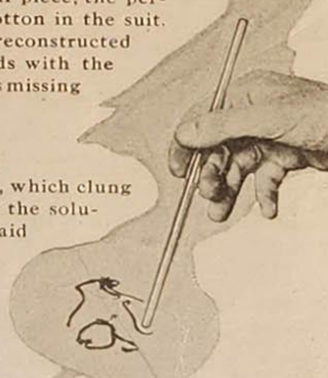


No. 1
The test begins. A bit of the cloth of the suit, taken judiciously from a place that could spare it without showing, is carefully weighed

No. 2
A bit of sodium hydroxide, which will eat animal but not vegetable tissue, is dropped into a test tube partly filled with water, where it dissolves. The cloth is also put into the tube

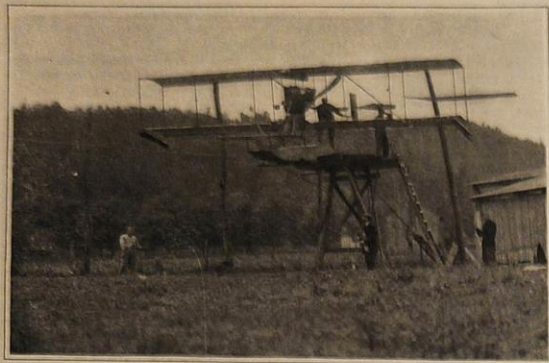
No. 3
The tube is held over a flame. If the cloth dissolves entirely during the boiling, it is all wool. If anything is left of it—

No. 4
That is cotton, a vegetable tissue, which the sodium hydroxide scorns. The contents of the tube are poured into a filter paper in a funnel



No. 5
The cotton shreds, which clung to the paper while the solution escaped, are laid out to dry

No. 6
The dry shreds are weighed to find, by comparison with the weight of the original piece, the percentage of cotton in the suit. Above, the reconstructed piece of goods with the wool threads missing



The biplane on the wire, balanced on two guys.

The machine in the air after leaving the wire.

Launching an Aeroplane from a Wire

The New Curtiss Naval Flying Machine

BY far the most serious problem which confronts the Navy Department in its effort to utilize aeroplanes is the difficulty of providing a suitable launching and alighting gear. Every one knows nowadays that before it can really fly, an aeroplane must be in [illegible]on; that, like any soaring bird, it must make an [illegible] run in order to get up speed. Alighting on land has always presented its difficulties; indeed, it may be safely said that the landing chassis as we know it is capable of much improvement. How much more difficult must it be to land on water?

The first experiments which were made in our navy with the aeroplane involved the use of a rather extensive platform on the forecastle of the scout cruiser "Birmingham." Down this platform, at a fairly steep angle, Ely in a Curtiss biplane, ran on November 8th of last year, and for the first time in history succeeded in launching a flying machine from the deck of a warship. Two months later he succeeded in starting from and alighting upon the "Pennsylvania."

Remarkable as this achievement was, it is obvious that warships cannot carry about with them platforms of such size. In action, every piece of unnecessary apparatus, every incumbrance, is simply tossed overboard. The platform unquestionably would have to go with the rest, if the ship is to be fought at all.

Mr. Glenn H. Curtiss seems to have succeeded in overcoming these difficulties, by adopting the hydroplane construction. He has shown that it is possible both to start from the water and to alight upon it with comparative ease and safety. In a word, he devised a type of flying machine peculiarly adapted to the needs of the navy.

The problem of providing a suitable launching gear, which can be used when the water is too rough for the hydroplane float, seems now to have been solved with equal felicity. At Hammondsport, on Lake Keuka, Curtiss has been making experiments which show that it is possible to launch a hydro-aeroplane from a wire cable. Perhaps the most successful trials were made by Lieut. Ellison. According to Mr. Curtiss, it would only be necessary to stretch one wire from the boat deck of a battleship down to the bow. On this cable the hydroplane glides down, being kept from falling by two auxiliary wires which support the wings until the machine gets up sufficient headway to keep its own balance by means of the ailerons or other control.

Such a launching gear does not interfere in any way with the guns or armament and can be stowed away after it has served its purpose in a very short time.

The experiment shows that whenever the sea is too rough to permit the hydroplane to rise from the waves, it can always take the air by means of the cable.

Submarine Cables and Longitude Determination

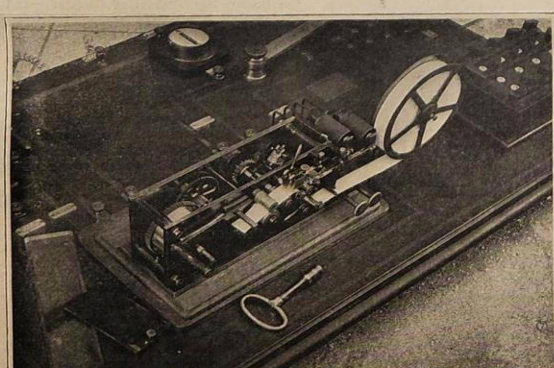
The Improvements Devised by Colonel Bourgeois

By Jacques Boyer

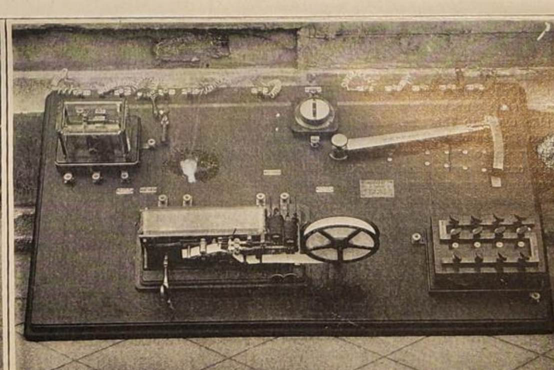
AN accurate comparison between two astronomical clocks, situated at a great distance from each other, can be made by overland telegraphy, by means of which the time signals given by both clocks are recorded, side by side, on an electric chronograph at each station. The ordinary electric chronograph is provided with two pens, or writing points, operated by electro-magnets, so that each pen makes a distinctive mark on the same uniformly rotating cylinder or moving strip of paper, when the circuit of its electro-magnet is made or broken. Usually one pen marks the time by the local clock, while the other records signals made by the observer, on the passage of a star over the wires of the transit instrument or the occurrence of any other event. For the determination of longitude, the electro-magnet of the second pen is connected with the clock at the distant station.

In order to determine the difference of longitude between two stations by this method, it is necessary to transmit from each station to the other currents

(Continued on page 305.)

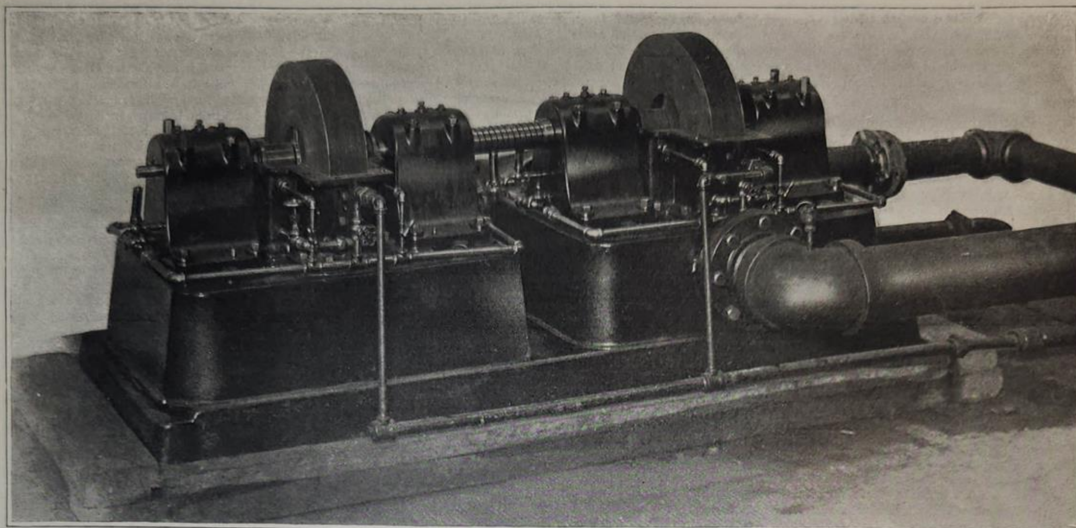


The double chronograph.



Apparatus for determining longitude by cable.

THE EMPLOYMENT OF SUBMARINE CABLES IN THE DETERMINATION OF LONGITUDE



The top half of casings is removed, showing two rotors. Each rotor consists of 25 disks $\frac{1}{32}$-inch thick by 18 inch diameter. The steam enters at the periphery, and flows in spiral paths to exhaust at the center of the disks. The driving turbine is to the left, the brake turbine to the right. Between them is a torsion spring. The steam inlets are on opposite sides on the two rotors; the driving rotor moving clockwise. The torsion of the spring is automatically shown by beams of light and mirrors and the horse-power is read off a scale. At 9,000 revolutions per minute, with 125 pounds at the throttle and free exhaust, this turbine develops 200 horse-power. It weighs two pounds per horse-power.

The Tesla turbine testing plant at the Edison Waterside Station, New York.

The Tesla Steam Turbine

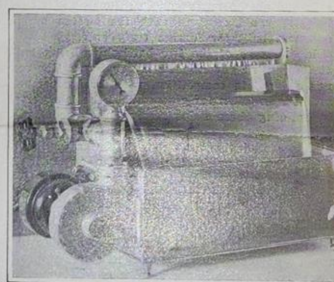
The Rotary Heat Motor Reduced to Its Simplest Terms

IT will interest the readers of the SCIENTIFIC AMERICAN to know that Nikola Tesla, whose reputation must, naturally, stand upon the contributions he made to electrical engineering when the art was yet in its comparative infancy, is by training and choice a mechanical engineer, with a strong leaning to that branch of it which is covered by the term "steam engineering." For several years past he has devoted much of his attention to improvements in thermo-dynamic conversion, and the result of his theories and practical experiments is to be found in an entirely new form of prime movers shown in operation at the Waterside station of the New York Edison Company, who kindly placed the facilities of their great plant at his disposal for carrying on experimental work.

By the courtesy of the inventor, we are enabled to publish the accompanying views, representing the testing plant at the Waterside station, which are the first photographs of this interesting motor that have yet been made public.

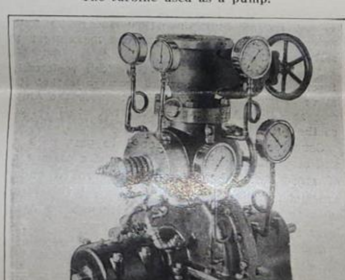
The basic principle which determined Tesla's investigations was the well-known fact that when a fluid (steam, gas or water) is used as a vehicle of energy, the highest possible economy can be obtained only when the changes in velocity and direction of the movement of the fluid are made as gradual and easy as possible. In the present forms of turbines in which *the energy is transmitted by pressure, reaction or impact, as in the De Laval, Parsons, and Curtiss types*, more or less sudden changes both of speed and direction are involved, with consequent shocks, vibration and destructive eddies. Furthermore, the introduction of pistons, blades, buckets, and intercepting devices of this general class, into the path of the fluid involves much delicate and difficult mechanical construction which adds greatly to the cost both of production and maintenance.

The desiderata in an ideal turbine group themselves under the heads of the theoretical and the mechanical. The theoretically perfect turbine would be one in which the fluid was so controlled from the inlet to the exhaust that its energy was delivered to the driving shaft with the least possible losses due to the mechanical means employed. The mechanically perfect turbine would be one which combined simplicity and cheapness of construction, durability, ease and rapidity of repairs, and a small ratio of weight and space occupied to the power delivered on the shaft. Mr. Tesla maintains that in the turbine which forms the subject of this article, he has carried the steam and gas motor a long step forward toward the maximum attainable efficiency, both theoretical and mechanical. That these claims are well founded is shown by the fact that in the plant at the Edison station, he is securing an



This little pump, driven by a motor of $\frac{1}{12}$ horse-power, is here shown delivering 40 gallons of water per minute against a 9-foot head.

The turbine used as a pump.



This view shows one complete high pressure unit, with the steam throttle above, and below it the reversing valve and the compact turbine. Note the many gages used in the tests.

A 200-horse-power high-pressure turbine.

output of 200 horse-power from a single-stage steam turbine with atmospheric exhaust, weighing less than 2 pounds per horse-power, which is contained within a space measuring 2 feet by 3 feet, by 2 feet in height, and which accomplishes these results with a thermal fall of only 130 B.T.U., that is, about one-third of the total drop available. Furthermore, considered from the mechanical standpoint, the turbine is astonishingly simple and economical in construction, and by the very nature of its construction, should prove to possess such a durability and freedom from wear and breakdown as to place it, in these respects, far in advance of any type of steam or gas motor of the present day.

Briefly stated, Tesla's steam motor consists of a set of flat steel disks mounted on a shaft and rotating within a casing, the steam entering with high velocity at the periphery of the disks, flowing between them in free spiral paths, and finally escaping through exhaust ports at their center. Instead of developing the energy of the steam by pressure, reaction, or impact, on a series of blades or vanes, Tesla depends upon the fluid properties of adhesion and viscosity—the attraction of the steam to the faces of the disks and the resistance of its particles to molecular separation combining in transmitting the velocity energy of the motive fluid to the plates and the shaft.

By reference to the accompanying photographs and line drawings, it will be seen that the turbine has a rotor *A* which in the present case consists of 25 flat steel disks, one thirty-second of an inch in thickness, of hardened and carefully tempered steel. The rotor as assembled is 3½ inches wide on the face, by 18 inches in diameter, and when the turbine is running at its maximum working velocity, the material is never under a tensile stress exceeding 50,000 pounds per square inch. The rotor is mounted in a casing *D*, which is provided with two inlet nozzles, *B* for use in running direct and *B'* for reversing. Openings *C* are cut out at the central portion of the disks and these communicate directly with exhaust ports formed in the side of the casing.

In operation, the steam, or gas, as the case may be, is directed on the periphery of the disks through the nozzle *B* (which may be diverging, straight or converging), where more or less of its expansive energy is converted into velocity energy. When the machine is at rest, the radial and tangential forces due to the pressure and velocity of the steam cause it to travel in a rather short curved path toward the central exhaust opening, as indicated by the full black line in the accompanying diagram; but as the disks commence to rotate and their speed increases, the steam travels in spiral paths the length of which increases until, as

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Free Ships vs. Discriminatory Duties

To the Editor of the SCIENTIFIC AMERICAN:

The statement that the United States pays from $200,000,000 to $300,000,000 to foreign steamship lines for carrying passengers, freight, and mails is correct, with the sum nearer the $300,000,000 mark.

It is an economic fact also that under present conditions it is cheaper to pay foreign steamship lines for performing these services than to attempt it with American-built tonnage aided by subsidies or discriminatory duties.

Such a state of affairs is, in the long run, detrimental to all American interests. In the case of two European nations, if not three, their mercantile fleets are practically dependent on American traffic for existence. Our present system keeps alive our sea rivals and hinders the development of our export trade.

That the United States should be restored to their old position in the deep-sea trade, is imperative from a political as well as from an economic standpoint. Without an adequate merchant marine as an auxiliary to our navy, our battleship fleet is like a bull without an engine—only half equipped for its work.

We have a big navy, and it is growing larger all the time, yet it is as dependent to-day on foreign built and owned steamers for transports, colliers, etc., as it was when the Spanish war broke out. The United States paid some $20,000,000 or more then for the obsolete tonnage that foreigners dumped on Uncle Sam.

The views of Mr. Bowles, formerly an admiral of the United States navy, now president of the Fore River Ship Building Company, are entitled to great respect.

His company is building the two battleships for the Argentine navy, and it has turned out some high-class coast freighters. His statement, therefore, "the experience of sixty years of 'free trade' in ocean transportation conclusively shows that it is not profitable to American capital under present conditions, and requires protection or some form of government aid or subsidy," merits marked consideration.

Mr. Bowles seeks to overcome conditions of "free trade" which exists in the deep-sea trade by the application of "protective principles:"

"First, by mail compensation such as is provided for under the ocean mail act of 1891 and which is still in effect.

"Second, the remission of the head tax of $4 when immigrants arrive in the United States in American registered steamers.

"Third, by discriminatory duties applicable to American-built steamers of all types. . . . A reduction of 5 per cent on all goods on which the ad valorem duties exceed 41 per cent, and on all goods under 41 per cent or free the importer shall receive an importer's certificate available only for the payment of duties at the custom house and equal in value to 2.05 per cent of the value of the goods so imported."

The mail compensation act is still in effect, but it has done little good so far; it could be made of value in establishing new lines if American capital were generally employed in ocean shipping under the American flag.

The second proposition: the remission of the head tax of $4 when immigrants arrive in American steamers. It should be amended by establishing a stamp tax of $4 on all outward emigrant tickets, the same to be remitted in case the passenger sails on an American steamer.

Foreign governments do not hesitate to legislate to make the emigrant traffic a source of profit to the State and to the upbuilding of their merchant marine.

Third: The discriminatory duty. This is highly objectionable. The refund to the steamer or the importer would run from $2.25 per ton on sugar to $4.50 on a ton of coffee.

These articles, as well as hides, flax, fruits, fibers, are imported in cargo lots. An American steamer operated under such discriminatory duties would earn approximately 50 to 100 per cent more than a foreign steamer in the same trade. Under such conditions the American steamer would control the traffic in such commodities, and the control of the import would carry with it the control of the export, and subject exporters to such rates of freight as the traffic would bear.

It would almost to a certainty create a monopoly in the deep-sea trade as effective as now exists in the coastwise.

Although the United States have never tried the policy of "free ships" for upbuilding our merchant marine, the advocates of subsidy and discriminatory duties have always denounced it as a fallacy; yet those nations which have adopted it, are the most progressive and successful ship-owning nations.

For over one hundred years our shipbuilders have been shielded from the competition of foreign builders; this has resulted in developing our coastwise and lake shipping, but it has steadily lost us the deep-sea foreign trade till it is now practically extinct. In justification of this, it is stated that it costs from 40 to 50 per cent more to build steamers of the same size in American yards than in foreign. This would seem to indicate that the American prices are excessive.

It is also true that shipbuilding material may be imported free if used in building American steamers engaged in foreign trade. This privilege, however, is so hedged about with restrictions as to be practically valueless.

"Shipbuilder's (American) labor costs are 70 to 100 per cent more than the foreigner."

This is also equally true of labor engaged in making everything, from needles to automobiles, ship plates, and rails. Yet we are constantly exporting a greater quantity of all kinds of these and other manufactured goods every year. And if the American scale of wages can be paid on American goods sold in foreign markets in competition with goods of foreign manufacture, it would not be unreasonable to expect that our shipbuilders could compete with the foreign builder on steamers built for foreign trade only.

In the case of the two battleships being built for the Argentine government, it was done. The contract was secured in competition with foreign competitors, and it is to taken for granted that the labor employed in building these ships receives the American wage scale.

It is stated that to build the hulls of the battleships costs more in the American yards, but that Americans can turn out big guns and armor plates so much cheaper than can the foreigner, that the total cost of building in American yards is less than the foreigner's price.

It is something to be proud of—to be able to build armor and big guns cheaper than can European concerns; and as this is the case, it is somewhat difficult to see why steamers cannot likewise be built cheaper in American yards. The labor in gun and armor making is as well paid as labor employed in shipbuilding. A few years ago Krupp offered armor plate to the United States at much under the American prices. Now apparently American makers can undersell Krupp.

Justification for denying American registration to foreign-built, American-owned tonnage is that it costs more to operate the foreign-built under the American flag and that Americans would not avail themselves of the privilege.

Congress has been petitioned to pass such a bill, and assurances were given that on its passage a fleet of modern fast boats would be enrolled under the American flag for foreign trade. Yet Congress hesitates to pass such a measure, although no American interest could be injured in any way.

Another stated objection to the admission of "free ships" is that "the admission of foreign-built steamers would kill the art of shipbuilding in the United States." Well, as far as building for the foreign trade is concerned, it is dead now. It is some years since any steamers were built for trans-Atlantic trade, and the few built in the last decade were in many cases put under foreign flags and are now operated between European and American ports.

Holland, Norway, Sweden, Belgium, are countries with a small population and but little natural resources, yet owing to their free-ship policy they have fleets of merchant steamers that trade in every quarter of the globe.

Up to 1849 England had navigation laws similar to those of the United States. In that year they were repealed, and with their passing England's shipping began to expand till to-day she is far and away the most important shipping nation in the world.

Germany took pattern by England and also passed a free-ship measure which is still in effect, and her merchant marine began to expand; she has continued the policy of allowing German citizens to buy or build steamers in the cheapest market, granting German registration, to this day. In addition, all shipbuilding material is admitted free of duty into Germany.

This policy has placed her second among the shipping nations of the world, and it has aided the development of her shipyards; they have kept pace with the growth of the German tonnage, and to-day vie with England in turning out the largest and fastest steamers afloat.

France is the one European country that stands out pre-eminently as a believer in bounties for shipbuilders and subsidies for tonnage. Her policy has been in effect for years; she pays enormous sums annually in aid of her merchant marine, yet it is a negligible factor as compared with England and Germany, and hardly compares with many of the smaller countries.

The freight rates on French ships are higher than on tonnage of countries not subsidized, and tonnage of other countries has no difficulty in competing with the French, even to the ports of France.

The policy of subsidy and bounty followed by France may induce the building of steamers, but it does nothing to advance trade and commerce.

For our foreign trade we need a merchant marine, and to secure it we should have "free ships." It is pointed out by Admiral Bowles that to move one-third of our present foreign commerce, it would require *ten* years to build the necessary steamers—and the Panama canal is to be opened in 1915; possibly in 1913 according to Col. Goethals. At the outside, less than four years from now steamers will be using this canal.

A free-ship bill is the solution of the American merchant marine. It can do no harm to any American interest. Our yards build no tonnage for the foreign trade; even if they could compete to-day, they could do no more than keep pace with the ever-increasing demand for tonnage.

If it is necessary to subsidize to keep our shipyards going, let it be for steamers of the highest class and of high speed—20 knots at least; steamers that will be of value in case of war, and that can deliver mails and passengers to South American ports in quicker time than is now possible. Such steamers will do something to stimulate travel and intercourse between the nations of South America and the United States.

The great lines of traffic are operated by steamers of moderate speed and low cost of operation, and until we can build steamers of such a type as cheaply as foreign builders, Americans should be allowed to buy foreign-built steamers with the privilege of American registration, to ply in foreign trade only. With the passage of such a bill, tonnage under the American flag would rapidly increase and our commerce correspondingly expand, and not the least important benefit to follow, will be that our battle fleet will have an ample supply of colliers and transports.

Chicago, Ill. CHARLES DEPESEE.

Oil as a Locomotive Fuel

THE advent of fuel oil has become an important factor in railway locomotion. It is estimated by the United States Geological Survey that from 20,000,000 to 25,000,000 tons of coal per annum are replaced by oil, and a large part of this is used by locomotives.

In this connection there is interest in a statement which will appear in the forthcoming petroleum report of the Geological Survey showing the extent to which oil is used as a locomotive fuel. The author of this report, David T. Day, computes the total length of railway lines operated during 1910 with petroleum as a fuel to be 21,075 miles, a trackage practically equivalent to that of five transcontinental lines stretching across the United States from ocean to ocean. The number of barrels of fuel oil used by the railroads (42 gallons per barrel) was 24,526,883. This includes 768,762 barrels used by the railroads as fuel other than in locomotives. The total number of miles run by oil burning engines during the year was 88,318,947. This would have carried one engine or train around the world approximately 3,530 times.

The advantages of oil as locomotive fuel over coal have been stated by Eugene McAuliffe as many. They include decreased cost of handling oil from cars to engines, with practically no loss by depreciation due to such handling; evaporation losses suffered by coal as not applying to oil; saving of time at terminals for engine cleaning and providing increased mileage per engine, the oil capacity of the tender being about 150 per cent of that of coal; freedom from physical failure of firemen in extreme hot weather; delivery of oil being unaffected by labor conditions, the coal situation necessitating in some instances heavy storage at great expense; greater cleanliness in handling all passenger trains, lack of smoke and immunity from right-of-way forest fires.

The expense of equipping the average locomotive to burn oil is about $800, and the cost of large steel storage tanks is about 25 cents per barrel; but the necessary terminal facilities for handling oil cost 50 per cent less than the amount required to handle coal.

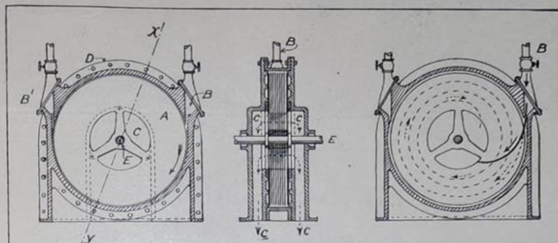
in the case of the present turbine, the particles of the fluid complete a number of turns around the shaft before reaching the exhaust, covering in the meantime a lineal path some 12 to 16 feet in length. During its progress from inlet to exhaust, the velocity and pressure of the steam are reduced until it leaves the exhaust at 1 or 2 pounds gage pressure.

The resistance to the passage of the steam or gas between adjoining plates is approximately proportionate to the square of the relative speed, which is at a maximum toward the center of the disks and is equal to the tangential velocity of the steam. Hence the resistance to radial escape is very great, being furthermore enhanced by the centrifugal force acting outwardly. One of the most desirable elements in a perfected turbine is that of reversibility, and we are all familiar with the many and frequently cumbersome means which have been employed to secure this end. It will be seen that this turbine is admirably adapted for reversing, since this effect can be secured by merely closing the right-hand valve and opening that on the left.

It is evident that the principles of this turbine are equally applicable, by slight modifications of design, for its use as a pump, and we present a photograph of a demonstration model which is in operation in Mr. Tesla's office. This little pump, driven by an electric motor of 1/12 horse-power, delivers 40 gallons per minute against a head of 9 feet. The discharge pipe leads up to a horizontal tube provided with a wire mesh for screening the water and checking the eddies. The water falls through a slot in the bottom of this tube and after passing below a baffle plate flows in a steady stream about ¾ inch thick by 18 inches in width, to a trough from which it returns to the pump. Pumps of this character show an efficiency favorably comparing with that of centrifugal pumps and they have the advantage that great heads are obtainable economically in a single stage. The runner is mounted in a two-part volute casing and except for the fact that the place of the buckets, vanes, etc., of the ordinary centrifugal pump is taken by a set of disks, the construction is generally similar to that of pumps of the standard kind.

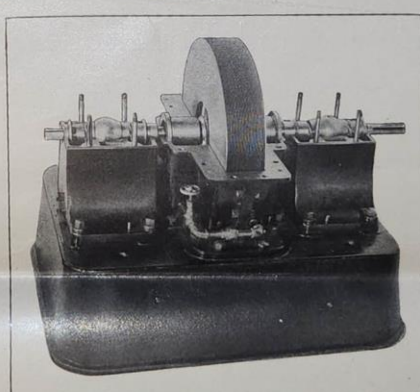
In conclusion, it should be noted that although the experimental plant at the Waterside station develops 200 horse-power with 125 pounds at the supply pipe and free exhaust, it could show an output of 300 horse-power with the full pressure of the Edison supply circuit. Furthermore, Mr. Tesla states that if it were compounded and the exhaust were led to a low pressure unit, carrying about three times the number of disks contained in the high pressure element, with connection to a condenser affording 28½ to 29 inches of vacuum, the results obtained in the present high-pressure machine indicate that the compound unit would give an output of 600 horse-power, without great increase of dimensions. This estimate is conservative.

The testing plant consists of two identical turbines connected by a carefully calibrated torsion spring, the machine to the left being the driving element, the other the brake. In the brake element, the steam is delivered to the blades in a direction opposite to that of the rotation of the disks. Fastened to the shaft of the brake turbine is a hollow pulley provided with two diametrically opposite narrow slots, and an incandescent lamp placed inside close to the rim. As the pulley rotates, two flashes of light pass out of the same, and by means of reflecting mirrors and lenses, they are carried around the plant and fall upon two rotating glass mirrors placed back to back on the shaft of the driving turbine so that the center line of the silver coatings coincides with the axis of the shaft. The mirrors are so set that when there is no torsion on the spring, the light beams produce a luminous spot stationary at the zero of the scale. But as soon as load is put on, the beam is deflected through an angle which indicates directly the torsion. The scale and spring are so proportioned and adjusted that the horse-power can be read directly from the deflections noted. The indications of this device are very accurate and have shown that when the turbine is running at 9,000 revolutions under an inlet pressure of 125 pounds to the square inch, and with free exhaust, 200 brake horse-power are developed. The consumption under these conditions of maximum output is 38 pounds of saturated steam per horse-power per hour—a very high efficiency when we consider that the heat-drop, measured by thermometers, is only 130 B.T.U., and that the energy transformation is effected in one stage. Since about three times this number of heat units are available in a modern plant with superheat and high vacuum, the above means a consumption of less than 12 pounds per horse-power hour in such turbines adapted to take up the full drop. Under certain conditions, however, very high thermal efficiencies have been obtained which demonstrate that in large machines based on this principle, in which a very small slip can be secured, the steam consumption will be much lower and should, Mr. Tesla states, approximate the theoretical minimum, thus resulting in nearly frictionless turbine transmitting almost the entire expansive energy of the steam to the shaft.



Sectional views. Spiral path of steam.

Details of turbine.



This turbine, whose rotor consists simply of a set of flat disks 18 inches in diameter, develops 200 brake horse-power on test.

Turbine with upper half of casing removed.

Some Striking Coal Facts

LAST year the United States mined 501,596,378 short tons of coal or nearly two-fifths of the year's total production for the world. This coal would load a train stretching back and forth across the United States from the Atlantic to the Pacific 33 times—a train approximately 100,000 miles long. Eleven years ago the United States for the first time surpassed Great Britain with a production of 253,741,192 tons, only a little more than half of last year's output. The mere increase of the coal output of the United States for 1910 over that of 1909—40,781,762 tons—was greater than the total production of any foreign country except Great Britain, Germany, Austria, Hungary, or France.

This increase alone was one and one-fifth times as great as the entire production of the United States in 1870. Excepting only Great Britain and Germany, either of the States of Pennsylvania or West Virginia produced in 1910 more coal than any foreign country. For the past seven or eight 10-year periods the coal production for each decade has been about equal to the entire amount of coal previously mined in the United States. Thus in the 10 years between 1885 and 1895 the production was 1,586,098,641 tons, while the entire amount of coal mined prior to 1895 was only 1,552,080,478 tons. In the 10 years betweeen 1895 and 1905 the production was 2,832,402,746 tons, while all the coal which had been mined prior to 1895 was 3,138,174,119 tons.

Incredible as it may seem, at the present rate of increase the ten-year period between 1905 and 1915 will show a production greater than all the coal mined in the United States prior to 1905. In 1850 the per capita production of coal was a little over one-fourth of a ton. In 1870 the per capita production had increased to nearly one ton; in 1890 it was 2½ tons; in 1900 it was 3½ tons, and in 1910 with the population of 91,972,266 the production was nearly 5½ tons for each person.

Last year 725,030 men mined coal in the United States. The great coal production record of 1910 was made in spite of a series of labor strikes participated in by 215,640 men. The loss in wages alone amounted to nearly $30,000,000.

The quantity of coal used for making coke in the United States for metallurgical purposes was 52,187,450 tons. This is additional to by-product coke produced in gas manufacture.

The total production of coal in the United States at the close of 1910 was 8,243,351,259 short tons. This plus the estimated loss incident to mining makes a total exhaustion of 13,395,000,000 tons. The United States Geological Survey estimates the original supply of coal in the ground in the United States, exclusive of Alaska, at 3,076,204,000,000 tons. This original supply less the exhaustion at the close of 1910 leaves an apparent supply still available of 3,062,808,972,000 tons, or 99.6 per cent of the original supply. In other words, in all the time since coal mining began in the United States the draft upon the original supply, *including loss in mining, has amounted to less than one-half of one per cent. At the present rate of production of approximately half a billion tons a year* the coal reserve of the United States would therefore last 6,000 years. At the present rate of increase in production, however, these three thousand billion tons of coal in the ground would last only a few generations.

Foreign Students in America

ADDRESSING the House of Representatives on the many new activities of the United States diplomatic service, Representative Foster, of Vermont, late chairman of the House Foreign Affairs Committee, recently called attention to the effort made by our diplomatic and consular representatives to advertise the United States as an educational center, an undertaking that has been fruitful of results.

One of the outcomes of this program was the formation in Buenos Aires two years ago of a United States University Club, which has been the means of sending at least 20 young Argentinians to this country to be educated. Under the auspices of this club lectures are given on university life in the United States, illustrated with a large number of appropriate stereopticon views. Negotiations are now under way for an interchange of schoolboys between the Boston High School of Commerce and the preparatory department of the University of La Plata. There are now at least 400 Latin Americans studying in the United States, and the number is steadily increasing.

Through the efforts of our ambassador at Constantinople, supported by the State Department, Columbia University has voted to receive, free of all tuition charges, three students annually from the Ottoman Empire for the next ten years, to pursue courses of study in any of the departments of the university. These students are to be selected by the Ottoman government, with the advice and approval of the ambassador at Constantinople.

The education of Chinese students in America, a matter in which the United States government has always taken a kindly interest, is assuming ever larger proportions. These students now number between 800 and 900. Half of these are "government students," supported by the different Chinese provinces, and by the remitted portion of the Boxer indemnity fund. To insure that the indemnity students coming to the United States should not start with a serious handicap, but be fully prepared to enter the American colleges, an academy has been established in Peking by the Chinese government, where these students receive preliminary instuctions under American teachers.

Celluloid first manufactured commercially for photographic purposes by John Carbutt of Philadelphia	1884
Celluloid film in ribbon form for use in kinematography first patented by Rev. Hannibal Goodwin, an American clergyman	1887
Later patented by Mr Reichenback for the Eastman Co.	

Kinematography and Inventions leading thereto.

Theory of persistence of vision applied by Dr Roget to moving objects	1824
Thaumatrope invented by Sir John Herschel	1826
Phenakistoscope or Fantoscope invented by Dr Plateau of Ghent	1827
Stroboscope invented by Dr Stampfner of Vienna	1827
Professor Faraday produced Faraday's Wheel	1831
Dr Horner of Bristol invented the Daedaleum	1834
Fox-Talbot claimed photographs in rapid sequence	1840
Perret and Lacroix applied front shutter to Fantoscope	1850
Franz Uchatius, an Austrian Lieutenant, first projected Fantoscope	1851
Omnius and Martin photographed the movements of the beats of an animal's heart	1865
J. A. Rudge of Bath showed moving photographs in the lantern	1866
Beale of Greenwich invented the Choreutoscope	1866
Linnett invented the Kineograph, the first book of moving pictures	1868
Thomas Ross, Junr., invented his Wheel of Life	1869
Mr Trevor patented a process for taking a series of radial photographs on a glass disc	1869
Mr Heyl of Philadelphia invented the Phasmatrope	1870
Professor Marey of Paris commenced experimenting with motion photography	1871
Eduard Muybridge invented the Zoopraxiscope and commenced experiments	1872
Wordsworth Donnisthorpe patented a lantern plate process	1876
Reynaud of Paris produced his Praxinoscope	1877
Friese-Greene first experimented with moving pictures on glass	1885
Friese-Greene invented commercial kinematography	1889
Thomas Alva Edison invented the Kinetoscope	1891
Cecil Hepworth commenced experiments with kinematography	1894
R. W. Paul first manufactured the Kinetoscope in England	1894
Birt Acres took first motion pictures for R. W. Paul	1894
Mons. Lumière first perfected and produced his Cinematographé, July, 1895	
First public display of animated pictures given by Mons. Trewey for Mons. Lumière at the Royal Polytechnic Institute, Regent Street, October, 1895, and later at the Empire Music Hall on 20th February, 1896	
R. W. Paul first showed moving pictures at Earl's Court, 1895, and later at the Alhambra Music Hall in March, 1896	

SPECTACLES AND SPECTACLE CONSTRUCTION

At a meeting of the Society held on 30th November, 1922, the following papers, dealing with some of the problems connected with spectacles and spectacle construction, were read.

An Exhibition of Instruments and Appliances connected with the Spectacle-making Industry was held on the same day. For a list of the firms represented and their exhibits, see *The Optician*, 8th and 15th December, 1922, pp. 260, 270.

SOME RECENT DEVELOPMENTS IN SPECTACLE LENSES

By W. A. DIXEY

After a period of comparative detachment from the optical trade, I find the following among recent developments to be open to comment:

(*a*) The use of a filtering glass which absorbs rays of higher frequency, and

(*b*) Some new developments in the provision of so-called periscopic lenses.

To take the latter first, the calculation for the best form of lens has furnished a subject for controversy dating from the days of Wollaston and Wharton Jones, down through Ostwald, Percival and others to the present day. Different mathematicians have given us different results, and this is not surprising when we remember that any formula on which calculations are based must contain constants which may be variously estimated. I can enumerate six limiting conditions which preclude an exact result.

(1) The distance of the centre of rotation from the front focal plane of the eye is a controlling factor; it varies with the size of the eye, and the human eye varies in individuals just as human stature does. You have to take an estimated average, which you may or may not adjust to the degree of ametropia.

(2) The range of direction of the visual lines is variable. You may take 40°, 50°, or 60°, and your results will vary accordingly.

(3) In an asymmetrical lens, e.g. sph. + 1·00, cyl. + 4·00, you have to choose between a curve of 1 *D* and a curve of 5 *D*. Whichever you select, the lens will be 4 dioptres out in the opposite direction, and if you take the mean you are 2 dioptres out at both axes.

(4) The accuracy of your calculated correction is dependent on the position of the spectacle lens relative to the front focal plane. This is not the same as (1). The conformation of the patient's face may render the assumed position of the spectacle lens impossible. A further (so-called vertex) correction is then necessary which will modify the curves of the lens.

(5) Variety of index and

THE PROGRESS OF SCIENCE

By Dr. EDWIN E. SLOSSON

SCIENCE SERVICE, WASHINGTON

A CRAZY EXPERIMENT

I SUPPOSE every scientific man occasionally tries experiments that he would not care to confess to his colleagues. Crazy ideas will pop up in the best regulated brains from some subconscious cellar and sometimes they are tried out, on Saturday afternoon when there is nobody else around, just to see what will come of them. They do not appear in the published reports, unless they happen to succeed, in which case the audacious experimenter will claim credit for foresight in undertaking an operation that ordinary minds would have condemned in advance as absurd.

Now it is interesting to observe that such erratic and irrational experimentation is distinctly recommended by the philosopher who laid down the laws of experimental science that have in the three centuries since accomplished such amazing achievements.

Lord Bacon, after listing in his precise and orderly manner all the various ways that we may be guided in our researches by theory, observation and previous experiment, concludes quite unexpectedly by adding a new category, what he calls the experiments of a madman and defines as follows:

"When you have in mind to try something not because reason or some other experiment leads you to it but simply because such a thing has never been attempted before."

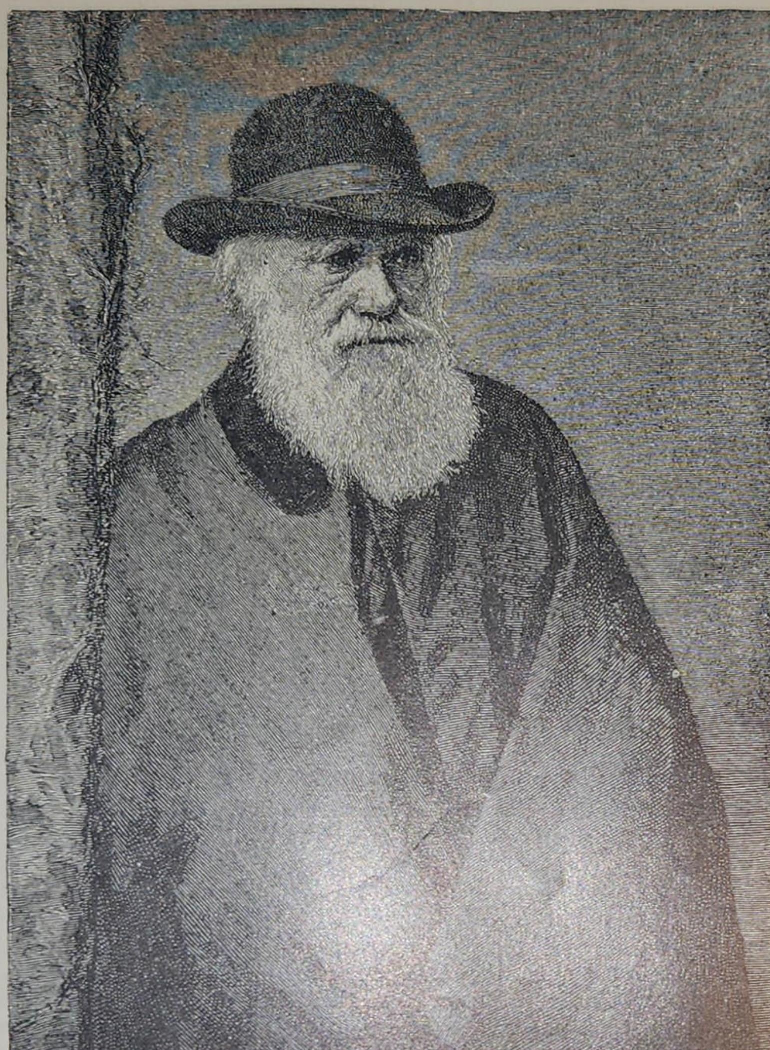
"The leaving I say, of no stone in nature unturned, for the magnalia of nature generally lie out of the common roads and beaten paths so that the very absurdity of the thing may sometimes prove of service. But if reason go along with it, that is, if it be evident that an experiment of this nature has never been tried, then it is one of the best ways and plainly shakes the folds out of nature."

The example Bacon gives of such unprecedented experiments is of peculiar interest to us:

"But of what I may call close distillation no man has yet made trial. Yet it seems probable that the force of heat, if it can perform its exploits of alteration within the enclosure of the body, where there is neither loss of the body not yet means of escape, will succeed at last in handcuffing this Proteus of matter and driving it to many transformations; only the heat must be so regulated and varied that there be no fracture of the vessels.

"No one should be disheartened or confounded if the experiments which he tries do not answer his expectation. For though a successful experiment be more agreeable, yet an unsuccessful one is often times no less instructive. And it must ever be kept in mind (as I am continually urging) that experiments of Light are even more to be sought after than experiments of Fruit."

What Bacon was "continually urging" that "experiments of Light"—those that lead to the enlightenment on fundamental principles—"are even



Ch. Darwin

more to be sought after than experiments of Fruit"—those that bring practical results—needs more than ever to be kept in mind at the present day when public and employers are impatient of research that does not bring immediate and profitable returns.

So it is worthy of notice that the example that Bacon cites, as the experiment of a madman, that is, destructive distillation, has been peculiarly productive of both light and fruit. Applied to coal it has given us coke for metallurgy, gas for cities, and shops and coal tar products of innumerable variety and inestimable value. Applied to petroleum in the cracking process it has increased the yield of gasoline by some 2,000,000 gallons a day. By this "handcuffing this Proteus of matter and driving it to many transformations" Light has been thrown upon the structure of the molecule and the chemistry of life.

TAKE YOUR VITAMINS IN FOOD

"VITAMINS should be sought in the garden, or in the market, and not in the drug store," says Dr. D. Breese Jones, chemist in charge of Protein Investigations of the Bureau of Chemistry, of the Department of Agriculture, in a recent report giving a summary of our present knowledge of vitamins. "In cases of suspected vitamin deficiency in the diet," according to the report, "corrective measures should be taken through the use of suitable natural foodstuffs, and not through commercial vitamin preparations, many, if not most of which are worthless."

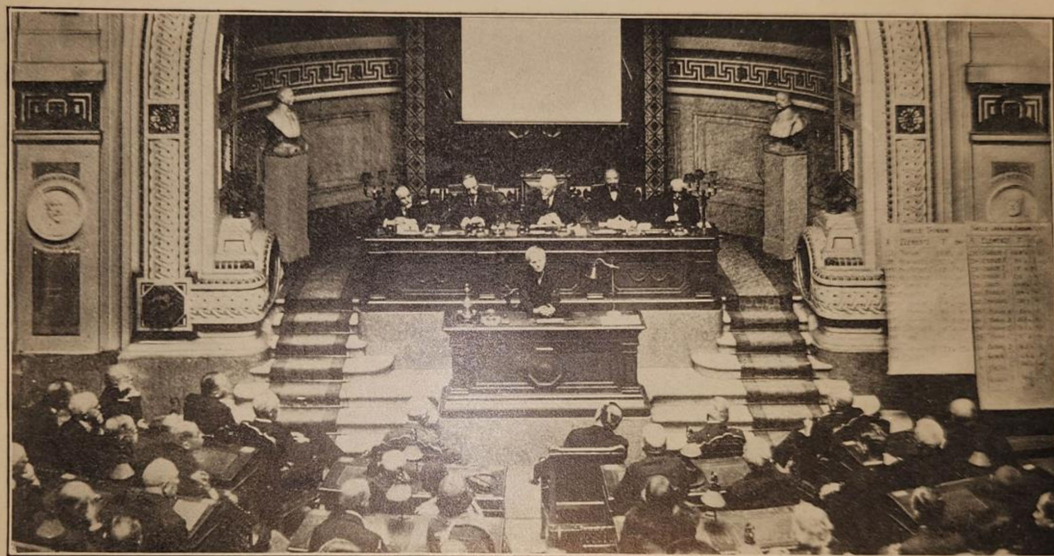
Vitamins play a very different rôle in nutrition from the other food constituents. They are essential to growth, health and life, but they contribute neither energy nor tissue building material. Their function has been likened to that of the spark plug in a gas engine. They are often referred to as the accessory food factors.

People and animals are unable to provide vitamins within their bodies. Lack of sufficient vitamins in the diet is soon followed by serious consequences. Young animals will fail to grow normally, and adults will rapidly decline in weight and develop certain characteristic affections known as deficiency diseases.

It is now known that there are at least five vitamins, designated as A, B, C, D and E, and it is probable that others will be discovered. The absence from the diet of any one of the five will produce certain characteristic effects.

Vitamin A, for instance, is essential to growth and health. Young animals on a diet devoid of it soon stop growing and lose weight. Their vitality becomes lowered and they are less able to resist disease and infection, particularly of the respiratory tract. In many animals, as rats, dogs, rabbits and poultry, and also in man, a characteristic affliction of the eyes results. The administration of Vitamin A prevents or promptly cures this affliction. Growing animals require more of it than do adults. It is abundant in butter, cream, cheese, whole milk, egg yolk, the liver, heart and kidneys of animals, in spinach, lettuce, cabbage, tomatoes, carrots, sweet potatoes, parsnips and green peas, and is present in varying quantities in many other foods. Cod liver oil is rich in this vitamin and the liver oils of some other varieties of fish contain it.

Vitamin B is also necessary for the maintenance of life and health at all ages. Lack of it promptly results in loss of appetite and arrest of growth, followed by various functional disorders and, finally, death. This



Wide World Photos

MME. PIERRE CURIE

Professor of general physics and director of the Curie Laboratory of the Radium Institute of the University of Paris, addressing a scientific meeting at the university.

DR. FLORENCE R. SABIN

Since 1903 connected with the department of anatomy of the Johns Hopkins University, who has become a member of the Rockefeller Institute for Medical Research, New York City. Dr. Sabin was this year elected a member of the National Academy of Sciences, this being the first time the honor has been conferred on a woman.

is the most widely distributed of all the vitamins. It is abundant in green plant tissues. Cereals and seeds contain it, the germ of the seed being an exceptionally good source. Yeast and wheat germ are standard sources of this vitamin in experimental work. Roots and tubers as a class are good sources of it, and it is especially abundant in tomatoes. Most fruits and nuts are well supplied with it. Meat is reported to contain Vitamin B. The heart appears to be the richest in this vitamin, and the liver and kidneys have only slightly lower values. The flesh of the chicken, turkey, duck and guinea fowl, however, are deficient in it.

Notwithstanding the wide distribution of vitamin B in foodstuffs, certain classes of people, as soldiers, sailors, travelers, infants and others, living on restricted or artificial diets, have suffered serious consequences because of a lack of it. Beriberi, one of the diseases produced by the absence of this vitamin, is most commonly found among those living chiefly on polished rice. Removal of the germ and seed coats or bran of cereals takes away practically all the vitamins. Consequently, polished rice, patent white flour, and degerminated corn meal are practically devoid of vitamins.

Vitamin C is sometimes known as the "anti-scurvy vitamin," because a lack of it in the diet causes scurvy, a disease which has been prevalent among sailors, soldiers, explorers and others compelled to live for long periods on dried and preserved foods.

Even in the late World War, Wilcox states, there were more than 11,000 cases of scurvy in the British colonial troops in Mesopotamia during the last half of 1916. Farm animals are not very susceptible to scurvy and it is considered that chickens and pigs are not harmed by a lack of Vitamin C in their diet. The best sources of Vitamin C are lemons, oranges, tomatoes, cabbage, lettuce, spinach, green beans and peas, and turnips. Most green vegetables, fruits, roots and tubers contain Vitamin C in varying quantities. Meat, excepting the internal organs, is a poor source. It has been reported that oysters contain it in abundance. Milk contains it to some extent, but is an uncertain source. This vitamin is easily destroyed by the processes used in the preparation of many food products. Orange juice or tomato juice is sometimes given to babies reared on artificially prepared food as a precaution against scurvy.

Vitamin D seems to control to a large extent the utilization of lime and phosphorus in the formation of bone by the animal organism. Its absence in the diet will cause rickets, a disease characterized by enlargement of the joints, softening of the bones and subsequent bending. Hess states that "Rickets is the most common nutritional disease occurring among children of the temperate zone, fully three fourths of the infants in the great cities, such as New York, show rachitic signs in some degree." This disease can be prevented by a proper diet. It can also be prevented or cured by administering cod liver oil, which contains vitamin D in abundance, or by exposure to the ultra-violet rays of sunlight or the mercury lamp, if the diet contains the other necessary food elements in adequate quantity. This vitamin has been found in egg yolk and to some extent in milk. Coconut oil contains it in slight amount. As yet but little has been learned of the general distribution of Vitamin D in the plant world.

Vitamin E, the anti-sterility vitamin, was originally referred to as Vitamin X, because of the uncertainty as to whether or not it should be classed as a vitamin. Most of the knowledge concerning it has been obtained within the last two years. It has been shown that rats reared on synthetic food mixtures containing fat, carbohydrate, protein, salts and Vitamins A and B, grow well and have every appearance of health, but exhibit complete sterility, affecting both males and females. When small quantities of natural food stuff were added to the ration of these same rats, there resulted in many cases normal sized litters of vigorous young. An excess of Vitamin E can not increase fertility beyond normal limits.

ANEMIA

THE discovery of anemia or pale blood in laboratory animals that is "quite identical with a similar condition that occurs in man," after removal of the stomach, and new data that may lead to the prevention and cure of the condition have resulted from an important experiment in the physiology department of the University of Chicago conducted by Dr. A. C. Ivy and his assistants and made public recently.

International News Reel Photos

MESA VERDE CLIFF DWELLINGS

The largest of the prehistoric ruins in Southwestern Colorado.

Dr. Ivy and his colleagues completely removed the stomach from experimental animals and joined the small intestine to the esophagus or gullet so that food when swallowed entered the small intestine directly. They found that dogs can grow fat and live happily for months on a specially prepared diet of cooked ground meat, bread and milk.

Finally an anemia developed that is said to be the same as that which causes the unnatural paleness of skin in anemic human beings. "It appears from this observation," according to a report on his work by Dr. Ivy, "that the stomach is in some way concerned with the metabolism of iron, a substance that is necessary for the normal functioning of the blood and tissues. Experiments are now being conducted to discover a means by which this anemia can be prevented and cured."

Additional facts illuminating the whole study of gastric secretion have resulted from this experiment. It has been found that the mechanical distension of the stomach by food is one of the causes of gastric secretion. The simple distension of the stomach with a toy balloon will cause the gastric glands to secrete, Dr. Ivy has shown.

Meat contains a substance which will excite the gastric glands when introduced into the stomach. Other foods contain very little if any of this stimulating substance. Fats inhibit or slow up gastric secretion. Partially or completely digested foods acting in the intestine cause the stomach to secrete its digestive juice.

Dr. Ivy and his assistants have been successful in transplanting a part of the stomach and pancreas under the skin in the same experiment. After a meal is eaten the transplanted stomach and pancreas secrete. According to Dr. Ivy, this shows that there is something in the blood after a meal is eaten that causes these organs to secrete digestive juices.

By using the transplanted stomach they have been able to show that during hunger some change occurs in the blood which causes the stomach to contract, resulting in the so-called hunger pains or pangs.

Causes for Variation in the Quality of Distilled-Water Ice*

By Peter Neff

It is apparent to all that there is a great variety in the quality of distilled-water ice, some plants produce a superior grade while others in the same locality do not. This may be due to a multitude of reasons. There are, however, several simple ones which to a greater or less degree affect the quality, and some of these will be considered.

If pure distilled water could be placed in the cans, the ice would be practically clear and of a uniform quality. This condition cannot be realized in practice and all that can be hoped for is to approximate the ideal condition as nearly as possible.

Air in the water is an ever present trouble. If it has not got into the water before, it will do so when the can is being filled. The amount will vary with different tank men, because intentionally or otherwise, one man will so place the can and filler that a minimum amount of water will seal the end of the filler. Where the storage tank is placed so high above the top of the ice tank that there is considerable pressure at the filler, the inrush of the water to the can when the filler is opened will cause a large amount of air to be taken up by the water. This can be avoided by choking the flow to the can-filler hose.

A frequent source of air introduction is produced by draining the storage tank so low that the outlet is exposed, or so nearly so as to cause a suction of the air. There are times when the packing about the stem of the can-filler valve is not tight. When the filler is not in use a small leak may be observed at this point, which usually disappears when the filler is put into service, for the water in passing this opening will cause air to be drawn in.

The most fruitful source of air is the flat cooler, and sometimes the filter as well, when located above the storage tank. In such an arrangement there is a tendency at all times to suck in air through small leaks about the valve stems and joints. By putting water pressure on this part of the apparatus, the leaks may be located. All parts of the distilling system from the reboiler or skimmer to the storage tank should at all times be full of water under pressure.

Where the condition noted prevails, a regulating valve controlled from the reboiler or skimmer should be placed at a point below the bottom of the storage tank. And the opening through this regulator should not be so great as to allow the water to flow through faster than supplied from the reboiler or skimmer, for if it does it will produce a suction on the apparatus between the regulator and the reboiler.

Care must always be exercised to see that the reboiler is not allowed to drain, for when it does enough air is introduced to ruin all the water in the storage tank and in some cases to cause parts of the apparatus to become air-bound. The surest method is to have the flat cooler and filter below the bottom of the storage tank, which will insure their being full of water at all times, but even then it is desirable to have the regulator below the storage tank.

A little care in these particulars, remembering that falling water will suck in air when passing a small opening, will reduce air troubles to a minimum.

Air in the water is manifested in the ice by a white core with radiating needles. But air is not the only cause of white ice. Other gases generated in the boiler from impurities contained in the water used, pass with the steam and are taken up by the water when condensation takes place. Some of these gases have a disagreeable odor, so often noticeable in manufactured ice. A proper venting of the steam condenser will help to get rid of these gases. In other words, allow a small amount of steam to escape from the condenser at all times.

The object of the reboiler is to further eliminate these gases as well as the air, and for that reason the reboiler does better work when the depth of the water is small in comparison with the area of the water surface, so that the gases have a freer exit. In spite of these precautions some gas will remain in the water, and for this reason it is customary to filter the water through charcoal, taking advantage of its peculiar property to retain or occlude them. The capacity of charcoal for this purpose is limited, especially when some oil is passing with the water, as the oil tends to fill up the small interstices in the charcoal. When care is not exercised to thoroughly eliminate these gases in the condenser and reboiler, it is but a short time before the charcoal filter is of no use, although to the eye the charcoal may appear all right.

Of all these gases the principal source is the foreign matter contained in the water used in the boiler. Some gas may come from the oil used, but the greater quantity comes from the water. As the process of concentration goes on in the boiler, more of these gases are driven off, and the higher the temperature of the steam, corresponding to a higher pressure, the more readily will the gases be formed. To obviate this trouble, the boilers should be blown down frequently, and the steam pressure carried no higher than is necessary for the work and supply only the requisite amount of distilled water.

There is another trouble causing white cores and sometimes a white or cloudy appearance of the outside of the cake of ice, with clear ice lying just under it. This trouble also comes from impurities in the water used in the boiler. More or less water is carried along with the steam, and if the boiler is priming the quantity may be considerable. When this raw water contains certain impurities, they crystallize at the same time as the ice crystals are formed, and produce the cloudy appearance referred to, which is easily distinguished from the white ice produced by air. Other impurities concentrate in the center of the ice cake and go to make up the white core. A separator on the main steam line will help eliminate this trouble, which is also lessened by the frequent blowing down of the boiler.

* Reproduced from *Power*.

Cellar Space Made Available by the Use of Prismatic Glass

By James Chittick

In many factory buildings, and other places where productive industry is carried on, there is frequently to be found substantial cellar space which is put to no other use than for storage purpose.

Wherever cellars are to be found, be they under private

Fig. 1.—The original state of the building, with dark cellar space.

Fig. 2.—After alteration, with the cellar space made available for manufacturing operations.

houses, shops, or other buildings, this is generally the case, and the reason they are not put to more profitable uses is the absence of light.

Usually, the top of the cellar is two or three feet above the ground level, and in this limited space are placed small single windows at infrequent intervals, giving but little light at high noon, and, during most of the day, the place is half dark.

Many such cellars will have good head-room, say 8 to 12 feet, and have well-made floors, and, but for the absence of light, would be just as good manufacturing space as any other part of the mill. In fact, for textiles, the cellar space would be superior, on account of its damper atmosphere which facilitates the work.

It is no uncommon thing to find every other inch of habitable space jammed full, and yet spacious cellar room existing but largely unused.

There is a simple, and not very expensive method, that can in many cases be used to make this basement space fully available.

In the accompanying drawing, *A*, I have sketched part of a building, showing how the cellar was originally arranged, and in the drawing *B* I have shown what changes were actually made.

Along the side walls of the building are dug area-ways of convenient and suitable depths and widths. About 4 inches wide and 4 inches deep will often be found to answer very well.

The retaining wall may properly be made about 12 inches thick, with a good stone or cement coping on the top, reaching a trifle above the ground level.

The floor of the area-way may be laid with single brick, and, if there is a convenient sewer connection, it may be faced with cement and sloped toward the outlet to the sewer. If there is no sewer connection available, the bricks should be laid without mortar, so as to allow seepage between them to pass away rain water, and this will be helped if, here and there between them, holes are worked into the ground with a crowbar, so that the water can soak away faster through these holes. The level of this floor can be a few inches below the window sills, so as to prevent any chance of water entering the basement during heavy rainfall.

It is judicious to put braces across the area-way, at frequent intervals, to prevent the chance of the retaining walls caving in. A convenient form of bracing is to place iron plates on the two walls with lengths of 2-inch steam pipe between them. If these are made in two lengths, joined by a coupling, they can be readily tightened or loosened by turning the coupling.

Then the masons should break holes for windows in the cellar walls, at as frequent intervals as the structure of the building will permit, always taking care to keep on the safe side.

The size of these openings should be arranged to hold some regular stock size of window sash, say 5 to 6 feet high and proportionately wide, being the usual double sash with six panes in each half. Starting about 2 inches from the ceiling they might descend to 2 or 2½ inches from the floor. These sashes are bought unglazed, and, being stock goods, are quite cheap.

In the lights of glass to be used, that sort of prismatic glass that is rolled in large sheets should be procured. The makers of this will cut it to order, and they make them charge by the square foot and at a most reasonable price. Sufficient panes for the sashes are ordered, and are glazed in in the usual way. As the weight of this glass is greater than that of the common window glass, heavier sash weights should be provided.

The panes are cut so that the ribs run horizontally, and are glazed so that the smooth side is inside, and the prismatic face outside, the slope of the prisms being downward. In this position, also, they do not fill up with dust easily, and the rain helps to keep them clean.

A good sky-line is very desirable, that is, other buildings should preferably not be so close as to interfere materially with the light.

With an installation made as here outlined, it will be found that the glasses seize the rays of light and project them promptly across the room, making practically every inch of it available for all ordinary purposes and this also, to a great extent, even if it be only lighted from one side.

When lighted from both sides it may be advantageous to arrange that the new windows be not opposite each other, so as to avoid the conflicting of the beams of light.

This means of turning cellar storage space into good manufacturing space for textile work has been employed by the writer on several occasions, and always with the happiest results. If the rental value of the space thus made of use for manufacturing be compared with its value as storage room, it will be apparent that the sum of money spent in making the necessary changes has been made to yield a very handsome profit.

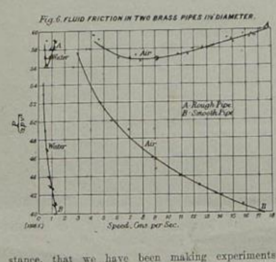
Hardening Steel with Compressed Air

A process whereby steel is hardened by means of compressed air is now in use by a German firm in cases where only certain parts of the metal require hardening. The customary methods of hardening by chilling the steel in water, oil, or special baths is not satisfactory in such cases, owing to the tension created between the hardened and unhardened portions of the treated metal. In the new procedure the compressed air is sprayed over the metal through specially designed nozzles, by means of which, by varying the number and spacing of the openings, the degree of hardening may be accurately graded. The claim is made that a wide range of results can be obtained by adapting the shape of the nozzle to that of the work.—*Journal of Industrial and Engineering Chemistry.*

conclusions.

A simple illustration will show the whole process of reasoning involved from the beginning of an experiment to the development of the law of similitude corresponding to it. Suppose, for in-

Fig. 6. FLUID FRICTION IN TWO BRASS PIPES IN DIAMETER.



stance, that we have been making experiments on a simple pendulum, an[d] [t]hat as a result we [ha]ve found that any alter... [i]n the length pro... very appreciable ... on the time ... we have al... that the for...

If the materials are the same from one size to another, *w* is constant, and we see that the bigger the dirigible the bigger the stress, and that doubling the size of an air-ship without altering the drawings or material reduces its factor of safety to half.

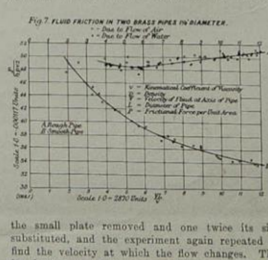
The application to similar aeroplanes which are to travel at the same speed is equally easy, and we find that increase of size does not produce difficulties due to increased stresses.

These rules are not new; engineers have acted on similar rules for a long time. Railway bridges of short span, in which the stresses are mainly due to the train, follow the aeroplane law. Long-span bridges, like the Forth Bridge, in which the stresses are mainly due to the weight of the bridge-girders, and only in a minor degree to the train, follow the dirigible law, and it is recognized that there is an upper limit to the size of cantilever bridges, just as there must be an upper limit to the size of dirigibles.

Interesting as these applications are, they are not so important as the application of the principles of similitude to the motion of fluids, because we have more complete theories available. Theories of hydrodynamics and aerodynamics are, however, very incomplete, and in naval ...tecture are rejected in favor of experiment... ...dels. The ... particular problem is here...

represented in Fig. 4. Instead of a continuous spiral streak, the eddies now come off in definite loops, and there is no resemblance between the new and the old flows. Now, further, imagine

Fig. 7. FLUID FRICTION IN TWO BRASS PIPES IN DIAMETER.



the small plate removed and one twice its size substituted, and the experiment again repeated to find the velocity at which the flow changes. This has been done at the National Physics Laboratory, and it is shown that as nearly as it can be measured the c... occurs in accordance with the friction

THE ROTATION OF MELTING ICE SUSPENDED IN BENZINE.*

BY

H. B. HACHEY, B.Sc.

A PAPER written by A. Artom concerning the formation of hail was published on June 18, 1922, in the *Accad. Lincei. Atti* (31 i, pp. 513–518). In discussing this paper, *Science Abstracts* (No. 306, June 25, 1923) makes the following remarks: " The electrical conditions for the formation of hail are discussed. This takes place in a medium rendered feebly conducting by ionization in which occur insulating bodies, such as the nuclei of the hail. The ionization is due (i) to the emissions from the sun regarded as an incandescent body at a high temperature sending out corpuscles negatively electrified, and (ii) to the action of the ultra-violet rays. Hail is usually seen in the hottest part of the day when the ionization by ultra-violet rays is strongest. Hail is formed frequently between rain clouds with high electric charges, and water vapor in the presence of ice has the property of feeble electric conductivity. In these circumstances the electric field causes an action of rotation which acts on the small drops of water. A piece of ice suspended in benzol begins to rotate and continues this motion as long as the suspending thread permits. Such a rotating mass forms a solid of revolution and such are seen in the case of hail. Helicoidal forms due to the additional action of gravity are also observed."

It is quite improbable that such a theory of the formation of hail could replace the precise explanation of Simpson, which is generally accepted at the present time. However, the writer's statement that a piece of ice suspended in benzol begins to rotate and continues this motion as long as the suspending thread permits, led to an investigation to determine:

(i) Whether ice does rotate when suspended in benzol;

(ii) Whether this rotation is a surface effect or a volume effect;

(iii) Whether it was true of liquids other than benzol.

* Communicated by Dr. A. S. Eve, Director of Physics, McGill University, and Associate Editor of this JOURNAL.

It was first necessary to obtain a suspension thread that would hold the portion of ice to be suspended and yet offer very little resistance to a slight turning moment. Again it was necessary to make certain that all twist was taken out of the suspension thread so that the results obtained would be due to the effects of ice in benzol.

Silk fibre was chosen as the suspension thread, and by attaching a weight (approximately equal to that of the ice) and leaving it in suspension over night, all twist in the thread was taken out. The ice was suspended in benzol whose temperature was about 20° C., and it was seen that the ice revolved until the suspension thread stopped the motion. This was repeated with the benzol at temperatures ranging from 20° C. to −10° C. and it was seen that the speed of revolution decreased with the lowering of the temperature until it reached the point (somewhere between 5° C. and 0° C.) where all motion ceased or was practically negligible. When a temperature of −10° was used, there was absolutely no motion of revolution noticeable. Then the height of the ice from the bottom of the vessel was varied and it was seen that the speed of revolution varied with the height of the ice above the bottom of the vessel, *i.e.,* the greater the height the greater was the speed of revolution, always, of course, provided that a portion of the ice was under the surface. Again, the speed depended to a certain extent upon the amount of ice immersed, for the revolving motion was much more rapid when the ice was completely immersed than when it was only partially immersed (keeping the height of the ice above the bottom of the vessel constant). It was also noticed that the direction of rotation was not constant and that when the same piece of ice was inverted it did not always turn in the opposite direction.

All through this investigation it was apparent that when the ice had motion of revolution (when the temperature of benzol was above 0° C.) a steady stream of water flowed from the ice to the bottom of the vessel containing the benzol. As soon as large drops, which also formed on the lower end of the ice, gave way and were precipitated to the bottom of the vessel, the rotation of the ice was accelerated.

The experiment was repeated with water and also with gasoline. When ice was suspended in water there was absolutely no motion of revolution noticeable; but when the ice was suspended in gasoline the results obtained were similar to those obtained with benzol.

From the results obtained the natural conclusion is:

(i) That ice when suspended in benzol does rotate.

(ii) That the speed of rotation decreases as the temperature of the benzol is lowered and all rotation ceases when the benzol is at the temperature of 0° C.

(iii) The rotation also takes place when gasoline is used, but in the case of water the ice did not rotate.

(iv) That the rotation is probably due to the downward flow of the denser melted water producing a torque owing to its irregular motion reacting on the ice, particularly when the surrounding medium is much less dense.

Use of Diphenylamine as an Indicator in the Volumetric Determination of Iron.—J. KNOP (*Jour. Am. Chem. Soc.*, 1924, **46**, 263–269) recommends the use of diphenylamine sulphate as an internal indicator for the titration of ferrous salts with standard potassium dichromate solution. Three drops of a 1 per cent. solution of diphenylamine in concentrated sulphuric acid are used as an indicator in each titration. The end-point occurs when the addition of one drop of the potassium dichromate solution produces an intense violet-blue color, unchanged on further addition of that reagent. The method may be applied to ferric salts, which have been reduced by stannous chloride followed by addition of mercuric chloride. This method also permits back-titration. J. S. H.

Mercury as an Industrial Poison.—J. A. TURNER, of the United States Public Health Service (*Pub. Health Rep.*, 1924, **39**, 329–341), has studied several cases of mercurial poisoning, due to the passage of mercury vapor into the atmosphere from the mercury gaps in induction furnaces. He finds that the signs and symptoms of mercurial poisoning are produced in man by exposure, for several hours daily during a period of two or three months, to an atmosphere containing as small a quantity as 0.02 milligram of mercury per cubic foot of air. If the daily period of exposure be between three and five hours, the daily absorption of mercury ranges between 0.771 and 1.285 milligrams. The symptoms develop chiefly in the mouth and gastro-intestinal tract; the blood and urine are not affected. The mercury vapor from the furnaces condenses, for dust from the furnace room contained from 1 to 3 per cent. of metallic mercury. Poisoning of this nature is best prevented by inclosing all apparatus in which mercury is used, and by conveying the fumes away from the worker's face so that it will be impossible for him to inhale them. J. S. H.

A Determination of the Vapor Pressures of Cæsium and Rubidium. D. H. SCOTT. (*Phil. Mag.*, Jan., 1924.)—The method used was that published by Haber in 1914. A quartz fibre .7 or .8 mm. in diameter and some 8 cm. long, supported in a wide glass tube, is illuminated from the side and observed through a microscope. "When the fibre is at rest a sharp line of light is seen in the field of view, and if the fibre is set in vibration this line broadens out into a band whose width can be measured on a scale in the eyepiece of the microscope. The method of using the instrument consists in observing the time taken for the amplitude of vibration to diminish to a definite fraction of its original value." Let there be more than one kind of gas present in the space surrounding the fibre as it executes vibrations in a plane. For each of these gases form the product of its pressure multiplied by the square root of its molecular weight. Add the separate products together and to the sum add a quantity *a*, a constant. Then the product of this final sum by the number of seconds required for the bright band to diminish to a definite fraction of its original width equals another constant, *b*. The values of *a* and *b* are obtained by measuring the pressures of known gases by means of a McLeod gauge in connection with observations of the times of dying down. Once these constants have been determined the relation given above may be used to get the pressure of a gas whose molecular weight is known.

As a test the vapor pressure of mercury at 20° C. was found to equal $1.30.10^{-3}$ mm. This is an intermediate value in comparison with those got by others. When used for cæsium and rubidium the apparatus had to be kept in an air-bath at 150° C. to avoid condensation of the metals. The metal was contained in a tube connected to the main tube in which the fibre vibrated, where it was electrically heated. The pressures were determined for temperatures ranging approximately from 50° to 130° C. Formulas for the pressures are given. By using the letter *T* to indicate two different things, the author has added unnecessary difficulty to his paper. G. F. S.

Hydrates of Lime.—R. T. HASLAM, G. CALINGAERT, and C. M. TAYLOR, of the Massachusetts Institute of Technology (*Jour. Am. Chem. Soc.*, 1924, **46**, 308–311), have demonstrated that lime forms only the monohydrate $CaO.H_2O$ or $Ca(OH)_2$. Efforts were made to prepare a dihydrate by evaporation of lime water at a temperature of 30° C. in dry air and in a vacuum, by precipitation of solutions of calcium salts by means of potassium hydroxide, and by long contact of hydrated lime with water at a temperature of 55° C. All these procedures yielded only the monohydrate. Redetermination of the solubility curve for calcium oxide in water showed definitely that no dihydrate exists. J. S. H.

THE BIRTH OF KINEMATOGRAPHY, AND ITS ANTECEDENTS

By W. DAY

A LECTURE on the above subject was delivered on 25th January, 1923. Some of the principal writings and inventions referred to are given in the following chronological tables*:

Science of Optics and Early Portrayals of Life Motion.

Chinese shadow shows, using buffalo hide figures on parchment screen	5000 B.C.
Glass formed at Sidon by the Phoenicians	*ca.* 400
First lens formed by glass globe filled with water—Hero of Alexandria	
Persistence of vision mentioned in writings of Lucretius	65
Persistence of vision mentioned in writings of Claudius Ptolemy	130 A.D.
Alhazen's writings on optics	1100
Bacon's writings mention many items of applied optics	1260
Many remarkable optical applications mentioned by Leonardo da Vinci, born in 1452	
Maurolycus' writings in the early part of the 16th century	
Girolamo gives many interesting facts in his book written about	1550
Giovanni Battista Porta wrote his book *Magica naturalis*	1558
Dr Dee's work on optics	1570
Thomas Digges' work on optics	1571
Francis Bacon's work on optics	1626
Descartes' work on lens grinding	1638
Galileo, Huygens, Manzini, James Hodgson, Smith, and Sir David Brewster all propounded important theories in their books on optics.	

The Optical Lantern.

The ancient Priests and Magi used optical lanterns and lenses in Temples at Tyre and throughout Egypt, Greece, and the Roman Empire	
Athanasius Kircher and Walgenstenius invented the optical lantern in its present form at the Jesuit College, Rome	1640
Zahn's *Artificialus telediopticus*—the first published work after Kircher's book *Ars magna lucis et umbrae* to give an exhaustive account and illustrations of the optical lantern	1685
Professor Child invented the Bi-unial Lantern and Phantasmagoria	1801
The Polytechnic gave early lantern displays	1838
The Coliseum, Regent's Park, gave early lantern displays	1850

The Camera Obscura, the Camera, and Photography.

Camera obscura first suggested by Friar Bacon	1260
Leonardo da Vinci first gave illustrations explaining theory and application of camera obscura towards the close of the 15th century	
Camera obscura written of and fully described by Giovanni Battista Porta in his book	1558
Camera obscura fitted with lens first mentioned by Daniel Barbaro	1568

Alchemists in Middle Ages noted change of white chloride of silver to black chloride
Germany wrongly claims invention of photography for Dr John Hermann Schultze 1727
First actual photography on paper invented by Thomas Wedgewood . . 1792
Sir Humphry Davy assisted Wedgewood and introduced him to the Royal Society
Dr Wollaston and Mr Ritter, early experimenters in science of photography
Nicéphore de Niepce, the originator of the Daguerrotype 1814–27
Daguerre perfected and produced Niepce's invention 1829
William Henry Fox-Talbot invented the Talbot-type process 1833
Professor Faraday and Sir John Herschel both carried out researches in the science of photography and read papers before the Royal Society . . 1839
Rev. J. B. Reade invented the ferro-prussiate process
Other clever inventors in the science of photography include Mons. Hippolyte Bayard, Scott Archer, Sir William Crookes, John Spiller, Sayce and Bolton, Dr R. L. Maddox, and Clerk-Maxwell

Light and its Application to Projection.

Sunlight reflected by the aid of mirrors and used to project forms of images in the ancient Temples of Egypt and Greece
Candle and oil lamps were both used by the ancients.
Huygens' undulatory theory of light
Sir Isaac Newton's corpuscular theory of light 1672
Professor Gravesend first produced four wick oil lamps for use in lanterns
Argand invented his atmospheric oil lamp 1789
Argand invented his atmospheric gas lamp 1808
Bude light invented 1810
Lieut. Drummond invented the oxy-calcium light 1826

Electricity.

First records of electricity by Thales of Miletus . . . . 600 B.C.
Sir Isaac Newton mentions knowledge of electricity . . . . . . 1675 A.D.
Sir Charles Newton
Count Alessandro Volta 1745–1827
André Marie Ampère 1775–1836
Professor Faraday
Sir Humphry Davy 1801
Soleil Dubosq clockwork arc lamp
The dynamo first suggested by Arago 1824
John Browning's arc lamp 1858
Other clever inventors of electrical generating apparatus include Pixie and Ritchie, Clarke, Nollett, Siemens, Wills, Ladd, and Gramme

Films as applied to Photography.

Celluloid—a mixture of nitro-cellulose and camphor—invented by Mr Alexander Parker of Birmingham 1675
Celluloid first used as a flexible support for a photographic negative by Mr Hyatt of Newark, New Jersey 1867

of Standards, No. 501. 110 pages, illustrations, plate, 8vo. Washington, Government Printing Office, 1925. Price, fifteen cents.

United States Department of Agriculture: Elimination of Waste Simplified Practice. Steel Reinforcing Bars. 8 pages, 8vo. Steel Lockers (Single and Double Tier). 8 pages, 8vo. Washington, Government Printing Office, 1925. Price, five cents each.

The Light Emitted by Tubes Containing Both Neon and Mercury Vapor, Along with the Liquid Metal. G. CLAUDE. (*Comptes Rendus,* March 23, 1925.)—Temperature has a considerable effect upon the quality of the light sent out by a mixture of neon and mercury vapor traversed by an electrical current, especially when the external diameter of the tube does not exceed 8 or 10 mm. "When the temperature is high, only the mercury spectrum appears. If the temperature is lowered progressively, some lines of neon are visible, then the light turns white, then rose, and finally red. This change manifestly comes about thus. As the tube cools down the tension of the mercury vapor diminishes step by step and the neon assumes more and more the task of transporting the current." With these ideas in mind the author constructed a tube with wide and narrow sections alternating, an electrical analogy to a chain of lakes joined by streams. He argued that in the constricted portions of the tube the temperature would be higher and in consequence the light from mercury would make its appearance, while in the wider and cooler parts the light of neon would show itself. Experiment, however, showed that the opposite took place. Under conditions not especially restricted, light from the mercury vapor alone was visible in the wide parts, while neon monopolized the emission of light in the narrow portions of the system.

The following experiment is valuable in getting an explanation of the unexpected results. In a tube of ordinary form that is emitting blue light, let the strength of the current be suddenly augmented. Then the light of neon springs into prominence, almost extinguishing that of mercury. "This effect is, however, fugitive. After a few seconds the stronger current volatilizes more mercury. This substance regains the upper hand and excludes the neon from light production. This shows us that a given mixture of neon and mercury has its mercury excited by a small density of current and has its neon excited by a high current density." In the case of the tube made up of wide and narrow sections, the temperature in the narrow parts is higher and more of the liquid mercury evaporates there. The tension of the vapor is, however, not permanently higher there than elsewhere in the composite tube, because the general tension is governed by that of the coldest part, which is the wide sections. There is thus established throughout the whole tube a certain pressure of mercury vapor. Where the current density is small, *i.e.,* in the wide sections, mercury light appears, and in the narrow parts with their high current density it is the neon that furnishes the light. The author has thus, notwithstanding the early error of his reasoning, come upon a way of getting mercury light and neon light at the same time from a uniform mixture of the two radiating substances. A simple method of constructing the tube with wide and narrow parts is by inserting into a tube of uniform bore closely fitting sections of other tubing with narrow bore. By changing the lengths of these inserted sections the relative proportions of the two kinds of light will be varied and thus the resulting color will be controlled.

Within the past year the resignation of the distinguished author of this paper, perhaps best known for his work in the production of liquid air, from the reserve of the French army, was announced in the *Matin*. He had been assigned to duty in the selection of horses and objected to this diversion of his abilities. G. F. S.

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PHILADELPHIA

How the Germans Utilize Waste—VI

Wealth That Has Been Earned By the Efficient Use of Raw Material

By Waldemar Kaempffert

(Concluded from page 534, June 15th, 1912)

[*THIS is a continuation of an article that was begun in last week's issue. It is the sixth of a series of articles prepared by the Managing Editor of the* SCIENTIFIC AMERICAN *on European industrial conditions. The author was sent to Europe by the publishers of the* SCIENTIFIC AMERICAN *for the purpose of studying the application of science to business abroad. So much have the Germans done in the application of scientific principles to the utilization of waste, that little more can be done than to give glimpses of a small part of a vast field that they have so admirably covered.*]

Making Precious Stones With Waste Gas.

At Bittersfeld, electrolytic hydrogen is also used for the production of artificial gems. At the beginning of the present century, Verneuil, of Paris, succeeded in devising a process of making synthetic rubies, and another Frenchman, Michaud, in the middle of the nineties, succeeded in making what are known as "reconstructed rubies" out of natural ruby fragments. Almost at the same time a German gem polisher named Herman Wild of Idar, began to make real artificial rubies. Later he collaborated with Prof. Miethe. They developed a process which was eventually adopted by the Bittersfeld works. In that process, hydrogen plays an important part. Not only are real rubies thus made, but genuine sapphires, topaz, and other precious and semi-precious stones. These products must not be regarded as mere imitations of real gems, but as genuine precious stones.

Germany's annual potato crop is somewhere in the neighborhood of 45,000,000 tons. The supply is considerably in excess of both household and industrial demands. New channels had to be found to use up the surplus profitably, and if possible, to save a portion of the 10 per cent of the total crop which annually goes to waste through decay and the lack of proper winter storage. About eleven years ago the German Association of Alcohol Manufacturers, the largest industrial consumers of potatoes, took this task upon themselves. They organized a branch of their association to be known as the German Potato Driers' Association and assigned to it the task of studying methods of using dried potatoes in the various forms in which they could be produced. To increase the general interest in this question, the Alcohol Association succeeded in raising from interested sources, including two subscriptions from the government, the sum of 30,000 marks to be distributed as prizes for the best methods of reducing potatoes to an available stock food. Of the forty entries received, only twenty-two failed to answer the requirements. One of the most successful systems proved to be a method of washing the potatoes, steaming them, and passing them between two rollers, heated to 284 deg. Fahr., then removing the dried and crushed substance from the rollers by knives and passing it through a cooling funnel, after which it is ready for storing. The surplus supply of potatoes is thus worked up into a nourishing animal food.

Generating Power from Sewage.

The city of Berlin affords an excellent illustration of the enormous development to which the pursuit of sewage disposal by sewage farming has led. The city itself covers an area of about 20,000 acres; its sewage farms are no less than 40,000 acres in extent. In a way the Berlin sewage farm is a gigantic real estate speculation. Ultimately the city will sell the sewage farm land at a large profit and turn to modern biological methods.

Our present mode of disposing of sewage by pouring it into streams is exceedingly wasteful. It represents so much nitrogen which has been extracted from the soil, and which ought, by right, to be returned to the soil. If it could be advantageously used, it would represent a value of about $200,000,000 a year to England alone. This, however, is distributed over a quantity of three billion tons. Sewage is so complex in its nature that the recovery of its chemical constituents would be almost a hopeless task. That, however, is no reason why some method should not be devised of utilizing it as a fertilizer. As a general rule, the sludge is dumped on land which has been bought for the purpose, but in many European towns land suitable for that purpose is nearly all filled up. Consequently it is a serious question what shall be done when no more land is available. Farmers have endeavored to use the sludge as a fertilizer; but that is not always practicable, partly because of the chemical character of the sludge and partly because of the farmer's distance from the dumping ground.

Experiments carried out at Bruenn have shown that sewage sludge, after it has been dried until it contains 25 per cent of dried substance, is superior to most animal fertilizers in its content of nitrogen and of phosphoric acid. As the quantity is too great to be disposed of locally, it has been successfully used after complete drying for the production of lighting gas.

Making Clothes Out of Wood.

From Germany we can learn how to make the most out of a tree in an industrial way; for in Germany a tree which as a cord of wood is worth little more than three-fourths of a cent to a cent a pound, is converted into artificial silk worth $2 a pound, and into artificial bristles of cellulose acetate worth $4 a pound. Thanks to the German chemist, trees may now serve to clothe a man. A whole industry has sprung up in the last decade for the express purpose of scientifically converting wood into cloth—wood, moreover, which would otherwise be wasted in fashioning round tree trunks into rectangular boards, and beams. In Saxony, for example, a yarn called "xylolin" is made from paper as well as directly from wood pulp. From that paper, yarn, twine, cord, carpet, imitation canvas, and even whole suits of clothes have been made—all of them proof against the action of both hot and cold water. A large corporation has built a factory not far from Berlin for the purpose of making "silvalin" yarn from spruce, of which there are fairly large tracts in Germany. Like its cousin "xylolin," "silvalin" can be woven in the loom to produce whole pieces of cloth which in their essence are nothing but transformed trees.

The whole German cellulose and nitro-cellulose industry is a brilliant example of what efficiency means in the utilization of wood. The production of artificial silk from wood is alone a triumph of the application of science to industry. The credit for the original discovery belongs to Chardonnet. The process that he devised has not been very radically changed to this day. An ether-alcohol solution of nitro-cellulose is employed. At first the liquid was squirted through a fine opening, the resulting thread congealing in cold water. Each thread was composed of a tube with a liquid interior. As it emerged from the fine opening, it was rather coarse, but it was spun into a thin filament later. Nowadays very fine openings are used, as small as 8/800 of a millimeter.

In the last twenty years, Germany has built up a huge industry on cellulose derivatives. All of them cannot even be mentioned here. In the manufacture of incandescent mantles, both for coating the mantle to enable it to withstand the shock of handling, and in the production of mantles themselves by the ejection of filaments containing the thoria and ceria, to be afterward woven into mantles; in the production of pyroxylin for imitation leathers and the manufacture of continuous film (an improvement which has undoubtedly contributed more than any other discovery to the popularity of photography and especially of the moving picture)—in all these we find that cellulose is nowadays employed as a vital necessity. Little did Schoenbein dream that the gun cotton (nitro-cellulose) which he had invented would find far greater application in the arts of peace than in the art of war. Thanks to his discovery many articles hitherto made from expensive natural products are now made chiefly from wood waste. Between five thousand and six thousand patents on nitro-cellulose and its uses are now to be found on the records. Even the scientist has benefited by the wider application of cellulose. Museum specimens are now prepared with it, particularly sections for the microscope; important documents are preserved by means of it; special tubes for deep sea sounding are made of it, the tubes being coated inside with silver chromate. All these are minor but still important applications of nitro-cellulose solutions.

Artificial Wood.

Many a large building in Germany is floored with a material which is obviously not cement, because it is not hard enough, nor linoleum because it is not quite soft enough despite its elasticity. Ask an architect what that curious material is and you will be told that it is pressed sawdust mixed with magnesium chloride. Wood is too expensive in Germany to be burned under a boiler—the American method of utilizing most sawmill waste. Hence the sawdust floor. We in the United States have not been blind to this new use of what was once a waste; for the German manufacturer will tell you that the American too is beginning to mix his sawdust with magnesium chloride. Like most German industries, however small, the process of making a flooring from sawdust is conducted on strictly scientific principles. Something more than a haphazard mixture of sawdust and magnesium chloride is required. The chloride absorbs water very readily. It is what the chemist calls hygroscopic. Unless some scientific method is adopted to effect the mixture, a perpetually damp floor will be the result. Accordingly, the manufacturers have employed chemists to solve that problem for them. It is the business of the chemist to ascertain the correct proportions of the mixture. The usual process is to add the sawdust in the right quantity to a cement-like mass composed of a solution of magnesium chloride to which powdered magnesia is added. Sometimes the manufacturer delivers tiles of this composition, and sometimes he mixes the composition on the spot, works it in the form of a plastic mass, and allows it to set. The cost is rarely greater than $2 a square yard. The effect of linoleum and parquet flooring is obtained by adding coloring matter. Even wainscoting, stair coverings, and roofing tiles are thus made. One manufacturer supplies the raw material itself and the formula for mixing it, so that you can lay your own floor, and exercise your own ingenuity and good taste. Some of these artificial wood floorings and wainscots are made from bottle corks. Perhaps that explains why the waiters in every German hotel have developed a squirrel-like faculty of treasuring cork stoppers.

The Manufacture of Soda.

There is a rivalry in applied chemistry in Germany that is just as keen as business rivalry. A brilliant example is to be found in the competition between the LeBlanc, the Solvay, and the electrolytic process for the production of soda from waste. A capitalization of $25,000,000 was practically wiped out in the last ten years in Germany when Solvay succeeded in placing the ammonia-soda process on its commercial feet by inventing suitable apparatus to compete with the LeBlanc process. A few factories managed to save themselves by turning to other fields; for example, a factory near Stettin started in to manufacture superphosphates in its sulphuric acid plant. In Aix-la-Chapelle, however, an ingenious chemical engineer succeeded in so far improving the old apparatus, that the LeBlanc process is still worked there with commercial success. The same holds true for Heinrichshall. The struggle between the LeBlanc and the newer processes was even keener in England. Forty-five factories were threatened with extinction. They united together to form the United Alkali Company. By increasing the efficiency of the old LeBlanc process, and by utilizing to the utmost such by-products as hydrochloric acid, chlorine, sulphur and chlorate, for which there was a great demand in England and the United States, they managed to keep their heads above water and to make money. What is more, they also succeeded in assimilating the new processes. A curious change in values of the individual products has taken place. Hydrochloric acid, which at one time was simply driven off into the air, to the intense disgust of the vicinity, or run into the sea, soon became the financial pivot of the entire undertaking. Sulphur, which combined with calcium, accumulated in great heaps or was poured into the sea with the waste dye, was afterward exported by the hundred-weight to America.

Very justly the LeBlanc process has been called the high school of all industrial chemical work. The process was of no use to such young countries as America, Italy, Russia. They had no means of disposing of the by-products which have now become actually main products. For their need the extraordinarily simple and cheap method of the ammonia-soda and the electrolytic processes are wonderfully efficient. Thus, even in Italy, which has begun to develop its water powers of recent years, these processes can be carried out commercially if the chlorine is disposed of in some way. The textile industries have thus far proved the chief consumers of the chlorine. The alkalis, on the other hand, are absorbed in enormous quantities by the textile, soap and candle industries. The result is that a good deal of soda must still be imported. Hence, it is a matter of vital importance to find a new outlet for the chlorine.

floating vessel or fuel accumulator. The main improvement in this type is that the steel columns scheme is worked out more completely than in previous engines.

In 1912 Sulzer Brothers also put a set of engines in the "Monte Penedo." These are two-cycle, single-acting engines with four cylinders 18.5 inch bore and 26.8 inch stroke, running at 160 revolutions. These engines are remarkable for the absence of inlet and exhaust valves. The only valves in the cylinders are the fuel injection and air starting valves. It makes a simple cylinder head but involves complications in the cylinder wall. The exhaust takes place through openings in the cylinder walls forming one half circle, the other half of the periphery is taken by openings for scavenging air. Of these there are two rows, one above the other, and the communication between the air main and the top row of openings can be blocked by a double seated valve. This ship is probably the most successful two-cycle marine motor in service. After some trouble with the pistons (the extension required to shut the exhaust and inlet ports worked loose) the construction was altered and since then the motors have given full satisfaction. It must not be forgotten, however, that these engines were of the very best workmanship and were worked by a carefully selected set of engineers.

The "Arthur von Gwinner" is fitted with two four-cycle Junkers engines. The principle of the Junkers engine has many attractions. The balancing of reciprocating forces, the absence of cylinder heads and stuffing boxes are advantages of great importance, but difficulties have arisen with the cylinders and the cooling of the pistons requires very difficult details. The ship had to repair very often before her working was stopped by the war.

Some data of a very light engine built for a small Netherlands gunboat by Werkspoor of Amsterdam is here given. The power in each propeller is 600 brake horse-power at 300 revolutions; the cylinders are 15.4 inch bore and 19.7 inch stroke. The two engines are inclined toward the center of the ship and form a triangle. The result is an extremely stiff engine, very accessible and as light as the lightest two-cycle motor of this power at these revolutions. There is one cast steel bed plate for the two motors. This bed plate, which is very light, is connected by steel columns to the two lines of six cylinders, which are united in one block by a bolted flange over the full length of the motor. The weight of this twin motor, including fly wheel, up to the thrust bearing is 33 tons.

In May, 1914, the "Arum," with English-built, Polar-type engines made her trials. The engines are of the single-acting, two-cycle type. Each has four cylinders of 16.2 inch bore and 33.9 inch stroke, speed 135 revolutions, rated power 650 brake horse-power each. After performing various short trips, the "Arum" was sent on her first long voyage to the Persian Gulf, which was perfectly successful.

In a motor ship an important question is how to drive deck machinery and engine-room auxiliaries. When money and a good personnel is available, the best system is electricity for everything. Where fuel is expensive, this system is also the most economical in the long run. In first cost it is the dearest and a staff of engineers is required who can tackle a great many novelties at once. To save cost and dispense with novelties the best plan is to have two donkey boilers. Fire them either by coal or oil and drive everything by steam, including the air compressor required to maneuver the main motor. When the ship runs several days continuously and the motor is four-cycle, the waste gases can heat the donkey boiler, giving plenty of steam for steering. The gain is about one ton of oil per day for vessels of 6000 tons. In short runs this system can not be applied. To drive the auxiliaries by compressed air has not proven a success. In tank ships it is a good system to make the main cargo-discharging pump centrifugal and drive it by a Diesel motor. The same motor can drive the air compressor for maneuvering. This system is slightly more expensive in first cost, but, when the ship has to unload often, is cheaper in service than steam pumps.

In the first years the builders of Diesel engines prescribed the use of solar oil, a distillate of petroleum having a specific gravity of not more than 0.88; a flash point of 180-212 deg. Fahr., and a calorific value of at least 18,000 British thermal units. Most of the Diesel engines up to the present day have run on oil of approximately this composition, but gradually other heavier kinds have come in use. The only inconvenience is that the starting of the motor is not always certain, so that some ship-owners prefer to use solar oil when maneuvering even if heavier oil is the usual fuel.

Although it was first thought that asphaltum prevents complete combustion and it was feared that it would cause deposits on the exhaust valves and the pistons, extensive tests proved that, when the motor is in good working order, the exhaust is perfectly clean and no trace of deposit is found after prolonged running. It was found possible to burn oil containing a very high percentage of asphaltum without trouble, as the cylinder temperature, at the moment the oil is introduced, is high enough to start combustion and once started, the temperature rises so high that when care is taken to mix the atomized fuel thoroughly with air, practically all kinds of oil can be burned.

For heavier oils it was necessary to construct a special sprayer, which atomizes the oil more effectively, and to heat the oil in tanks and pipes to and from the fuel pump to diminish the viscosity. On the heavier oils the motor can not be started, so it is necessary to change the motor before stopping to solar oil till the pipes and fuel pump are filled.

This is, in main, the history of the Diesel motor as applied to merchant ships at present. It has proved that this engine, if well designed, well made and well attended to, is reliable enough for the longest voyages and is at least four times more economical in fuel, weight for weight, than a coal-fired steamship, or nearly three times more economical than an oil-fired steamship. The short history has also proved, in my opinion, that it is more difficult to make a reliable two-cycle motor, under the normal sea attendance, than a four-cycle.

Probably the two-cycle motor will become cheaper than the four-cycle, although the results thus far have not shown it. The running economy of the latter is greater, especially when the waste gases are passed through a steam donkey boiler. The cost to make a good marine motor is, and will remain probably, about one third higher than to make a good reciprocating engine of like power, but this higher price is partly compensated by the cheaper ship, because the motor takes up less room and weight than the steam engine and the bunkers can be made smaller. This latter saving depends upon the distance between the places where it is economical to fill up bunkers. The large motor ship requires fewer men than the large steamship; the quality of the men must, however, be higher. Difficulties with firemen are eliminated; but the motor, if not very well attended to, is apt to require more repair than the steamship. Balancing these good and bad qualities of motor and steamships, the fuel price in the parts of the world where the ship has to run will generally decide a choice. In special cases, however, the fuel factor will not be the main consideration, as the following qualities of the motor-driven ship are of greater value: That it does not require any warming up of boilers or engines, the motor ship can start at full speed as soon as the oil tanks are filled. That it is possible for a motor ship to bunker at very long intervals, three or four times longer than a steamship. And last, but not least, that motor ships can be made in which the part of the ship where the engines are placed is of the same temperature as the other parts of the ship. In hot climates this quality will go far to turn the balance when the engineers have a say in the decision.

Micro-Weighing*

Emerging from primitive life man, in observing his surroundings, is gradually led to explore Nature experimentally with a view of controlling her, as far as possible, in his own interest. In doing so his observations proceed in opposite directions. On the one hand he extends his sphere of activity in endeavoring to survey his home, his country, his continent, his planet, his planetary system, and finally the entire universe. This has been called the macroscopic world. On the other hand he attempts to fathom the inter-relation of particles growing smaller and smaller. This is the microscopic world. In his macroscopic observations he soon finds that ordinary, everyday devices are insufficient and that probably every extension of his horizon requires new means of investigation. (Thus man did not thoroughly know his own planet until the means of communication had been improved; the telescope revealed the solar system; the spectroscope, the bolometer, photography, photometry, indicate the existence of other systems.) On the other hand we may also say that it was only by refining and extending his means of research that man was enabled to penetrate the micro-world. In this direction investigation was stimulated chiefly by the evolution of optical devices: the magnifying glass, the microscope, the ultra-microscope, micro-photography, micro-chemistry. In this category—although only remotely related to the rest—we may also place the weighing of minute masses, which may be called micro-weighing. The problem here becomes to sharpen our sensibility concerning variations in mass to as high a degree as possible in order to ascertain whether our deductions and extrapolations from our more elementary and cruder experiments—deductions that most of us erroneously consider, and were taught to consider, as absolute—whether, we repeat, such deductions also hold for minute and infinitesimal changes, or whether, in this case, variations become noticeable that would alter or modify our original theories. It is thus seen that it may not merely be a question of adapting our instruments to the new requirements, but that the result, ultimately, leads to a further adaptation of our theories, and hence of man himself, to nature; for a new theory or conception, once established, influences our life accordingly and brings us into closer harmony with nature.

The evolution of micro-weighing is somewhat different from that of other micro-investigations. With all of the latter the microscope is of primary importance in as much as phenomena are observed directly under the microscope. The weighing of minute masses, i. e., micro-weighing, has not yet been attempted directly under the microscope and, in the writer's opinion, this possibility is quite remote, although it is true that optical means may be resorted to in reading deflections, i. e., only indirectly. This condition of things is caused by the relation of gravity to the other forms of energy, for in weighing even the smallest object which could easily be placed under the microscope, an apparatus would be required which would be entirely too bulky under the microscope. This reflection may seem rather idle, for the instrument for weighing is simply the balance, and in micro-optical observations, for example, the microscope is the medium corresponding to the balance. We may conclude, however, that a comparison of masses (i. e., the determination of weight) under the microscope (possibly without the aid of a balance), precisely like optical phenomena and possibly by means of the latter, cannot be proved offhand to be impossible. If this should be feasible, however, the microscope—the most sensitive instrument at our disposal—would have become applicable to the determination of masses, just as it is used with other phenomena. This is a mere suggestion which will require much thought and effort before it will be possible to make any definite predictions as to its practicability.

Regarding the gradual development of micro-weighing we may add the following data. The first micro-balance was probably constructed by Warburg and Ihmori in 1886 (i. e., comparatively recently). The beam of this balance consists of thin quartz rods to which razor knife-edges are fastened by means of cement. The deflection produced by the load is read from a mirror and scale without taring with weights. The smallest weight that can be determined with this balance is one one-hundred thousandth of a grain (1×10^{-5}g.). At present the trade supplies small analytical balances having the same sensibility but a much greater capacity up to 10 grains. These balances are used with weights.

The principle of elasticity for the comparison of masses was first applied by Salvioni. Here, then, we meet with the first departure from the devices used in ordinary work. In the spring balance, it is true, elasticity also finds application, but in an entirely different form. Salvioni horizontally clamps at one end a quartz fibre which is straight and not bent in the form of a spiral as in spring balance; he then observes, by means of a mirror, the deflections caused by different loads placed in a tiny pan suspended from the other end of the quartz fibre. The deflections are, within the limit of error and just as in Warburg's balance, proportional to the load and the sensibility is about the same in both balances. In Salvioni's balance the mass to be determined counteracts the elasticity.

A new physical principle is involved in the torsion micro-balance according to Nernst and Riesenfeld. In this device a quartz fiber is cemented to the prongs of a vertical brass fork. To this fiber a thin glass rod is fastened horizontally by means of cement. One end of the glass rod is bent and moves, as a pointer, over a silvered scale; the other end carries a tiny pan. In this balance, we have no swinging on knife-edges, but all parts are rigidly connected and a load causes a torsion of the quartz fiber. The lower limit of the sensibility is five millionths of a grain (5×10^{-6}g), with a maximum load of 2 milligrams.

Another type of beam balance does away with the taring with weights ordinarily used with beam balances. The entire operation of weighing is carried out in a case from which the air can be exhausted. A quantity of air inclosed in a small glass sphere serves as a counterpoise. Now if the air within the case is gradually exhausted the ratio between the loads changes according to the principle of Archimedes as applied to air, i. e., the ratio between the glass sphere and the mass to be determined—provided that the volumes on the two sides are not alike; the latter, of course, is never the case in weighing solids or liquids. A certain definite pressure inside the case will therefore correspond to the zero point. From this pressure the weight may then be calculated. In this case, therefore, a manometer takes the place of a set of weights. In this manner one ten-millionths of a grain (1×10^{-7}g.) may be determined with accuracy.

Recently Riesenfeld and Möller have described a new micro-balance which is a refinement of the Nernst balance. This new balance, will carry a maximum load of five thousandths of a grain (5×10^{-3}g.), and is sensitive to thirty-three billionths of a grain (3.3×10^{-8}g.), and is therefore regarded as the most delicate micro-balance known.

*Translated from *Prometheus* for the Scientific American Supplement.

Percussive Electric Welding*

Process and Machines for Uniting Similar or Dissimilar Metals

By Douglas T. Hamilton†

Percussive electric welding, which is one of the latest developments in the electric welding art, was originated by L. W. Chubb of the Westinghouse Electric & Mfg. Co., during the year 1905. While he was experimenting with electrolytic condensers and rectifiers, he noticed that the wires could be connected to the aluminium plate by the condenser spark when the cells were discharged. It was also noticed that copper wires could be attached to aluminium or that two pieces of aluminium could be joined by the condenser spark. The joint thus made, however, was not strong, but after a careful consideration of the results of these early tests, it was decided to try out this method of welding with a greater condenser discharge.

This method of electric welding was first applied to the welding of aluminium, because this metal had given such trouble in soldering, especially when joining small wires. With the substitution of aluminium wire for copper wire, which has taken place in the last few years, the need for a good means of joining aluminium has become urgent, and the percussive electric method was developed primarily for this purpose after a thorough investigation of the methods available. In addition to the welding of wire, several other special applications have been successfully made, so that a general review of some of the more important points should be of interest. Percussive electric welding differs from the resistance method chiefly in the nature of the current used. For resistance electric welding alternating current is used, whereas for percussive welding direct current is employed. It is possible to weld any two metals, whether alike or different, of high or low melting points or of an unequal thermal conductivity. With aluminium, the oxide which covers the surface of the pieces being welded prevents the metals from flowing together after the ends have been melted in the usual way. Large wires and rods of aluminium can be welded by melting the metal under the oxide film and then suddenly pushing the ends of the pieces together, breaking the oxide film and allowing the clean metal to flow together, but on small wire this practice is not feasible.

DEVELOPMENT OF PERCUSSIVE ELECTRIC WELDING APPARATUS.

Following up the experiments made in 1905, Mr. Chubb designed a condenser giving a discharge on a larger scale, and employing the same principle of simultaneous condenser discharge and percussive engagement that had been used in the original experiments. During the test and development of the welding apparatus, however, it was found that the best results depended upon several variables, such as the condenser capacity, the velocity and force of impact, the voltage and the resistance and induction in the circuit. The first apparatus consisted of two hinged arms with wire grips in their ends. Wires placed in the grips were connected to the terminals of a charged electrolytic condenser. Upon being released, these arms were drawn together, and at the instant of contact of the wires the explosive condenser discharged and the force of impact welded the ends together. This apparatus was not very satisfactory, as it did not allow of a separate study of the effect of the variations in velocity, momentum, kinetic energy, etc. A second apparatus similar in construction to a pile driver on a small scale was then built. This was provided with one stationary and one movable wire grip or chuck. In this apparatus the "forge effect" and velocity could be varied independently by a separate adjustment of the length of drop and mass of the moving parts. Other welding tools have been designed in which springs have been used to shoot the wire holders together horizontally, but this type of device has not been as satisfactory as the "drop-hammer" type.

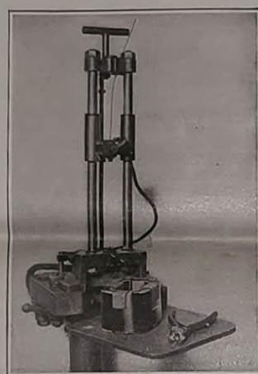


Fig. 1.—Portable welding apparatus.

CONSTRUCTION OF PERCUSSIVE ELECTRIC WELDING APPARATUS.

A percussive electric welding device of the portable type is shown in Figs. 1 and 2. Fig. 1 shows this device set up for welding a copper lead wire to a coil of aluminium wire, and Fig. 2 shows plan and sectional elevations of the device. Referring to Fig. 2, it will be seen that this machine has a base A carrying two parallel uprights B, which are held together at the top by stationary head C. Sliding on these guides B is a carriage or head D which carries a clamping chuck for holding one of the pieces of wire to be welded.

In order to support carriage D in a raised position, adjustable trip E held on the rod F is provided. Trip E contacts with trip G, held in the sliding head D, and is insulated from it. Rod F is so located in its bearings that it can be rotated to bring trips E and G into alignment with each other. Both trips E and G are beveled, enabling carriage D to be raised, but not lowered until trip E is released by a slight rotative movement of the rod F, which is again returned to its operative position by means of spring H. The wires I and J to be welded are held in chucks K and L. Clamping chuck L has the general form of a spool or flanged cylinder, and is split longitudinally into two parts which are grooved to receive one of the wires to be welded. The chuck is mounted in a slot in the base of the machine and is held in position and also caused to grip the wire by a thumb-nut The clamping chuck K is similar to L and is held in the same manner. The other wire I to be welded is conducted down through the top cap of the machine as illustrated, passing through an insulating bushing.

The electrical energy is supplied from a generator M or any source of direct current which charges the electrolytic condenser N. There is a high resistance T in the circuit, and the condenser charge can be varied by resisters T and U. In operation, the pieces of wire I and J to be welded are secured in the chucks K and L so as to project out from the chuck for a short distance. The carriage D is then raised to the desired height, which is determined by the setting of the trip E. The position of trip E is governed by the diameter and composition of the wire to be welded. After the wire has been clamped in position and trip E properly set, switch O is opened to permit generator M to charge condenser N. Trip E is then released, allowing the carriage to drop and carry the end of the wire I into percussive engagement with the end of wire J. At the instant of contact, the condenser N is discharged, and the energy thus concentrated at the point of contact is sufficiently great to produce a perfect weld between the wires. The weld is then complete, and after being removed from the machine the wire will be found to have the same strength at the joint as anywhere else.

A percussive electric welding machine embodying the general principles just described, but of slightly different

* From *Machinery*. Illustrations Figs. 1, 3, 5, 6, 7 and 8 used through courtesy of *The Electric Journal*.

† Associate editor of *Machinery*.

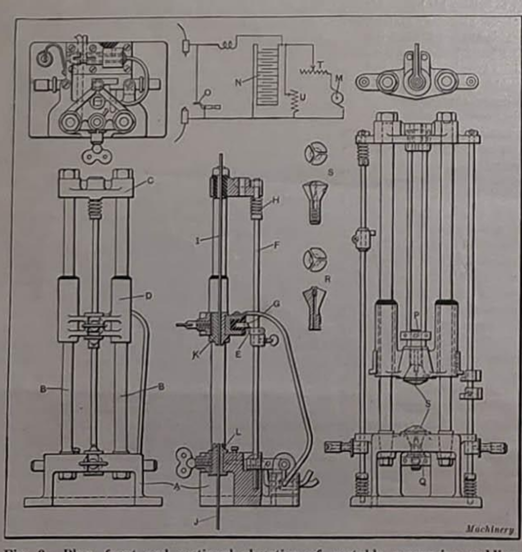


Fig. 2.—Plan, front and sectional elevation of portable percussive welding machine and connections. Two types of machines are shown.

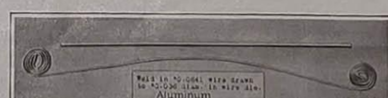


Fig. 3.—Sample of aluminium wire welded and drawn through a die without disintegrating the joint.

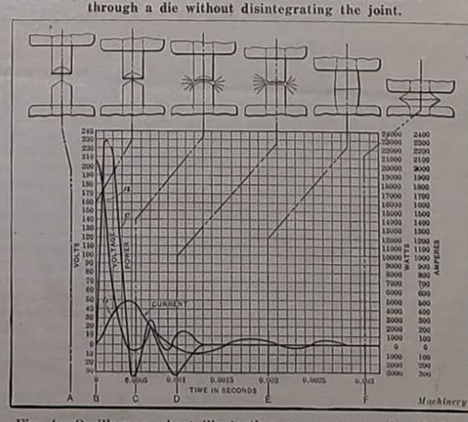


Fig. 4.—Oscillogram chart illustrating power consumed and time taken for making electric welds by percussive welding.

Fig. 5.—Microphotograph of copper and aluminium wire electrically welded, showing intermingling of metals.

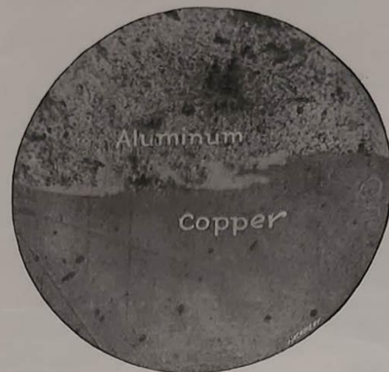


Fig. 6.—Microphotograph of a copper-aluminium weld. This shows a magnification of 850 times.

construction, is shown to the right of Fig. 2. In this machine the tripping mechanism is guided by two rods instead of one, and it is also provided with a different type of work-holding chuck, which is shaped similarly to that used on a screw machine and is also split to allow for expansion and contraction. The chuck body is tapered to fit into a correspondingly shaped hole in the base and sliding head of the machine, and is tightened on the work by means of nuts P and Q. The jaws of these chucks may be threaded as shown at R to adapt them to receive small screws if desired. By supporting a small screw in this manner in the chuck and holding a section of platinum wire in the upper chuck, the screw may be easily provided with a platinum tip. Each of the chucks has a pin projection which engages a notch in the holder for the purpose of preventing the chuck from rotating when the nut is being tightened.

DESCRIPTION OF PERCUSSIVE ELECTRIC WELDING PROCESS.

The action that takes place when the wires are percussively engaged covers such a short period of time that it is practically impossible to see it with the naked eye. The only possible way of analyzing the action is to consider it from a theoretical standpoint. From careful observation of a large number of welds and the study of oscillogram records, the theoretical action that takes place between the engaging terminals of the rods to be welded has been graphically set forth as shown in Fig. 4. At A the wires to be joined are shown close together as they appear when approaching each other. It will be noticed here that the ends of the wire have been provided with chisel-shaped edges, arranged at right angles to each other. This is done so that the first engagement between the two wires is at a small point. These chisel-shaped edges require no particular care in making, and in fact the thin edge usually produced when wires or rods are cut off with an ordinary pair of pliers or shearing device is satisfactory.

At the instant of contact B, the voltage of the circuit falls away as shown by the curve a. The current and power, on the other hand, increase rapidly as indicated by curves b and c. In this particular case, the voltage drops from approximately 207 volts to 160 volts in 0.0001 second and reaches zero at the end of 0.00035 second. The power expended in the circuit rises from zero to 23,000 watts in 0.0001 second, and then almost as suddenly decreases, crossing the zero line with the voltage. The weld in this case is completed electrically, that is, so far as a perfect junction of the two metals is concerned, in 0.0012 second, although the upsetting action still continues to forge the metals together until the upper chuck is brought to rest. Although 23 kilowatts is being dissipated between the ends of the wire at a certain instant, the total energy used at the weld is only 0.00000123 kilowatt hour, or enough to light an ordinary 50-watt 16 candle-power lamp for 0.09 second. The cost of this amount of energy at 10 cents per kilowatt hour would be twelve millionths of a cent. Referring to Fig. 4, it will be noticed that the watt curve c is oscillatory and that the negative value would indicate a return of stored energy. Such an action would be impossible from a metallic arc, but can be explained by the fact that the voltage was measured above and below instead of between the wire chucks, so that the storage and return of energy is from the magnetic flux produced in the steel chuck set up by the current of 500 amperes flowing through them.

The time between the first contact and the finished weld is of such short duration that the exact action cannot be recorded, but is supposed to be about as shown in Fig. 4. At A the wires are approaching each other at a velocity of about 65 to 200 centimeters per second (25.59 to 78.74 inches). At B the first contact is made, at which time the current begins to build up and heat the small section of metal carrying the current. At C the ends of the wire have separated, not by any appreciable retarding or reversing of the motion of the upper wire, but by the melting and vaporizing of the metal which first came into contact. At D the wire chucks are closer together, but the arc is still burning between the wires. At E the second contact has been made, the arc extinguished and the upsetting of the metal has begun. At F the complete weld is shown after the upper chuck has come to rest and the upsetting is completed.

The generation of heat is so localized, so sudden, and so intense that there is no time for unequal heat conduction through the shanks of the wire, and the ends wil be melted and even vaporized whether the melting point of the metal is high or low. For this reason various metals and alloys can be welded together independently of their electrical resistance, melting point or heat conductance. All the combinations of metals or alloys that have been tried will weld together, but the joints will not be permanent with such combinations as aluminium and tin or lead and iron.

INTERESTING PHENOMENA IN PERCUSSIVE ELECTRIC WELDING OF METALS.

Although the action of percussive welding is complex, as indicated by the chart, Fig. 4, it is not necessary to construct the welding apparatus or to adjust its parts with more than an ordinary degree of accuracy. Furthermore, it is not necessary to be very careful about determining the capacity of the condenser, the voltage of the charging circuit, or the inductance of the welding circuit. As an example, perfect welds have been made on the first trial between such metals as tin and platinum, platinum and nickel, and copper and aluminium, without special precautions, calculations or adjustments. While the machine is relatively light, a sufficient compression is obtained to forge the terminals of the metals to be welded, and by the use of a condenser of suitable design and capacity a sufficiently intense heat is supplied for a fraction of a second to melt the engaging surfaces and weld such metals as platinum and tin without injury to either metal.

It is believed that such a tremendous amount of energy relative to the size of the conductors not only fuses the engaging surfaces, but vaporizes them, producing a small explosion and actually separating the solid portion of the wires for an instant as shown at C in Fig. 4. At this stage of the welding action the terminals of the wire being welded are surrounded by a metal vapor. That this is true is abundantly proved by deposits of metal particles found on the chucks of the welding machine after a number of welding operations have been performed. It is believed that metal vapor surrounds the terminals before they are brought into permanent engagement, and that this is one of the reasons why successful joints have been secured between such unlike metals as aluminium

Fig. 7.—Microphotograph of a copper-silver joint, showing sharp line of demarcation. Magnified 1,000 times.

Fig. 8.—Microphotograph of a copper-platinum weld. Magnified 1,000 times.

and copper and between two aluminium conductors, the surfaces of which become oxidized with extreme rapidity when exposed to the air under ordinary welding conditions. It is thought that the small explosion previously referred to actually blows out a certain portion of the terminals in the form of vapor and consumes such a short time that the mechanical energy produced by the dropping of the chucks is still effective in welding the "wetted" terminals. The terminals are not permitted to cool after the explosion and previous to their percussive engagement because the current in the welding circuit, as indicated by the curve *b*, does not die out immediately, but continues to oscillate for several thousandths of a second.

NATURE OF THE WORK PRODUCED BY PERCUSSION WELDING.

It has been found that on account of the intense heat that can be concentrated at the desired point for a short period of time the electric percussive method is particularly effective in making a satisfactory joint. The effect of the concentration of energy referred to on an aluminium wire is to vaporize a small quantity of the aluminium on the engaging surfaces, thereby blowing out laterally in all directions the vaporized material, and carrying off, or at least breaking up, the oxide film which has hitherto prevented the welding of aluminium successfully. In the welding of copper to aluminium by the percussive method it would be expected that the joint would be unsatisfactory, owing to the fact that certain combinations of these metals form a brittle alloy. This, however, is not the case, as welds between these two metals are so ductile that they may be worked in a die, forged or rolled into thin foil. Any alloy that is formed at the junction of the aluminium and copper wires must range from 100 per cent copper on one side to 100 per cent aluminium on the other, but possibly the brittle combinations are so thin that the joint as a whole is flexible and ductile. The possibility of making satisfactory joints between aluminium and copper is of great commercial importance, as copper feed wires which solder easily can be welded to aluminium coils. It was thought at first that a diffusion of the two metals in service would result in a brittle joint, but tests show that after four years the joint is apparently as strong and ductile as when first made. Similar ductility has been noted in almost every combination of metals when first welded, but diffusion, disintegration and loss of ductility eventually result in such welds as silver to tin or aluminium to tin; the welds are effected by what is known in the trade as "tin disease" or "tin-pest"—a disintegration of the molecules.

Metals which are either hardened or softened with heat and sudden cooling can be welded together without appreciable change in the physical properties of the material. Tempered spring steel wire welded and reduced to uniform diameter and tested has shown equal or greater strength at or near the weld without any noticeable change in temper. Metals such as hard drawn copper, silver, aluminium, etc., can be welded without causing any local annealing, and these metals, as well as soft steel, can be welded together without detrimental local hardening. In welding unlike metals by the ordinary method of electric welding a brittle alloy is sometimes formed between the joints of the metal. In percussion welding this is not the case, as the energy and heat are so concentrated, and continue for such a short interval, that there is no appreciable flowing of one metal into the other, the line of demarkation being very sharp, even when the welded pieces are rolled out into a thin sheet or foil. If a film of alloy is produced at the joint, the film is so thin that it is flexible. This is true of various combinations of metals, as will be described later.

EXPLANATION OF SUPPOSED LACK OF CHANGE IN MOLECULAR STRUCTURE IN PARTS ELECTRO-PERCUSSIVELY WELDED.

Several explanations are given for the mechanical properties of various metals before and after welding; some of these are: First, such a sudden heating and cooling may not allow change in molecular structure; second, with hard steel, the heated metal at the weld is so suddenly cooled by conduction of heat into the adjacent cold metal that it is again hardened; third, with hard copper, silver, aluminium, etc., the heating and sudden cooling would ordinarily soften the metal, but the cold upsetting of the blow in welding possibly hardens it again; fourth, the metal is subjected to the sudden heating and cooling so that it may be hardened or annealed (depending upon the characteristics of the material welded), but the amount of material affected may be too small to be detected.

As an example, in welding No. 18 (0.043 inch diameter) hard drawn aluminium wire, 0.00123 watt hour or 1.06 small calories are dissipated at the weld. Assuming that none of the energy is lost in noise, radiation or metallic vapor and that one half of the total is propagated in a heat wave in each direction along the wire, it can be shown mathematically that an annealing temperature will not be reached more than 0.05 millimeter (0.002 inch) from the weld. The total amount of metal softened would be a disk 0.1 millimeter (0.0039 inch) long and 1.02 millimeter (0.0403 inch) in diameter. A soft insertion of such proportions could hardly be detected.

In welds between some metals diffusion takes place, but in any of the useful combinations the change is too slight to affect the ductility of the weld. The welds, as a rule, show only a sharp dividing line between the metals, but there is often an intermingling of the two at or near the center for a short distance. Figs. 5 and 6 show a new weld and a three-year old weld between aluminium and copper. The microphotographs, which are enlarged 850 times, were taken at the irregular point in the weld; elsewhere the line of division is sharp and rather straight. In addition to the small irregularity of the dividing line, some spots of bright material, possibly aluminium-copper alloy, are present at this point, but do not appear at other points in the weld. Both of these welds are so malleable that they are capable of being rolled into thin foil. Wire having such welds was used in actual service at a temperature over 100 deg. Cent. (212 deg. Fahr.) carrying a heavy direct current, and failed to show sufficient diffusion to affect its mechanical properties. The heating current was maintained for weeks and tests were made with the current flowing in both directions. At higher temperatures (red heat) there was a rapid diffusion of the metals, and in a few minutes the metals were diffused for a distance of two or three inches. A percussive electric weld offers a very convenient specimen for the study of the diffusion of different metals at different temperatures and under various conditions. The microphotographs, Figs. 7 and 8, show copper-silver and copper-platinum welds respectively. Both of these welds show a sharp dividing line when enlarged to 1000 diameters. The weld, Fig. 8, is three years old.

It has been found that the electrical resistance of two wires welded together is not appreciably increased by the small film of high resistance alloy at the joint formed in welding. Tests on 85 alternate pieces of aluminium and copper wire joined with 84 welds, making a total length of 23.5 centimeters (9.254 inches) showed an increase of 0.56 per cent in resistance in three years. This test was made to determine whether or not diffusion at the joints would occur. The increase is small and may be due to a change in the joints, or error in observation or oxidation. This sample was recently rolled and showed no change in malleability.

METALS THAT CAN BE ELECTRO-PERCUSSIVELY WELDED.

Thus far, no difficulty has been experienced in welding together any metal or alloys of metals, nor in fact, any combination of metals or alloys. The following are a few of the combinations that have been welded: Tin to aluminium, copper and platinum; lead to tin; tin to platinum; tin to copper; nickel to platinum; steel of various alloys and carbon contents. The chief advantage of the electro-percussive method of welding at present is in the uniting of copper and aluminium, since it is almost impossible to make this weld with the other well known methods, and when made by the resistance method the joints are as brittle as glass. Another interesting feature of the joint made in wires of different materials by percussion welding is the fact that the metal is just as ductile at the weld as it is any other place along the surface.

EXAMPLES OF ELECTRO-PERCUSSIVE WELDING.

While the development of this method of electric welding was brought about primarily to secure successful joints between aluminium and copper wires, it is evident that it possesses wide application. Metals varying widely in characteristics, such as platinum and tin, may easily be welded, from which it follows that almost any metal can be joined where the joint is within the capacity of the machine. The apparatus up to this time has only been made for welding wires 0.072 inch in diameter and smaller, but there is no reason why, with a larger machine and suitable apparatus, wires much larger than this could not be welded as well as other classes of work. Sufficient experimenting has been done to show that the welding of wires to plates or blocks can be successfully accomplished. For example a piece of 1/32 inch copper wire has been electrically butt-welded to a piece of copper 3/16 inch thick; and a piece of 1/32 inch copper wire has been butt-welded to a piece of 1/32 inch brass. In the ordinary method of electric welding, it would be practically impossible to join two pieces for the simple reason that the area of one is so much greater than the other that the wire would fuse and melt away before any perfect junction could be secured. By means of percussive welding, this operation is comparatively simple and a joint is made that is as homogeneous and strong as the metal itself.

In order to show the ductility of metals when percussively welded, two pieces of aluminium wire were joined as shown in Fig. 3. This piece of aluminium wire, which was 0.0641 inch in diameter after welding, was then drawn down to 0.036 inch in diameter through a wire die. The point at which the weld was made could not be determined even under a microscope, which showed that there was no physi change in the wire due to welding and that as far as ductility was concerned the metal was just as ductile at the weld as it was any other place along the section.

There are also many uses of the electro-percussive method, especially in the jewelry trade, where it can be employed for joining platinum without showing any solder line; welding sterling tips to table forks without annealing; welding pins to badges; and many other similar applications. The attaching of contact points of platinum, tungsten, silver, etc., for various electrical purposes is also readily accomplished.

The Conditions of Industrial Accidents

The enactment of laws in various States on workmen's compensation for injuries has aroused increased interest in the statistics and physical and psychic conditons of industrial accidents. The total number of these accidents is almost appalling. The lowest estimate places the fatal accidents to adult workers in the United States at 35,000 a year, with an additional 1,250,000 non-fatal accidents. The Massachusetts Industrial Accident Board, on the other hand, placed the number of workers killed by accident yearly at 75,000, which apparently includes not only adults, but also workers of all ages, while the number of injured of the same classes was placed by this Massachusetts authority at 3,000,000 or over. An earthquake in a foreign country that kills half this number of persons and maims one-fiftieth of those injured in our United States industries is spoken of as catastrophic.

A greater proportion of accidents occurs on Monday than on any other day of the week. Accidents are said to be due often to fatigue. As, after the day of rest on Sunday, workmen should be less fatigued than on other days, some other factor must be sought to explain this feature of the statistics. It has been suggested that the "blue Monday" accidents are really due to the fact that workmen take more liquor on Sunday, and thus become unnerved and more liable to accidents during the following twenty-four hours. There is, perhaps, something in this contention, says *The Journal of the American Medical Association*, though it has been disputed. In the Massachusetts Industrial Accident Board Reports, in which the official figures are given, there is scarcely more than one twentieth more accidents on Monday than on Tuesday, while Tuesday is not much above the average in the number of accidents reported for other days. Saturday, of course, shows a noteworthy reduction, because of the half holiday in some trades.

By far the larger number of accidents occur at about 10 A. M. and 3 P. M. This fact is confirmed by the reports of two State boards, Washington and Massachusetts. The tendency to speed up employment has been incriminated, as the predisposing condition for the occurrence of accidents. This desire comes over the workman when he is not yet fatigued, but has been employed for several hours. He starts the morning's work "cold," and as he warms to his work, the danger of mischance because of haste becomes greater. Just when the speeding up reaches a climax in the morning hours, most accidents happen. The same thing is true in the afternoon. Workmen feel sluggish after their lunch, but after an hour of work warm up again, and by about 3 o'clock they are doing their most rapid work, and are at the same time more subject to accidents.

With regard to accidents among children, however, there is no hour of maximum. Accidents occur at all times, and they are comparatively much more frequent among children than adults. The United States Bureau of Labor reported that "there is clear evidence of great liability to accident on the part of children. Though employed in the less hazardous work, their rates steadily exceed those of the older co-workers, even when in that group are included the occupations of relatively high liability." This was said with regard to the Southern cotton mills, but the same thing is true of practically all industries in which children are employed.

A Substitute for Platinum-Iridium Alloy

Owing to the scarcity and high price of iridium a recent inventor has proposed to substitute osmium in the well-known platinum-iridium alloy that has been widely used for many purposes. One part of osmium has been found to give the same hardness as two parts of iridium and the resulting alloy is ductile and is less affected by acids than platinum-iridium. Alloys with 10 per cent osmium are so hard as to be worked with difficulty, while a 2 per cent alloy is well suited for jewelry, as it is hard and tough, while alloys containing 6 to 10 per cent of osmium will serve all purposes that iridium alloys of from 15 to 25 per cent of iridium for contact points in electrical apparatus. In making these alloys metals of a very high degree of purity must be used. This alloy has been patented.

A Scientific Test of the Electric Truck

An Impartial Study of the Comparative Cost of Horse-drawn and Power Vehicles

By John Ritchie, Jr.

BUSINESS men, especially those who are contemplating the use of motor trucks, will do well to keep informed of the experiments that are under way at the Massachusetts Institute of Technology, for here there is partly completed a scientific investigation of greatest commercial importance, an investigation which is a critical consideration of the transportation of merchandise in large cities with especial reference to the comparative performance and the cost of electric, gasoline and horse-drawn trucks. The research has been undertaken by the electrical department of the school. The funds were available in May, 1911, for the beginning of the investigation and there has now been issued a report of progress, which is published for the benefit of those interested in the matter, in a Vehicle Research Bulletin, published by the Electrical Engineering Department, Massachusetts Institute of Technology, Boston.

The situation has been looked over and a plan of research has been devised and instituted. Already a large amount of valuable data has been assembled.

The fundamental question to be discussed is, just what are the advantages or disadvantages of electric trucks for real commercial work. It is a field in which very little information is available as to the details in point of costs, and the company, despite its own facilities for making tests, turns to the Institute which has the plant and the working force to make researches whose findings shall be beyond question.

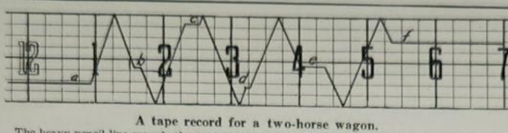
It is a plain business problem that has been taken up by the Technology experts and is in the service performed in the transportation of merchandise within a thickly-populated area—city and suburbs—a service that ranges from the delivery of the small parcel from the department store to the customer's house to the moving of heavy freight from one railway terminal to another. There are available three types of vehicle—horse-drawn, gasoline and electric. It is necessary to analyze the service and note the relationships between each element in it and the cost of operation and repeat this analysis for each type of vehicle. The Technology study has thus far been along two lines, the determination of the demands of the different kinds of service and, second, the study of the relative economy of the three types of wagons when used in any given service.

For the collection of facts, research assistant H. F. Thompson, who has charge of the investigation, has availed himself of special recording devices. These registers furnish tapes on which an oscillating pen draws a line while the tape moves regularly forward. The relations of the pen line to the time lines on the tape tell the story of speed. If the wagon is at rest the line is parallel to the axis of the tape, and in ratio to the rapidity of the motion of the wagon the pen line assumes an angle with this axis.

This ingenious device is a trustworthy detective and has revealed much. The little line tells how much longer than necessary the grocery delivery driver has tarried with attractive Mary, the maid, and how fast he has had to urge his poor horse to make up the time spent with her. It tells the whole story of the movements of the vehicle.

The Technology professors made arrangements with six business firms in Boston to affix registers to their vehicles and three others have recently been enlisted in the research. They are regular business houses, engaged in their regular work with their regular employees. They represent different types of teaming, city pick-up, furniture moving, freight handling, wholesale and retail coal delivery, parcel delivery, bottled goods delivery, the different services of an electric lighting company and miscellaneous hauling. The vehicles vary in size from one-horse to three-horse wagons and in the trucks from seven hundred pounds to five tons. The number of tapes received daily will be presently increased from forty-five to seventy, and these are read and tabulated by Mr. Thompson's staff.

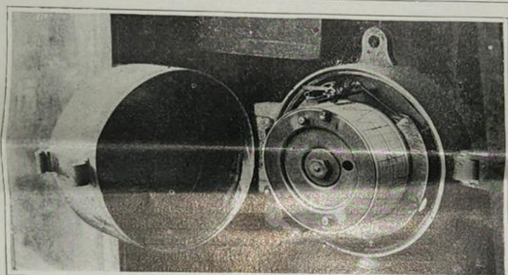
Besides the tapes, forms are used for reports, these giving the conditions of work, the items, and the details of expense including operating, maintenance and fixed charges. There are certain expense factors which the investigation is already clearing up, for example, the cost to the teamsters of congested streets, insufficient railway platforms, etc. The amount of work that a truck can do in a working day is the number of miles that it can go plus the standing time plus the time taken for loading and unloading. The latter is an important factor to cost that is generally overlooked. It is more noticeable when motor trucks are used. To illustrate, a horse-drawn truck with a two-ton load can be counted on for a maximum in city streets of fifteen miles a day, while an electric truck in the same service is good for about thirty-five miles. With the speeds that are practicable, 3.5 miles per hour for the horse and 6.5 miles for the motor, the horses will make their mileage in four hours a day while the motors must keep moving 5.5 hours. There is little gain in a nine-hour day in reducing the standing time of the horses to less than fifty-five per cent of the whole time, while the electric truck must not stand longer than forty per cent of the time.



A tape record for a two-horse wagon.

The heavy pencil line records the movements of the wagon. Where the line is inclined the wagon is moving; the slope is proportional to the speed; where the line is horizontal the wagon is standing still. The horizontal distances are proportional to the time. Each tape is analyzed by noting the total time the wagon was in use during the day, the time standing still, distances traveled, speeds during the morning, mid-day and afternoon, total number of stops, and any special items which apply to the particular work the wagon is doing. Below is the interpretation of the record:

Stops.	Speeds.	Distances
a. Batchelder's Wharf, Dinner	— — — —	— — —
b. Brookline, Loading	a-b 4¼ miles per hour	a-b 2.7 miles
c. Batchelder's Wharf, Unloading	b-c 4 miles per hour	a-c 5.4 miles
d. Brookline, Loading	c-d 4 miles per hour	a-d 8.0 miles
e. Batchelder's Wharf, Unloading	d-e 3¾ miles per hour	a-e 10.7 miles
f. Stable	e-f 3½ miles per hour	a-f 14.2 miles



An open indicator which was attached to a large motor truck.

The marks across the tape are quarter hours; the figures indicate the hours; the lines around the drum mark quarter miles. The position of the pencil shows that the photograph was taken at 2:30 and that the wagon had then been standing about forty minutes.

The speed indicator is here shown in place beside the lamp.

The ratio of what the truck actually does to what it might do is termed by the investigators the "distance factor." It has been made evident that the larger the distance factor the less the cost per unit of service. It is desirable, therefore, to maintain a large distance factor and the consideration of means to increase it in the various classes of traffic is now under consideration.

While it is perfectly true that mechanically driven wagons have evident advantages in rapidity of movement and radius of action over the horse, still it must not be forgotten that cost proportions are very important. If the expense of handling a given class of merchandise is very small in proportion to other costs, the matter of a few cents a ton for haulage may readily be secondary to such points as reliability and punctuality. It is therefore necessary to the business man that he have the costs accurately determined before selecting the kind of truck. It is really true that the horse may have his advantages for delivery service if the business is such that he can fit into it.

One matter which this investigation has brought out, and which is important to the business man, is the general lack of uniformity in accounts. In one case the drivers' wages were not included in the teaming costs; there is usually no charge for garage, although there should be such a one, even if the teamster keeps his auto-truck in a shed in his yard. Insurance and taxes are usually omitted, while amortization, administration and interest are sometimes not included. It is difficult, therefore, save in some such clearing house as this, to make a proper comparison, and the greater part of the comparisons have been without a common foundation, so that many users of vehicles have been misleading themselves with reference to operating expenses through such omissions.

Delay at freight stations in Boston is an important matter which has hitherto received no scientific consideration. This is important according to its relation to the length of haul, and here the wholesale districts are comparatively near the freight sheds. A group of students is distributed throughout the freight district, gathering the actual facts.

The first thing that suggests itself as an outcome to the investigations up to date is that "Service requirements are as important a factor in determining costs as is the type of vehicle selected." Every class of service must be considered by itself.

For parcel delivery, nine-hour day, three trips, four parcels delivered per mile and with one minute consumed in each delivery, three-quarters of an hour being allowed for loading and the maximum load being half a ton, the horse-drawn vehicle does only two thirds as much work a day as the electric or gasoline truck, at a cost per delivery of 5.9 cents, 5.4 cents and 6.5 cents, respectively. The cost per mile by horse is likewise between the two other costs. In the delivery of coal, which is a very different kind of delivery, at the heavy end of the scale, with loads of five tons, the horse wagon (three horses, one resting every third day) does only about half as much work per day as either of the motor trucks. The cost per mile here runs in much the same way as with the light work, being 55 cents for horses, 47 for electrics and 58 for gasoline, while the costs per delivery are in the same order, $3.91, against $3.32 and $4.07.

Some experiments have been made in special service requirements as affecting the cost of operation, and for the parcel delivery two minutes per call has been allowed instead of one. This increases the standing time, reduces the mileage per day, lessens the distance factor and raises the cost of delivery.

Engineering

Stepless Cars in Favor.—The Public Service Commission has granted permission for the New York Railway to issue bonds to the extent of $640,000, the proceeds of which are to be applied to the purchase of 175 new cars of the stepless type recently described in the SCIENTIFIC AMERICAN.

Lattice Masts to be Retained.—As a result of the firing tests carried out some months ago against a lattice mast that had been erected on the "San Marcos," now lying on the mud in Chesapeake Bay, the Navy Department has decided to make the lattice or basket mast the standard type for future warships. The mast, under test, showed remarkable endurance, several successful hits being necessary to bring it down.

Diesel Engines with Electrical Reduction Gear.—The firm of Swan & Hunter are about to build a vessel for the Canadian lake trade of between five and six thousand tons, which will be driven by two 800 horse-power Diesel engines. A novel feature will be the insertion between the engines and the propellers of an electrical transmission system, of the same type that was successfully tried out on the steamship "Electric Arc."

Diminutive Dreadnoughts.—In view of the fact that our latest dreadnought, the "Pennsylvania," will displace over 30,000 tons, it is interesting to note that the Spanish are building a small dreadnought, one of three, which will be less than half her size, displacing only about 15,000 tons. On this displacement, however, she will carry eight 50-caliber, 12-inch guns, and 8 inches of armor and will have a speed of 19.5 knots.

Marine Engines Subject to Duty.—The act regulating Panama Canal tolls does not, as has been frequently stated of late, permit the importation of marine engines. The circular of the Treasury Department limits the materials which can be imported to unfinished forgings, plates and shapes, pipes and tubes of all kinds of metal, bolts and nuts and similar things, but not to any finished or assembled machinery which forms a part of the actual construction of a vessel.

Four-mile Tunnel Through the Selkirks.—At an estimated cost of over $12,000,000 the Canadian Pacific Railway expects within a few years to have opened a *two-track tunnel, four miles in length, through the Selkirk range of mountains between Calgary and Vancouver.* One object of the tunnel is to eliminate the ever-threatening possibility of interruption from snow-slides, which, on the present line through Rogers pass, have given a large amount of trouble. The tunnel will, of course, be operated electrically.

Question of Statues at Panama.—The suggestion has been made in the daily press that statues to Col. Goethals and Col. Gorgas be erected at Panama, one at each end of the canal. We appreciate the motive, but condemn the practice as here suggested; and we agree with our contemporary, the *Army and Navy Journal*, that it would not be well, even in the case of these officers, to violate the sound rule that monuments should not be erected to living men. The canal is their monument, and an appropriate bronze tablet would be sufficient.

To Depopulate the Canal Zone.—The census of the Panama Canal Zone gives the population there to-day as 63,810, of which about 42,000 are employees of the Canal Commission, the Panama Railroad and of the various canal contractors. Generally speaking, the soil is not suitable for farming. It is not likely that Americans will be attracted; and since other occupants than Americans, for obvious reasons, are not desirable, Col Goethals is in favor of the depopulation of the zone, except so far as it will be occupied by canal operatives and by the military necessary for the protection of the canal.

Death of Alfred Pancoast Boller.—We regret to cord the death of Alfred Pancoast Boller, president the American Institute of Consulting Engineers and of the country's best known bridge builders, fol-ng a year's illness. He was seventy-three years old. Boller was a native of Philadelphia. He was grad-l from the University of Pennsylvania in 1858 and ed his engineering degree from Rensselaer Polytech-titute, Troy, N. Y., in 1861. He was chief engineer Hudson River Railroad for a short time. In 1870 ame vice-president and engineer for the Phillips-Ianufacturing Company, and for twenty years employed by this company. During the same he was consulting engineer for railroad building ti and Cuba, chief engineer for the Manhattan d Railway and consulting engineer for the nent of Public Parks of New York city. Mr. ntered into partnership with Henry W. Hodge , and they became consulting engineers for the National Railroad. The firm also was concerned onstruction of the 96th Street viaduct, New York ne stone bridge over the Connecticut River at l, Conn.; the Singer and the Metropolitan uildings and the Wabash Railroad entrance into gh, and with the cantilever bridges over the d Monongahela rivers.

Electricity

A 900-Foot Wireless Tower.—To replace the tower of the German Wireless Company's station at Nauen, which was blown down a year ago, a new tower 917 feet high is being erected. It is expected to have a radius of 6,000 miles.

Snow on High-tension Transmission Lines.—In an article attacking the German requirements regarding aerial transmission lines, which hold that the accumulation of snow on the lines is proportional to the diameter of the wires, Dr. Maguene states that snow never collects on lines carrying 100,000 volts or more, even when they are not charged and are cold. This he attributes to electrostatic action.

New Leadless Storage Battery.—A Swedish inventor has put on the English market a new type of alkaline storage cell. The plates consist of inactive retainers which are loaded with active material, oxyhydrate of nickel mixed with graphite in the positives and finely divided alloy of iron and cadmium and certain other substances in the negatives. This new cell much resembles the Edison cell not only in the electrochemical reaction employed but in the fact that extreme ingenuity is employed in the mechanical construction to obtain high space and weight efficiency and durability.

A Coppered Incandescent Bulb.—A big tungsten bulb in a store window suddenly burned out and passers-by were astonished to note that the bulb took on the appearance of polished copper. Investigation showed that a thin film of copper covered the inner surface of the glass and formed a reflecting surface as fine as any silver mirror. The bulb hung vertically and the larger end was opaque, but the copper coating at the other end was thin enough to see through if held against a strong light. The explanation is simple. When the tungsten filament broke, a short circuit was produced on the copper supports, heating the copper until it vaporized (not difficult in a partial vacuum). The copper vapor coated the glass like so much dust, adhering more firmly, however. Atomized metals are now produced on a commercial scale for coating glass, wood and other objects. The usual procedure is to force the molten metal with a jet of steam against the object to be coated. The steam breaks up the metal into a very fine state of division and the particles adhere very well.

A Speaking Incandescent Lamp.—The incandescent lamp is not the mute electrical apparatus that we have always supposed it to be. It has just been discovered that given the right conditions it may be made to speak as readily as the arc, which for the last fifteen years has monopolized this accomplishment. According to *Physikalische Zeitschrift*, Messrs. K. Ort and J. Ridger have used a metal filament lamp as a telephone receiver. An Osram lamp of 100 candle-power is employed. The lamp is placed in a 120-volt direct-current circuit including a self-induction coil. Shunted across the two terminals of the lamp are a capacity and the secondary of a telephone transformer, the primary of which connects with a battery of five storage cells and a powerful microphone. Words spoken before the microphone are reproduced in the lamp. The discoverers of the speaking incandescent lamp explain the action on the principle that the telephonic current variations superposed on the current that passes through the lamp produce corresponding variations of heat in the filament, which radiating to the glass of the bulb, cause the latter to expand and contract proportionately and thus transmit the vibrations to the exterior air. This effect cannot be produced with 16 or 32 candle-power lamps because the glass is too thick and the heat variations too feeble.

Peace Between the Marconi and Telefunken Companies.—It is gratifying that the patent litigation which has for several years been pending between the two largest concerns in the field of wireless telegraphy, Messrs. Marconi Company in England and the German Telefunken Company, should, at last, have come to an end. It will be remembered that the two companies charged one another with interfering with their respective patent rights and contested the validity of their patents. There are no less than seven lawsuits of this kind pending in different countries. Now the Telefunken Company, with the agreement of the Marconi Company, has published in Germany the following statement: "Messrs. Marconi Company and the German Telefunken Company have agreed to cancel any patent litigation pending between themselves in different countries. The Marconi Company forego any intention of contesting the validity of such Telefunken patents as have been acknowledged by German courts, e. g., the Braun patents." Messrs. Marconi Company, with the agreement of the German Telefunken Company, has published in England the following statement: "Messrs. Siemens Bros. & Co., Ltd., who in England represent the interests of the German Company, have admitted the validity of the Marconi statement No. 7777 of 1900, arrangements being made for settling any mutual patent litigation pending between the two companies."

Automobile

New York's Shows.—The annual automobile shows in New York city will take place in January, on the following dates: 2nd to 11th, show of imported cars in the ballroom of the Hotel Astor; 11th to 25th, double show of domestic cars in Madison Square Garden and the Grand Central Palace.

Ghent to Have a Six Months' Automobile Show.—In connection with the great international industrial exhibition which will be held in Ghent next year, and which will remain open for six months, the Belgian Motor Union will organize a collective exhibit of automobiles, motorcycles and aeroplanes.

Motorbuses Need Many Tickets.—The extent of London's motorbus traffic will be appreciated when one hears that no less than 200 tons of pulp are required to manufacture the tickets for one year's rides. It would be interesting to know how much the New York Subway consumes, because subway tickets, while much smaller, are much thicker than London bus tickets.

Ventilating the Dash Hood of an Automobile.—George W. Dunham of Detroit has patented, No. 1,045,776, a ventilator which consists of a curved deflector embracing the upper edge of the dash hood of an automobile and suitably spaced with portions on both the inner and outer sides of the hood so that the air current induced by the motion of the car will be deflected from the outside of the hood to the inner side thereof to ventilate and cool the portion of the car immediately in rear of the hood.

Hemery Establishes New World's Records.—Victor Hemery, whose thrilling driving in American road races of the past four years is still remembered on this side of the Atlantic, on November 27th broke the world's record for six hours' continuous driving at the Brooklands track in England. At the wheel of a 60 horse-power Lorraine-Dietrich he covered 518 miles in the period at a sustained speed of 86⅓ miles per hour. The former record was 451 miles in six hours.

Segregating Show Cars According to Price.—Because the cheap and medium-priced car naturally suffers somewhat in comparison with very high-priced cars, especially when placed alongside of the expensive product, it has been suggested to divide automobile exhibits in the future according to price of cars, keeping the cheapest in one section, medium-priced in a second section and high-priced machines in a third section. Three separate buildings would be still better.

How a Lost Motor Was Found.—An unusual story of finding lost property comes from England. A repair shop received by express an automobile motor which was to be repaired, but the package contained no intimation of who the sender might have been. In one of the cylinders an old copy of a British motor journal was found and the repairman promptly concluded that the owner of the motor was a reader of that paper. The story was sent to the paper and the owner got his motor back.

Would Charge $25 Admission to Automobile Show.—It has been suggested to charge an admission fee of $25 on a certain day of the next automobile show to be held at Olympia, London. The great crowds which throng the exhibition halls make it impossible for the intending purchaser to examine the cars closely and to get adequate information from the attendants. On the purchase of a car on the floor of the exhibition, the admission fee would be refunded. Losers under such an arrangement would naturally be the accessory dealers who cannot get along without crowds.

British War Office Wants Motor Trucks.—The regulations for the tests which must be undergone by motor trucks submitted to the British War Department have just been issued. The first set of tests, dealing in particular with the standardization and interchangeability of parts, took place in August last, and only two types of trucks succeeded in passing them. A new subsidy trial has been announced for February next, when motor truck manufacturers may submit their vehicles to the War Department's scrutiny. As in the case of France, Germany, Russia and Austria, motor trucks which pass the test will be subsidized.

Taxicabs Need Not Drive in Fog.—That a taxicab need not be driven in a typical London fog, and that the would-be passenger, after being taken for part of the agreed distance, must pay for the mileage covered, is the decision of a London justice. As the story comes from England, it cost the motorist 11 shillings and 8 pence to find it out, while the original taxicab bill had only been 1 shilling and 2 pence. A taxicab driver had been engaged to drive from St. James' to St. John's Wood, but at Clarence Gate the fog was so dense that the driver could not see the hood of the motor. He stopped and refused to drive any farther, claiming it to be too dangerous. The taximeter registered 1 shilling 2 pence, and the passenger refused to pay. The matter was carried to court with the result that the "taxi" was complimented by the judge on his good sense and the passenger ordered to pay the fare and costs.

The Death of Prof. Sir George H. Darwin

PROF. SIR GEORGE H. DARWIN, M.A., F.R.S., LL.D., D.Sc., who died recently, was the second son of Charles Darwin, the great naturalist. The Darwin family for generations has included men distinguished in the arts and sciences; and while the originator of the Darwinian theory, one of the most eminent investigators and thinkers England has ever produced, unquestionably overshadowed the others, it has not been through his reflected glory that his sons took their deservedly prominent position in the world of science.

Sir George H. Darwin was born at Down, in Kent, England, in 1845. He was educated under the Rev. Charles Pritchard, who subsequently became a Fellow of the Royal Society, and the Savilian Professor of Astronomy at Oxford. In 1864 George Darwin entered Trinity College, Cambridge, from which he was graduated in 1868 as Second Wrangler and Smith's Prizeman. From 1868 to 1878 he was a Fellow of Trinity College, and was re-elected in 1884. He studied law, and was admitted to the bar in 1874, but he did not subsequently practice that profession.

In the following year he returned to Cambridge, and devoted his entire time to the study of the mathematical and astronomical sciences, and particularly to experimental investigations on the pressure of loose sands, on changes in the level of the earth's surfaces, and on minor earthquakes. His interest in astronomical and meteorological studies and investigations had been aroused prior to this, and in 1870-71 he accompanied the English expedition to Sicily to observe the eclipse which occurred during that period. In 1882 Prof. Darwin assisted Sir William Thomson (Lord Kelvin) in the preparation of a new edition of Thomson's and Tait's "Natural Philosophy," and in the following year was appointed Plumian professor of astronomy and experimental philosophy at Cambridge, succeeding the Rev. James Challis, M.A., F.R.S., to a chair which Prof. Darwin held with distinguished success. From 1885 to 1905 he was a member of the Council of the Meteorological Office of Great Britain, and he served on the Meteorological Committee of 1905. He was chosen a member and later, in 1879, a Fellow of the Royal Society. He was a president of the British Association for the Advancement of Science, and as the head of that association, he formally opened the Victoria Falls Bridge over the Zambesi Gorge in Central Africa in September of last year. In 1885 he received "a royal medal" from the society for his scientific work, and also one from the Royal Astronomical Society.

Prof. Darwin was an honorary graduate of the universities of Glasgow, Dublin, and Padua, as well as a member of several British and foreign academies of science.

Prof. Darwin's published contributions to scientific literature include papers on consanguineous marriages, for the Statistical Society; jointly with his brother on Small Deflections of the Plum Line Due to Movement of the Earth, British Association Report; a series of reports to the British Association on Harmonic Analysis of Tidal Observations, 1883 and later; several papers on the same subject in the Proceedings of the Royal Society; a series of memoirs on the Effects of Tidal Friction on the Earth and on the Moon, Philosophical Transactions of the Royal Society; papers on subjects cognate to the last, and on Figures of Equilibrium of Rotating Masses of Fluid and on the Mechanical Constitution of a Swarm of Meteorites, Philosophical Transactions of the Royal Society; a paper on Periodic Orbits, in 1896; and one on the Tides and Kindred Phenomena in the Solar System, 1898.

To Our Subscribers

WE are at the close of another year—the sixty-eighth of the SCIENTIFIC AMERICAN's life. Since the subscription of many a subscriber expires, it will not be amiss to call attention to the fact that the sending of the paper will be discontinued if the subscription be not renewed. In order to avoid any interruption in the receipt of the paper, subscriptions should be renewed before the publication of the first issue of the new year.

To those who are not familiar with the SCIENTIFIC AMERICAN SUPPLEMENT a word may not be out of place. The SCIENTIFIC AMERICAN SUPPLEMENT contains articles too long for insertion in the SCIENTIFIC AMERICAN, as well as translations from foreign periodicals, the information contained in which would otherwise be inaccessible. By taking the SCIENTIFIC AMERICAN and SUPPLEMENT the subscriber receives the benefit of a reduction in the subscription price.

Removing Acid Stains from Instruments

A GOOD method of removing acid stains from laboratory instruments is to rub with pearl ash and then boil for a few minutes in soap water. The instruments should then be dried in magnesia powder and polished with a dry cloth.

Capturing Frost Flowers

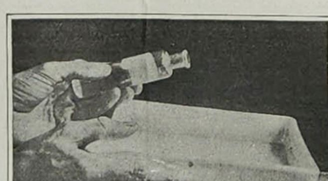
By S. Leonard Bastin

THERE must be few people who have not admired the exquisite patterns which Jack Frost traces

A captured frost pattern in gelatin.

Smearing the piece of glass with the gelatin solution.

The glass should be supported on a cup placed out of doors in freezing weather.



Flooding the plate with absolute alcohol when the frost flowers are well developed.

A captured frost flower.

with his icy fingers. The thought is irresistible, that it is a great pity the charming flowers are not of a permanent nature. It is all the more interesting to be able to bring forward a scheme whereby it is possible to secure lasting records of the ice designs. This is so simple that anyone can carry it out with good hopes of success, and in this way provide one's self with an absorbing pastime for the winter days.

The frost patterns are most satisfactorily secured on pieces of glass. Before proceeding it is important to see that these are quite clean, and free from any grease. In passing it may be mentioned that a very good glass cleaner is methylated spirit, rubbed on with a piece of crumpled-up paper. Next prepare, or get the druggist to make up for you a solution of two per cent clear gelatin dissolved in distilled water. Also secure a small quantity of absolute alcohol; a few ounces will be all sufficient for the purpose. It is well to get all these things ready in advance, before any attempt is made to take records of the frost flowers.

At a time when there are at any rate several degrees of frost out of doors, we may make the first trial at securing the ice patterns. It is, of course, understood that the gelatin solution, the spirit, and the plates of clear glass, are to hand. If the weather is cold it is likely that the gelatin will be in a partially solidified condition, and in order to make it ready for use it may be necessary to place the bottle in a bowl of warm water for a few moments. When the mixture is fairly liquid a quantity of it may be smeared over a sheet of glass. This is perhaps best accomplished with a good sized brush. In any case it is important that the solution should be spread over evenly, and be quite free from air bubbles.

The best results are secured when the freezing process is as rapid as possible, and it is desirable to support the glass so that it will be in a very exposed position. To bring this about a good plan is to raise the glass on an inverted cup in the manner indicated in the accompanying illustration. Even in a comparatively slight frost, if the glass is placed in this way, a few inches above the level of the ground, the chilling influences of the air will speedily begin to make themselves felt.

It is well to watch rather closely the action of the frost on the gelatin solution. The freezing process should not be arrested until the pretty flowers are well developed, although on the other hand if the action is allowed to continue for very long, the pattern will become too involved for the best effect. When it is considered that the design is at its best, the glass may be taken into a cool room for further treatment. No delay is permissible, as the pattern will, of course, rapidly fade away in a warm atmosphere.

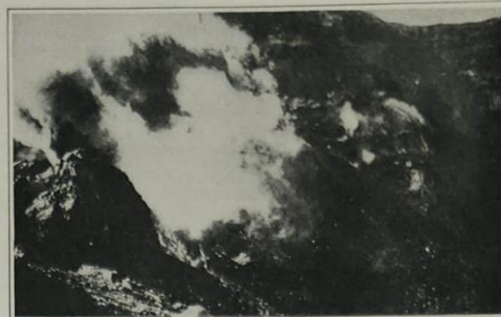
Place the glass in some kind of a dish and immediately flood the plate with the alcohol. For about two minutes rock the dish backward and forward, so as to insure that every part comes under the influence of the spirit. Eventually it will be found that the alcohol will have entirely removed the ice, leaving behind a permanent formation of the gelatin which may, without difficulty, be preserved for an indefinite period. The best way in which to protect the gelatin, which otherwise would be likely to be affected by atmospheric moisture, is to cover it with a film of clear varnish. This should be applied with a good deal of care in order that the beautiful ice flowers may not be disturbed.

The best results will be obtained if a number of attempts to secure the patterns are made. Thus the sheet of glass may be put out of doors, and if the resulting pattern is not very good, the gelatin solution should be cleaned off and another trial be made. In this way we may be quite certain of getting some very fine pictures. By a few experiments of this nature it will be easy to discover how far the freezing process should be allowed to go.

Of course these captured frost flowers will make the most beautiful transparencies, and as such may b used in the form of window ornaments. Apart fro its fancy side the idea has a useful object, as lar pieces of glass which could be used for putting in w dows may be frosted with real ice patterns. Where an undesirable view needs blocking out the result i once useful and highly decorative. If liked, the e can be very much enhanced by coloring the gelat some bright tint. For this purpose any aniline d very useful, the substance being mixed with the g before this is placed on the glass. Most of the br colored inks which are commonly sold are prac solutions of aniline coloring, and as such m used with effect for this particular purpose.

Walter Johnson on October 31st broke the Am aeroplane endurance record for a flight with on senger. He flew a Thomas biplane, and remain the air 3 hours, 51 minutes and 12 seconds, cove distance of 235 miles. The course lay between S and the village of Bath, New York. The averag tude was about 650 feet.

A cluster of fumaroles near the arch of the crater toward the south. The cross marks the spot where Prof. Malladra began his descent. The course which he took for the first 350 feet is indicated by white dots.



A battery of fumaroles toward the southwest. The picture was taken about 326 feet within the crater on the south wall. To the right appears the "devil who laughs"—a large face that appears in the rock amid fumes.

come up again, leaving their ropes in the crater, held by three wooden posts, so that they could continue the next morning.

That night Prof. Malladra told me he was so excited that he could not sleep. He had found a way to descend to the very bottom of the crater. He was so nervous that he could not calm himself.

The next morning the professor and the servant started with food to be consumed 950 feet beneath the mouth of the crater, 70 pounds of Manila and flax rope (950 feet in length), a barometer, a thermometer, and a camera. Prof. Malladra had also brought along several fusible wires of different metals to measure temperatures higher than those that could be recorded a temperature higher than that for which the thermometers were graduated. They were also provided with a magnetic needle (compass), a hatchet, a stick and plummets.

The first big wall was descended—a wall formed by the remains of the different eruptions—and this was followed by a descent over red lava from which several *fumaroles* opened. The temperature of these *fumaroles* registered 187 deg. Fahr. At this point a side wall descended for about 160 feet and presented the first obstacle. Wherever the two courageous men placed their feet, new *fumaroles* opened, from which sulphur vapors poured. When the descent of this wall was accomplished there was a second gigantic perpendicular one of lava followed by a *talos*, or cone covered by a bank of lava. There was a continual breaking and crumbling of ground difficult to escape from. Isolated masses fell with tremendous noise, bounding to the bottom, filling the air with dust and fine ashes. Prof. Malladra's hands were frequently cut. A big stone fell on the brim of his hat. Varvazzo was struck on the head but was so slightly injured that he could continue the descent. After a while the two explorers discovered another perfectly perpendicular wall completely bare, with no projections or crevices of any kind. After some moments of uncertainty Prof. Malladra was able to find a passage between two ridges of lava. At this moment he became aware that he had no more rope. One hundred and fifty feet had been left at the top, for he had not thought that it would be needed. Besides, he was left with more freedom of action.

There was still another 350-foot wall to be overcome, absolutely bare of any projection. No rope could be of assistance. The explorers, notwithstanding the stones, pebbles and land-slides, abandoned themselves to the slope, clinging to the smallest projections, till they reached the bottom of the crater, bruised and exhausted. Prof. Malladra and Varvazzo were nearly suffocated by the exhalations of sulphur. The two men crawled over the bottom of the crater, which measures in diameter 1,500 feet, bravely took photographs, made observations, collected salts and minerals, heroically bearing a frightful temperature.

At the bottom of the crater there are little hills and valleys, all irregular and not discernible from the top.

At about 2 P. M. Prof. Malladra and Varvazzo commenced the ascent, struggling with all their might. At 4 o'clock they reached the mouth of the crater.

A great slide on the west-southwest side which occurred on March 12th, 1911. To the right appears a group of fumaroles, emitting strong sulphurous vapors.

The famous "yellow" fumarole, so called on account of its strong yellow color. The fumarole is the cone in the center of the picture.

Fish Culture in Germany

THE industry of raising fish for the market is rapidly growing to large proportions, especially in Germany. There the tanks and ponds used for this culture number some fifty thousand, and cover an area of about 247,000 acres. The fish chiefly cultivated is the carp.

Tanks and ponds of different sizes are used, according to the age of the fish. The fresh spawn is placed in shallow basins, about twelve inches deep. The ponds and tanks are frequently emptied and cleaned, to remove animal parasites which might injure or kill the fish. After the fifth day, the young fry is placed in larger tanks for growing. The loss at this stage amounts to as much as from thirty to fifty per cent.

At the end of the first summer the small fish weigh from two-thirds of an ounce to two ounces. The fish are now placed in small ponds for the winter, and are again transferred in the spring to growing ponds for the second year. At this stage they are placed in the water at the rate of about 200 to the acre, and are kept here until they attain a weight of about one pound each. During the third year they are fattened up to three pounds on a special food prepared chiefly from the seed of the yellow lupine and corn, and they are thinned out to about sixty to the acre. The yield for the market varies from about twenty-five to one hundred and fifty pounds to the acre. The haul is made by means of nets, and by the draining of the ponds each winter.

Clay soils are found to be the most suitable as sites for the fish ponds. This agrees with the experience in other countries. When the ponds are made in sandy or granitic soil, the fish reproduce abundantly, but do not fatten up satisfactorily. When the ponds are emptied, advantage is taken of the exposure of the bottom to add lime and other fertilizers. The wintering tanks are emptied in the summer.

The carp and the tench, like most other fresh-water fish, become passive when the temperature goes below about 37 deg. Fahr. The loss sustained by the fish cultivators on account of the wintering is from one to ten per cent.

At three years of age the German carp weigh about three times as much as the French. The fish raised under artificial conditions present a nearly uniform size; this is an important factor in determining their market value.

The History of Lead-burning

IT is not generally known that the operation of soldering lead pipes with lead (the "lead-burning" of to-day) was known and practised in the middle ages. Reference to this matter is made in one of the books of Vincent de Beauvais (a reader of the court of Louis IX of France) who died in 1264. Following is the passage in question, taken from an essay on tin (vol. viii, part i): "If tin is exposed to a moist atmosphere, it will corrode; but human ingenuity has of late invented useful improvements by which it is possible to unite leaden subterranean water pipes with the aid of molten lead instead of soldering with tin. Pipes soldered with the latter metal never lasted long, but if lead is used it will last for all time."

How the Germans Utilize Waste—V

Wealth That Has Been Earned By the Efficient Use of Raw Material

By Waldemar Kaempffert

[THE following is the fifth of a series of articles prepared by the Managing Editor of the SCIENTIFIC AMERICAN *on European industrial conditions. The author was sent to Europe by the publishers of the* SCIENTIFIC AMERICAN *for the purpose of studying the application of science to business abroad. So much have the Germans done in the application of scientific principles to the utilization of waste, that little more can be done than to give glimpses of a small part of the vast field that they have so admirably covered.]*

If the Germans are thriftier and more systematic than we, the reason is to found not so much in any racial or temperamental difference between the two nations as in economic conditions. Germany's supply of raw material is exceedingly limited; labor is abundant and cheap. In the United States, raw material is still to be had in plenty; labor is comparatively scarce and expensive. What has been the result? Germany has developed to an amazing degree the utilization of raw material, but has still much to learn in the handling of great masses expeditiously by mechanical means. On the other hand, we in America have been recklessly extravagant in the use of our natural resources, but commendably ingenious in devising mechanism for handling what we do use. A change in American industrial methods is imminent. We have discovered that our coal and iron mines are not inexhaustible, that crops cannot be grown on the same soil year in and year out without rotation and without restoring the nutritive elements that have been removed; that our timber must be husbanded; and that what we call "factory waste" is not waste at all but so much raw material to be worked up in another form. We can learn much from Germany in the more efficient use of our wonderful natural resources; but we can learn still more in the more effectual disposition of by-products.

The Transformation of Waste.

The most fantastic tale that ever appeared in the Arabian Nights is no more astonishing than the feats performed with waste material by the German engineer and industrial chemist. To the German a dump heap is a kind of gold mine. Better than any other man in the world, he has demonstrated the truth of Lord Palmerston's saying: "Dirt is merely matter in the wrong place."

It was the German, for example, who taught us how to use the by-products of the blast furnace. The smelting of iron ore was once accompanied with much waste. One of the most interesting examples of German industrial thrift is the briquetting of the enormous quantities of flue dust produced in the iron foundry. It has been estimated that the production of flue dust in the United States amounts to 3,000,000 or 3,500,000 tons annually. A large part of this is discarded as valueless. It is generally a fine material containing considerable coke and iron ore. The dust usually contains 20 per cent of coke and more than 40 per cent of iron. The coke is worth $3.25 per ton, and the iron ore 70 cents per ton. Hence, a ton of flue dust, unless made available, presents a considerable loss to the furnace man. The Germans realized this long ago. They have evolved several processes for pressing the flue dust into briquettes.

The Waste of the Foundry.

For every ton of pig iron produced per day, about twenty-five horse-power was once wasted by permitting the blast furnace to eject the gases into the atmosphere. Some 150,000 cubic feet of gas are generated in producing a ton of pig iron according to modern practice. About 35,000 cubic feet of that huge volume is carbon monoxide—a gas that burns with a blue flame in every household stove and that has great heating value. Time was when the carbon monoxide of a blast furnace was simply allowed to float into the atmosphere. Even at this late date we Americans do not husband it as we ought to. Here is a gas that contains so many heat units, so much energy in a word. Why waste it? Thus reason the Germans, whose fuel supply is none too generous. After years of investigation they found a way of collecting and cleaning the gas and of using it in engines of special design, thereby setting an example in the conservation of fuel to the entire world. At the Friedrich-Alfred Huette, one of the large Krupp plants, the gas from eight blast furnaces drives fifteen blowing-engines. That plant is not considered the most modern in Europe, but the story that it tells is told over and over again in every large German blast furnace installation. To our own credit be it said that the lesson has not been lost upon us. In 1902 the Lackawanna Steel Company installed the first American plant for the practical utilization of blast furnace gases. Since then, other American steel works have adopted the plan. At Gary we find the most remarkable example of the practical utilization of blast gases in the world.

How Waste Gas is Utilized.

Waste coke-oven gas is practically utilized on an amazing scale at Aalsdorf, near Aachen, Germany. Here will be found the largest plant in the world for the utilization of coke-oven gas. Following the practice of many European collieries, the directors of the Aalsdorf mines formerly burned the waste coke-oven gas under boilers to generate steam for a number of isolated steam-engine plants scattered over a wide area. That was certainly better than turning the gas into the atmosphere. But it was found that a large expense was incurred in maintaining many small steam plants. Besides, there was the cost of an extra engine in each plant, held in constant readiness in case a breakdown occurred. The condensation losses that occurred in long pipes leading from the boiler houses to the engines were difficult to contend with. Why not combine the plants into a single power station, generate current, and send it wherever required? That was the obvious remedy. One after another the steam engines were sold. A single gas engine plant was built. Current is now generated at a small cost and sent to any desired point.

Besides gas, the coke-oven yields tar and ammonia as by-products. Germany has built up a stupendous chemical industry on the utilization of tar. She needs tar as badly as she needs coal; for tar is the raw material out of which countless dyes, perfumes, explosives, photographic developers, drugs, extracts and narcotics are made. The tar left in the retorts of street-gas works soon proved insufficient to supply the demand. Tar had to be bought in England. That meant sending so much money across the Channel every year, money that might just as well be invested in Germany. Steps were taken to substitute retort coke-ovens for the old wasteful bee-hive type. By 1900 Germany produced 30 per cent of her coke in retorts; by 1910, 80 per cent. In a few more years all the coke will be produced in retorts, and Germany will increase her own supply of tar and ammonia. It may well be questioned whether the by-products of the German coke-oven are not now the main products. How stupendous is this industrial change may be gathered from the fact that before 1856 the gas maker was glad to rid himself of the coal tar by giving it away. He dared not pour it into streams because it polluted the water; and if he buried it, he was bound to kill vegetation. The advance that Germany has made over England in the substitution of retort coke-ovens for beehive coke-ovens is truly astonishing. Up to 1910, England was the greatest producer of ammonium sulphate. Now Germany has outdistanced her, simply because she systematically went about the business of supplying her own demand.

The lesson that the United States can learn from this admirable way of utilizing coke-oven by-products was driven home by Mr. John D. Pennock in a paper that he read before the American Chemists' Society. In 1893, he pointed out, the retort coke oven was introduced. From 1893 to 1910 inclusive, the coal coked in beehive ovens where the volatile nitrogen was ruthlessly wasted, amounted to 810,000,000 tons. Had this been coked in by-product ovens, Mr. Pennock assures us that the volatile nitrogen of the coal would have yielded twenty-three pounds of ammonium sulphate per ton, or a total of 9,315,000 tons, which at $60 per ton would have had a value of $558,900,000. But this would not be all. Had this ammonium been recovered, it would have been used to fertilize the soil, with the result that crops would have been increased fully 20 per cent and that a saving of many millions more would have been effected. While we stand far behind Europe in the utilization of coke-oven by-products, the situation is not as bad in this country as it once was. According to government statistics, a smaller number of beehive ovens is now made annually than in previous years.

The single item of nitrogen alone which is wasted in the coke oven is astonishing. Last year 63,000,000 tons of bituminous coal were converted into coke containing $22,000,000 worth of nitrogen, easily recoverable as ammonium sulphate in by-product ovens. As a matter of fact, we actually received but $3,800,000 worth and allowed more than $18,000,000 of this valuable material to go absolutely to waste. Worse even than this, over $20,000,000 worth of valuable gas and coal tar was wasted at the same time.

Benzol is one of the chief by-products obtained from coke ovens and gas works. It is of immense importance as a raw material to the German chemical industry. The owner of a German coke-oven plant recognizes how important is the recovery and rectification of benzol. From 25 cents to 35 cents can be extracted per ton of coke in the form of benzol. That is why the benzol plant is usually an adjunct of the German coke-oven.

The Ever-new Story of Coal Tar.

Nowhere in the whole world can there be found a more striking illustration of the wealth that lies in what was once regarded as a waste, than in the huge chemical works that have been built at Elberfeld, Leverkusen, Griesheim, Ludwigshafen and elsewhere in Germany, in all of which coal tar in some form is used as the raw material. So frequently has the story of coal tar been told, that it is now familiar in all its wonderful details to every well-read man. Yet the complete significance of the discovery of mauve by Perkin over sixty years ago is not really driven home until one has seen the enormous German chemical factories, in each of which thousands of men and women are employed in the task of extracting dyes, perfumes, flavors and drugs from derivatives of what was once a noisome ooze. From the coal tar which gas companies once disposed of with difficulty an industry capitalized at $750,000,000 has grown. In 1910, Germany made aniline and other dyes to the value of $29,250,200; alizarin worth $2,318,120; various alizarin dyes worth $2,641,800. And these are but a few of the thousands of products obtained from coal tar. The stock of the more important coal tar works listed on the Berlin Exchange pays from 10 to 32 per cent dividends annually—proof enough that money can be made out of waste if the scientist only points the way.

Hardly a week passes but patents are taken out for some new dye, some new explosive, some new drug or medicament, some new photographic developer that has been discovered in the laboratories of one of the great German chemical companies. One firm alone has taken out over 6,000 patents to protect its many discoveries in coal tar. It manufactures no less than 1,800 aniline, azo, and alizarin dyes, and one hundred and twenty pharmaceutical and photographic products. Naphthalene, one of the products of coal tar that was formerly a troublesome waste, choking gas pipes and otherwise making itself obnoxious, is now one of the most valuable substances for the preparation of dye stuffs. The manufacture of alizarin, an artificial preparation of the by-products of tar, has practically destroyed the madder industry of Europe. Synthetic indigo has completely supplanted the natural indigo of the Far East.

In all the large German chemical works, built to utilize the waste of the coke-oven and the gas retort, by-products are obtained, which, off hand, would seem to be of small use. It would be paradoxical indeed if an industry built up on the utilization of waste could not employ its own by-products. One of these waste materials is gas—oxygen and hydrogen in enormous quantities. A few years ago the German chemist (he now admits it blushingly) allowed these gases to drift into the atmosphere. The coming of the airship and the invention of the oxy-hydrogen flame has changed all that. At the vast plant of the Griesheim-Elektron Works near Frankfurt-on-the-Main, a more or less elaborate system of pipes and gas-holders has been installed to conduct and store the hydrogen in steel bottles, under a pressure of one hundred and fifty atmospheres. Hundreds of steel blocks are filled with the gas under high pressure, and shipped all over Germany. The demand for oxygen has increased so enormously since autogenous welding was introduced that a special plant has been installed at Griesheim to manufacture liquid air by the Claude process (described in the SCIENTIFIC AMERICAN some years ago), and from the liquid air, oxygen, as well as the other constituents of the atmosphere, is obtained by fractional distillations.

So large is the quantity of waste hydrogen generated at Griesheim that it has been found profitable to install a large balloon-filling plant at the works. Here the giant airships of Zeppelin and the smaller craft of Parseval may frequently be seen receiving their charges of buoyant gas, and here too as many as seven spherical balloons are inflated during a morning for one of those cross-country races which are more popular in Germany than in the United States. Even when they are not at Frankfurt the airships are often inflated with Griesheim waste hydrogen; for the gas is sent to them by rail in long steel flasks.

(To be concluded.)

alters, while the other elements[1] remain constant, no change occurs in the net pressure. For the density of the air, and hence the buoyancy of the vessel, changes directly as the barometric pressure; and the vessel will rise or fall to a level where the density of the air is equal to what it was at the first position of equilibrium. But if the density at the new position equals that at the old, so also must the atmospheric pressure, since the other elements have not changed. Hence the net pressure is unaltered, which proves the theorem.

Again, if the atmospheric and gas temperatures alter equally, while the other elements remain constant, no change occurs in the net pressure. For the density of the air varies inversely as the temperature; and the vessel will move to a level where the density is the same as at the first position of equilibrium. But if the density at the new position equals that at the old, the proportionate increment of air pressure must be directly as the increment of temperature, and therefore equal to the increment of gas pressure. Hence the net pressure remains unaltered, which proves the theorem.

Combining the two theorems just established, we obtain the more general one, viz., if the gas temperature of a vertically free balloon keeps pace with the air temperature, no change of net pressure occurs for any thermometric or barometric changes in the atmosphere.

Furthermore, it may be affirmed that if the vessel's bulk varies, while its mass remains constant, practically no variation of net pressure ensues from the bulk change itself. For the pressure increments of the gas and air equal each other, since when the bulk enlarges or contracts the vessel moves to a rarer or denser atmosphere, while the gas pressure changes proportionately, thus leaving the net pressure practically unchanged.

Again, if air is pumped into or out of the balloon, practically no change of net pressure occurs if the balloon is free to alter its pressure accordingly, and if the temperatures of the gas and surrounding air remain equal. For changing the weight of air in the hull causes a corresponding change of atmospheric level, and with it a change of external pressure equalling the change of internal pressure. Practically this means that by pumping air into a balloon or its ballonet the vessel can be brought down from any elevation without altering the net pressure. This and the preceding theorem are rigorously proved in the paper previously cited.

The four theorems just proved assert that, in a high-speed metal balloon (which promptly assumes the temperature of the environing air), practically no change of net pressure can occur from any change of density or temperature of the air, from any enlargement or contraction of hull, or from the alteration of weight caused by pumping air into or out of the hull, providing the vessel is free to float to its level of equilibrium.

To be continued.

[1] The other elements of density are the temperature and percentage of moisture.

Colloids and Colloidal Solutions*

Some Examples from Everyday Life

By Elwood B. Spear

If we stir sugar into a cup of water we make what the scientist calls a solution. It is a homogeneous mixture of water and sugar, that is to say, the smallest portion of the liquid that we can see even under the most powerful microscope contains relatively the same amount of sugar and water as any other portion of the solution. According to the modern theories of the constitution of matter, both water and sugar are present as molecules. These molecules are too small to be seen by the eye even aided by the microscope, and the whole solution, therefore, appears to us to be made up of only one substance. Solutions where the single molecules of the dissolved substance move freely about among the molecules of the solvent are called crystalloid solutions, and the dissolved substance is called a crystalloid. These solutions may be colorless like white sugar dissolved in water or colored like strong tea, but they are always clear and more or less [illegible]

Colloidal Suspension.—The water in our rivers and streams in early spring is almost always turbid. This is due to the fact that it contains large quantities of mud and other substances that are divided into very small particles. These particles are held in suspension by the water because their weight is so nearly equal to that of the same volume of water that the whole mass must remain quiet before the mud particles can settle down to the bottom. If the water is moving, the mud particles are carried along with it, and the settling out is prevented by the mixing action of the running water.

If muddy water is allowed to stand, we notice that the largest particles fall out in a few minutes, while it usually takes hours before the water is clear of all the very small particles. This is a general law that for a very finely divided substance suspended in a liquid the larger the particles, the faster they will fall to the bottom. It is possible to obtain particles so small that they do not fall out for several months, and these particles have been given the names of "colloids," while the whole solution is called a "colloidal suspension."

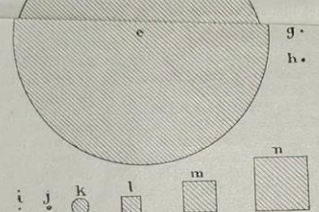
Some of these colloidal particles contain a few, some of them many hundreds of molecules of the dissolved substance. Each particle forms a single community in the liquid and moves as a whole, just as eleven individual players form a football team and make a concerted attack on the opponent's goal, or a thousand soldiers form a regiment and charge a fort.

Colloidal suspensions can be made of many metals, such as iron, silver, gold and platinum, by allowing an electric current to jump across through water between the points of two wires of the metal in question. The particles of a colloidal suspension of platinum made by this process are of various sizes, some of them large enough to be seen with the unaided eye, while others are not much larger than water molecules. Some of the large particles fall out in a few hours, while the extremely small ones may remain suspended in the water for years.

Size of Colloidal Particles.—Suppose one of these particles and the head of a pin were each enlarged in the same proportion until the particles could be seen by the human eye, the head of the pin would then appear as a huge mass of metal as large as a seven-story building.

True Colloids.—If we attempt to dissolve a small piece of jelly in warm water we obtain a solution that appears to be clear. In reality the molecules of the jelly are not single and independent of each other, but have formed groups of two's, three's, ten's, etc., like school children at intermission. We have made here a true colloidal *solution*, which differs from colloidal suspensions chiefly in the fact that particles are soft and plastic, resembling jelly, soap, rubber, etc., while those of the *suspensions* are much harder, like tiny pieces of metal.

Blood a Colloidal Solution.—Most people imagine that the blood is a solution like red ink where every portion of the liquid, however small, is the same color. In point of fact, however, the red color is due to the presence of innumerable small red particles called corpuscles, floating about in a waterlike liquid. These are large enough to be seen by a powerful microscope. In addition to the red particles there is also a considerable number of white corpuscles present in the blood.



In the above figure, e represents a blood corpuscle enlarged 7,000 times, and f, g and h the comparative size of the particles in a colloidal suspension of gold. Now consider that f, g and h are enlarged to l, m and n, then i, j and k will represent the comparative size of molecules of alcohol, chloroform and starch, respectively

Milk.—Milk also is a most interesting colloidal solution containing yellow and white particles. If milk is allowed to stand, the yellow particles unite and float on top, and we call them cream. When the milk sours the white particles unite and we get thick milk. Cream, however, contains both white and yellow particles, because when it is churned we get the yellow particles in the form of butter, while the white ones remain in the buttermilk. If now the buttermilk is allowed to stand, we find that the white particles have united and fallen to the bottom, while the clear amber-colored liquid is left on top.

Colloidal Particles Grow.—The colloidal particles of a gold solution may be caused to unite together and grow larger by violent stirring, just as churning will gather the yellow particles of cream to form solid butter. This uniting of the colloids to form larger particles is called "coagulation," and is produced most easily by violently stirring a hot solution. Some of our readers will remember in boyhood days when obliged to churn how delighted they were when the cream became too warm, because the butter came faster; in other words, the heat had done a part of the churning.

The reason that the flow of blood from a wound can be stopped is because the red particles under the action of the air unite or coagulate and stop up the wound and thus prevent further loss of blood. This is spoken of as the "clotting" of blood.—*Science Conspectus.*

The Effects of Electric Currents on Reinforced Concrete

Alarming news has been published repeatedly of late years on the destructive effects supposed to be exerted by electric currents on concrete and iron concrete. Some experimenters have even asserted that blocks of concrete submitted to a relatively weak current might become loosened sufficiently in their structure to be cut with a knife.

Now a German magazine, *Die Bauwelt*, has addressed a circular inquiry to the experts and engineers of all [illegible] From this inquiry it appears that not a single case of electric currents having in any way endangered a concrete building or some of its parts is so far on record in Germany. The data collected related to a great number of power houses as well as iron concrete masts and all sorts of private houses. Even iron concrete water towers which by their isolated positions and the water contained in their interior, would be particularly exposed to destructive effects, have never shown the least trace of destruction due to the action of electric currents.

It will be remembered that in connection with Knudson's experiments in 1908, a series of concrete and iron concrete blocks were submitted to high pressure in fresh water or sea water, those kept in fresh water being found to be crushed more easily under the action of electric currents than blocks immersed in salt water. On the other hand experiments made in 1910, by W. Gehlet, have shown the prolonged action of strong electric currents to result in desiccation not only of concrete blocks previously kept in water but even of those stored in a dry place. Rammed concrete, however, undergoes an appreciable reduction of its resistance to pressure. The vaporization of the moisture of concrete under the action of electric currents, however, takes place only under greatly exaggerated conditions as compared with those occurring in actual practice. The richer the concrete mixture, the more rapid will be the process of desiccation, while a poorer mixture, on the other hand, has a higher initial strength.

In the case, however, of iron concrete blocks, experiments show, under the action of electric currents, the formation of fissures at the positive electrode. The surface of the iron armature forming the positive pole is covered entirely with rust, whereas a negative iron electrode remains perfectly smooth and the concrete absolutely intact. When using brass electrodes in the place of iron ones no harmful action is observed.

Incidentally, these experiments show concrete to be a conductor "of the second class," its electrical resistance decreasing as the temperature increases and inversely.

Preserving Furs and Woolen Clothing.—Thymol powder has been recommended as one of the best preservatives for furs and woolen clothing. The articles should be sprinkled with the powder and wrapped in paper and then put by in tight boxes.—*Cosmos.*

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

The Drain Water from Refrigerators

We have received the following letter, in which a subject of obvious interest is brought up for discussion. We publish it here in the Correspondence Column and shall be pleased to receive from our readers any comments which they may have to make on the subject. In the meanwhile, one does not hesitate to indorse Mr. T. W. Sprague in the warning note that he has struck. Waste water from any source, however slightly contaminated it may be, is obviously not a desirable material to use for household purposes, least of all for consumption.

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

You have occasionally discussed the subject of "pure water" for household use. Below I give you a different phase of the question than I have before seen and should be pleased to get your opinion of the matter.

It is well known that the water, melted ice, which passes through the drain pipe of the ordinary refrigerator, carries with it, the congealed odors from the butter, cheese, onions, fish, meats, vegetables, fruits, etc., placed there for the purpose of keeping them cool.

Certain families in my neighborhood save the "refrigerator water," collecting one or two tub-fulls a week, and because it is soft use it in doing the family washing. By the end of the week, this water in the tub, contains great ribbons of white slime made up of the collected odors from the provision compartment of the refrigerator.

Before washing the water is strained, and, of course, much of the coarser particles of slime is eliminated, but the finer particles still remain in the water. A portion of this water is placed in the boiler in which some of the clothes are boiled; the clothes are then thrown into a tub and washed and then run through the wringer into a second tub of the same kind of water used as a rinse or bluing water. After rinsing and bluing and being run through the wringer, they are hung on the line to dry. Now it seems to me that this last rinse or bluing water must con- [illegible] of the finer portions of the slime not [illegible] next to the skin, must certainly get the benefit of this poisoned water.

I know of one family who have been using this kind of water for the past two years. Their cistern gave out, and this water was used as a temporary expedient; but as a matter of fact, has been used continuously to the present, and every member of the family has been sick; some of them from the time the water was first used, and others were taken sick later.

There is perhaps no family in the neighborhood who live so hygienically, save in this respect, as the family in question. They use no meat, are vegetarians, have fruit on the table every day in the year and give a great deal of attention to pure air sunshine and cleanliness.

I know of another family who used the water from the refrigerator for both cooking and drinking. They were keeping boarders; one gentleman and his wife who were boarding there were sick all the time they remained in the family. I have reason to believe that quite a good many families are using this kind of water. Should be pleased if you would give this subject a write up.

Yours truly,

D. W. SPRAGUE.

Dissolving Copper in Ammonia

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

Probably some of your readers interested in chemistry may find use of an observation, new to us, made to-day of a peculiar property of copper.

For some hydro-metallurgic treatment it was desirable to find a way of dissolving metallic copper in ammonium hydroxyde. We found that if metallic copper is placed in a solution of aqua ammonia, and powdered ammonium persulphate is introduced into the mass, the metallic copper enters at once into solution, giving the intense blue color of Schweitzer's reagent. Precipitated metallic copper (cement copper) dissolves as rapidly as it would in nitric acid. This property of which we were not aware, may probably be employed in analytical chemistry to separate copper from other metals. In our case the problem was the separation of cement copper from the metals of the platinum group.

This method of dissolving copper rapidly and in an alkaline solution may find applications in chemical aechnology, and this is the reason why I take the liberty of communicating our observation to you. Mr. Charles S. Witherell, the eminent electro-metallurgist made the observation conjointly with me.

Newark, N. J. MORTON LIEBSCHUTZ,
Chemist to Balbach Smelting and Refining Company.

Science Notes

The Weight of Animals' Stomachs.—In a recent issue of *Comptes Rendus* M. A. Mangin reports on some observations which he has made regarding the weight of the stomach of various mammals. He has extended his observations over 280 animals, weighing the stomach, empty of food, and determining its proportion to the total body weight. He finds that the smallest stomachs are those of insectivorous animals, with a mean weight of a quarter of an ounce; next in order come omnivorous animals, with 3.5 ounces, grain eaters with 6 ounces, and carnivorous animals with 18 ounces. Animals which live on fish stand high in the scale, with an average weight of 190 ounces. Far the greatest capacity, however, is shown by herbivorous animals, whose stomachs weigh on an average no less than 1,600 ounces. Expressed as percentage of the body weight, that of the stomach ranges between 5.8 and 9.3, except for herbivorous animals, where it amounts to 14.6. It is worth noting that the proportion of the length of the intestine to the length of the body follows the same order for the several groups of animals mentioned, ranging from 2.5 (insectivora) to 15.1 (herbivora).

Experimental Investigation of the Origin of the Moon's Craters.—By the use of plastic material some ingenious experiments have been carried out to test M. Emile Belot's theory of the origin of the moon's craters. Melted paraffine is poured upon water and when this has nearly set, a fine stream of cold water is allowed to fall upon the surface, which produces a depression and other characteristic features very similar to those observed on the moon's surface. Still better craters are obtained by pouring paraffine upon hot alkaline solution and then allowing a few drops of acid to fall through the paraffine, causing a violent ebullition.

Effect of Microbes on Sterilized Chickens.—Our readers will remember the experiments which M. Cohendy has carried on with chickens raised with scrupulous exclusion of all microscopic germs. The question has arisen what would happen to these birds if various microbes, not necessarily harmful in themselves, were introduced into their system. The experiments carried out to settle this point seem to show that the chickens were not affected in any abnormal way, but seemed [illegible] This result is not by any [illegible] the reaction of the system toward other germs.

Decomposition of Water at Ordinary Temperatures by Magnesium.—A. W. Knapp, writing in *Chemical News*, describes a very interesting experiment in which water is decomposed by magnesium at ordinary temperatures. When magnesium is mixed with water, no reaction is observed at ordinary temperatures, although the formation of magnesium hydroxide and the liberation of hydrogen is an exothermic reaction. This is commonly explained by saying that the film of hydroxide first formed covers the metal and retards further action. However, if magnesium powder be added to ten times its weight of water, and then to this mixture such an amount of palladious chloride as contains about one-hundredth part of the weight of magnesium used, a brisk evolution of hydrogen occurs. The magnesium reduces the palladious chloride and metallic palladium is formed, which acts as a catalytic agent. The small amount of magnesium chloride formed possibly also accelerates the reaction at first by dissolving the hydroxide. The temperature rapidly rises until the water boils and considerable white hydroxide is formed. The palladium, which has accelerated the *decomposition* of the water, now accelerates its *formation*, for it is warm, and some of it rising on the bubble-films, which separate the hydrogen from the air, causes the hydrogen to ignite spontaneously.

The Size of Raindrops.—For about two years past the English meteorologist, Spencer C. Russell, has been carrying on investigations on the size of raindrops. The method employed was to catch the drops on a piece of porous plaster plate. The most frequent size for drops is 2 or 3 millimeters in diameter. The figures obtained were as follows: Of a total of 885 drops, 257 were 3 millimeters in diameter, 222 measured 2 millimeters, 175 had a diameter of 1 millimeter, and 107 fell below this limit. Larger drops were scarce, the classes of 4, 5 and 6 millimeters being represented respectively by 73, 44 and 7 drops.—*Prometheus.*

Zinc for Sterilizing Water.—According to a note in *Cosmos*, a very simple and thoroughly satisfactory means of sterilizing water is to place a few granules of zinc in the vessel containing the same. Zinc does not to any appreciable extent dissolve in water, so that there can be no objection to its use in this manner.

The New Weight and Measure Regulations in Germany.—The new German Weight and Measure Regulations, making the use of the metric system compulsory in all transactions, went into effect on April 1st of this year. For very small weights as used by jewelers or chemists, a special design is prescribed. The 200 milligramme plates are to be square, the 100 milligramme weights triangular, the 50 milligramme weights hexagonal; the 20 milligramme weights are again square, the 10 milligramme weights triangular, and the 2 milligramme weights square.

A City Map for the Blind.—A city map of London has been published which enables blind people to find their way unaided through the highways of the city. The map is constructed on the well-known Braille system; it contains the more important thoroughfares and leading buildings, together with all the necessary directions.

The Smallest Republic.—The smallest republic is not San Marino, as usually supposed, but the diminutive island Tavolara, about 7½ miles off the coast of Sardinia, according to a recent issue of *Deutsche Rundschau für Geographie.* This island is only 1¼ miles wide and its whole population numbers but 55. In 1836 Tavolara was granted independence by Carl Albert, and a certain Barteleoni assumed the title of king under the name of Paul I. At his death in May, 1882, he expressed the wish that the people should become self-reigning. In 1886 the Tavolarians proclaimed the republic, and according to their constitution a president is elected every ten years.

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The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

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Curiosities of Science and Invention

READERS are invited to contribute to this department photographs of novel and curious objects, unique occurrences, and ingenious contrivances. Such as are available will be paid for promptly.

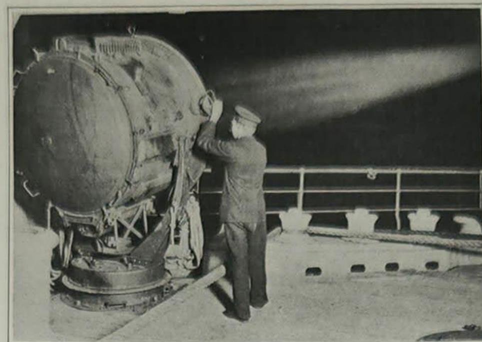
The Licensed Sand Sculptor

THE sand sculptor, familiar to visitors to the sea shore, has advanced from a small beginning and a somewhat checkered career to the dignity of a regularly recognized artist. At first the efforts of this picture maker were crude in the extreme. Fashioned from real sand the figures he produced were scarcely worthy of serious notice, either as art productions or as a bid for the coins of the beneficent. It was almost impossible to work with sand alone, and as the productions were as unsubstantial as the snow figures of the winter season, no one was interested in the "artist's" work to the extent of more than a glance in passing on the boardwalk at one of the seaside resorts.

But in this country no one is satisfied for long with crudities. While sand artists abroad continued to work in sand alone, the American "sculptor" experimented with various materials until he had found something that would pass as sand but which was almost as substantial as hardened clay. As soon as the improvements began to be evident and the public began to take serious notice of the sand artist and his work it became a profitable business and the sands along the boardwalk began to swarm with "artists." Many were quite ignorant of art, but contrived to fashion a few figures that a good-natured public recognized as well intended, and rewarded with small coins. Some were genuine artists seeking in this way to pay for a summer vacation, or students trying to earn enough in the summer to weather the financial storms of the winter. These of course were annoyed by the ridicule brought on the business by the unskilled ones and encounters took place between rivals that at last compelled the authorities to take notice of the presence of the sand artist colony and take steps to regulate the business in some way.

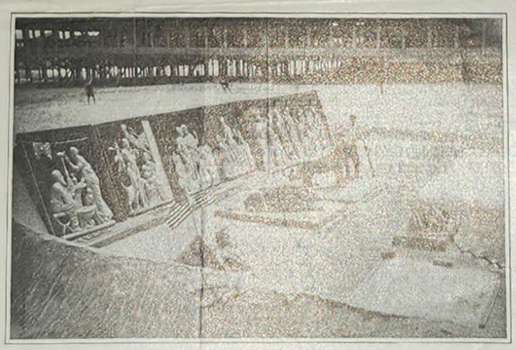
Atlantic City was the first sea shore resort to insist on a license being first obtained before any one could stake out a claim on the sands and start business as a sand sculptor. There was appointed a committee to examine the work of the various artists and pass on its merits. The decree went forth that all work that could not pass muster with the committee as possessing some sort of art merit should be demolished and the artist driven from the beach. Some of the workers had been unwise enough to stoop to vulgarity in their creations and this hastened the work of the committee. The long line of sand sculpture exhibits that stretched along the front of the boardwalk was inspected closely and the committeemen retired to compare notes and report. Next day a band of large-footed policemen marched down the line and whenever they reached a sand sculptor's exhibit that had come under the ban they proceeded to stamp it to pieces, with a warning to the "artist" to come there no more. As a result of this proceeding the exhibits that will be seen this summer are only those that are really attractive and have some claim to being artistic.

The figures are made of sand and cement mixed, to give the finished work the hardness of mortar. One of the best sand artists, the leader of the colony at Atlantic City, originated the exhibit of classic figures shown in one of the photographs. He was the first to construct his sand display on a slanting base so that the exhibit faced the board walk at an angle suitable for observation and he also gave the figures a coat of white paint which brought them out in bold relief against the dark sand. It was not long before others imitated the classic artist and even improved upon his idea. Subjects were selected that lent themselves to original coloring and with fine disregard for historical correctness the sculptors adorned George Washington, standing in the boat of sand in the act of crossing the Delaware, with a bright red coat and provided his sailors with blue shirts and his attendants with sartorial accessories of any hue that harmonized with the general color scheme.

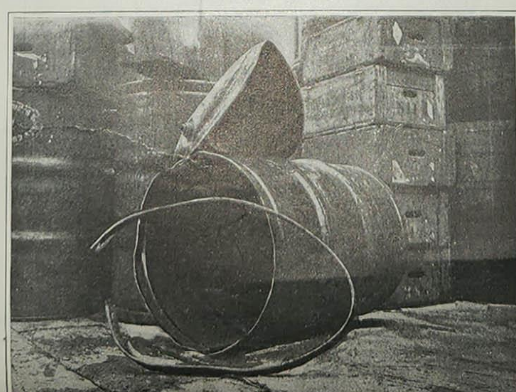


An 80,000 candle power searchlight for a transatlantic liner.

A clever bit of work done in sand and cement.



General view of the classic figure exhibit.



"Empty" gasoline barrel exploded by the sun's heat.

First Searchlight for Transatlantic Liners

THE most powerful searchlight ever carried on a merchant ship was a conspicuous feature of the "Kaiserin Auguste Victoria," which arrived in New York recently. The great light, which is the largest type ever constructed, is designed for the steamship "Imperator." It is being carried across the Atlantic to be thoroughly tested at sea and on entering harbors. It throws a beam of light of 80,000 candle power. On approaching port, the searchlight was turned on the Scotland Lightship, rendering the name of the ship clearly visible at a distance of several miles. The great light is effective for seven miles at sea, and when thrown upon the clouds is clearly visible for a distance of thirty miles.

The searchlight reached the vessel only three hours before her sailing and was carried on the forward deck. It will be installed on the lookout, high up on the mainmast, where it can be swung quickly to any angle. The searchlight is of the type used heretofore only on the largest dreadnought battleships. The lens is 42 inches in diameter. It is operated by a current of 13,000 watts on a 110-volt circuit. In actual tests at sea, the ray has pierced fogs and distinguished distant objects at every point of the horizon.

Precautions With Empty Gasoline Barrels

THAT gasoline is dangerous is pretty generally understood, though the death toll from careless handling is heavy. Usually familiarity with any dangerous thing breeds contempt, but even down in the "oil country" gasoline is treated with a respect that is greater than that given to nitroglycerine.

Many persons have always had the wrong idea regarding the dangers from gasoline. They have taken the greatest precautions with the full barrels and have given scant attention to the partially filled and empty ones; in fact, very few dealers and users have ever given any thought to the care of empty gasoline barrels. That this is wrong is shown by the accompanying photo of an exploded "empty" gasoline barrel. This barrel "went up" while standing in the hot sun on the platform of the freight station. It is a 50-gallon barrel made of heavy iron. The heads are of a single sheet, slightly crowned and set on a projection rolled on the inside of the cylindrical barrel sheet. A solid welded ring is placed against and around the head and the end of the sheet is rolled over the ring and tightly crimped. In the exploded barrel the head was bulged like a grocer's scoop, the ring torn apart and the crimp of the barrel sheet pulled out straight. This explosion made a very loud report and the pieces were blown to a great distance. Fortunately, no one was injured, though some damage was done to other equipment about the barrel. By "empty" gasoline barrels is meant those that have been unloaded by dealers or garages, both public and private. They are the barrels rolled out to be returned to the refineries for refilling. These barrels are a source of danger and should receive greater care. The cause of the explosions of these barrels is the excessive pressure of the gasoline vapor generated when standing in the hot sun. A little oil is liable to be left in them and if the vent plugs are screwed in tightly there is danger of an explosion. Drain the barrels thoroughly and have the vents opened; also store the barrels in a cool or shady place.

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes on Trademarks

Stagmatypy: A New Half-Tone Printing Process

If a solution of gelatine is cautiously mixed with one of gum arabic the two do not coalesce into a single homogeneous solution, but form an emulsion composed of minute drops of gum suspended in the solution of gelatine. If a glass plate is coated with this emulsion an irregular vibratory movement of the gum globules, of the character of the Brownian molecular motion, may be detected with the naked eye, while observation with a microscope shows that the minute globules gradually agglomerate into larger, though still very small spheres, which finally come to rest at approximately equal distances from one another. The configuration can be fixed by carefully drying the plate.

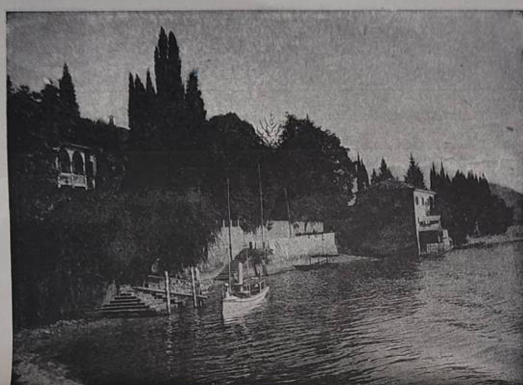
A plate of copper or zinc, coated in this manner with a gum-gelatine emulsion which has been made sensitive to light by the addition of potassium bichromate, forms the starting point in a new and remarkable half-tone printing process which Dr. Hans Strecker has devised, and named stagmatypy, from the Greek word *stagma*, a point.

In all methods of reproducing, by the printing press, photographs or other pictures having a continuous gradation of light and shade, the various tints, technically called "half tones," are represented by lines or dots separated by white spaces. All of these lines or dots are necessarily of the same color—that of the ink used in printing—but they vary in width according to the depth of tint, so that every gradation of the original picture, from black to white, is represented by the proportion of black lines or dots to white spaces in the corresponding part of the reproduction, as in a highly elaborated pen-and-ink drawing. This principle applies to all varieties of printing plates, including relief plates in which the raised portions alone take ink from the roller, as in wood-cut printing, etched plates in which the ink is wiped off the general surface but not from the depressions, and lithographic plates, which take the oily ink only at parts prepared for printing by previous applications of such ink.

The disintegration of the half-tones into separate lines or dots is usually accomplished by photographing the original picture through a fine grating of parallel lines or network of intersecting lines, photographed on glass. The result is a mechanical, lifeless print which often fails signally to reproduce the individuality of the original. The actual pattern of the grating, fortunately, is apt to escape the notice of the superficial observer, but it appears conspicuously under a magnifying lens and is often apparent to the naked eye. A person who has seen it in one picture is tempted to look for it and find it in others, and then his eye involuntarily follows the straight lines of dots, and the artistic effect is spoiled.

Several processes have been devised for making the "grain" of the picture less regular, but none of them have achieved complete and lasting success. In some of these processes the picture is photographed through a stippled or dotted screen, while in others no screen or grating is employed, but the "grain" of the half-tone print is produced by particles of asphalt applied to the metal printing plate in the form of dust, and then fused, before the sensitive film is applied. In the heliogravure process, for example, the polished copper plate is first dusted with asphalt in a special apparatus, and a second operation is required to melt the dust and attach it to the plate. A photographic copy of the picture is made on paper coated with bichromated gelatine and the undeveloped print is applied, face downward, to the asphalted copper plate. The paper is then washed off, and the gelatine film, which remains attached to the plate, is developed into a picture in relief by the action of hot water. This process, which is common to all half-tone printing methods, is based on the property of bichromated gelatine to swell in hot water to a degree inversely proportional to its exposure to light. After all of these operations the plate is etched by immersion in a bath of ferric chloride.

Even the ordinary half-tone process is tedious and laborious in comparison with negative and immediately etched without having undergone the separate operation of development followed by drying and varnishing, which the ordinary half-tone processes require. The four distinct operations employed in heliogravure, namely, the formation of the grain, the coating of the plate with the sensitized or exposed film, development and etching, are replaced by two operations in stagmatypy. The grain is formed automatically during the coating of the plate, and development and etching are effected simultaneously by stagmatypy, and the glass gratings employed are costly and fragile.



This half-tone was printed from a Stagmatype plate

The new stagmatype process is remarkably simple. The granulation required to reproduce the half-tones is effected automatically by the agglomeration and precipitation of the gum globules when the bichromated gum-gelatine emulsion is poured on the metal plate, forming a grain of approximately but not entirely regular pattern which, when dried, resists the action of the etching fluid very well. The plate is then exposed under an ordinary immersing the plate in a solution of ferric chloride, the water of which produces the development while the iron salt, diffusing through the film, etches the metal in exact correspondence with the progress of development.

This remarkable simplicity makes stagmatypy much cheaper, as well as more expeditious, than heliogravure or the ordinary grating method, both of which it may replace with advantage. The only conceivable additional amplification would be to make the original photograph directly on the printing plate, and even this may prove to be practicable.

Another advantage of stagmatypy over the ordinary half-tone process is the greater richness of detail obtained in the print. It is obvious that a photograph made through a grating or net cannot reproduce every point of the original. A continuous black line, for example, is necessarily represented by a broken line. In stagmatypy, on the contrary, the unaltered negative is laid directly on the printing plate, the grain of which is formed automatically according to the character of the picture, so that the reproduction of a black line is as continuous as the original. For the same reason, the stagmatype reproduction shows a great superiority in contrast and depth of shadows—qualities in which the ordinary half-tone print is sadly deficient.

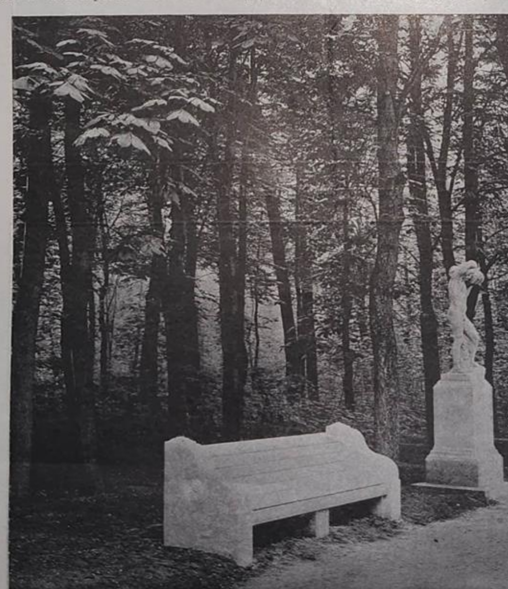
In order to obtain fairly satisfactory results by the usual half-tone methods it is necessary to use very finely ruled screens and the best grade of printing paper, and to employ great care and skill in all of the operations. This is not commercially practicable for ordinary work, in which coarser screens are employed, with inferior results. In this respect, also, stagmatypy presents an advantage, for a coarseness of grain that would be intolerable in an ordinary process print is barely perceptible in a stagmatype print, where the grain is not arranged in straight lines and set figures. On the other hand, the automatic stagmatype process can be made to furnish a much finer grain than can be obtained from ruled screens. Stagmatypy, therefore, may be applied to all grades of paper and subject, from the finest art reproductions to newspaper illustrations.

The new process is particularly advantageous in color printing, because it cannot produce the *moiré* effect which is often caused by inaccurate adjustment of the regular patterns of the several colors in the ordinary process. In stagmatypy the colors are automatically blended, and their proportions can be regulated in a novel manner by varying the size of grain for the different tints.

The most important application of stagmatypy appears to be to lithography, both monochrome and polychrome. By printing the stone with a stagmatype plate etched in intaglio a wonderful softness of effects is produced, as only the fine interstices of the granulation are impressed on the stone. Another interesting application is to the direct reproduction of drawings in pencil, charcoal, crayon or India ink without the intervention of the camera. The drawing, executed on a sheet of gelatine or similar transparent material, is laid on the sensitized stagmatype plate in a photographic printing frame, and the plate, after exposure, is simultaneously developed and etched, in the manner described above. In lithographic copies made in this way the character of the medium, pencil, crayon, etc., is reproduced with wonderful fidelity.

For etching the stagmatype plates Dr. Strecker has devised an electrolytic method which greatly facilitates the operation. The plate, suspended in the ferric chloride solution, forms the anode. An amperemeter, included in the circuit, indicates the moment at which the action begins and the rapidity with which it progresses. Hence, the etcher is not compelled, as he is in the useful chemical method, to follow the progress of the action on the plate itself with the greatest care, in order to replace the strong etching bath by a weaker one at the right moment. He can, therefore, conduct the etching of a number of plates at the same time. The electrolytic etching process can be applied to zinc, brass or steel, as well as to copper.

Stagmatype plates retain their sensitiveness to light for a long time, copper plates



Another example of Printing by Stagmatypy

In order to exclude the air the skins are covered with planks on which are placed heavier weights. This second soaking lasts from one to two hours.

6. *Preparing.* The skins are coated on the flesh side with a solution of sulphate of sodium and lime, or with a solution of sulphate of arsenic. The solution is applied to the skins with a rag fixed to the end of a stick. The skins are hung by the legs in pairs on frames provided for the purpose. At least twenty-four hours must elapse before the skin is ready for pulling. Nevertheless they are left hanging for five or six days.

7. *Pulling.* The wool is pulled either by hand, as already described, or by power. In the latter case the Mollnier machine is used. It consists of a cylinder armed with helicoidal bars without a cutting edge. The skin held by special clamps is pressed against the cylinder by a rubber-covered roller adjusted by a pedal. Before the wool is pulled it is necessary to remove the preparing solution either by rinsing or wiping.

8. *Rinsing.* The skins from which the wool has been pulled are rinsed in large tanks.

9. *Liming.* The skin is left in a solution of milk of lime for twenty-four hours in order to remove all traces of the wool. The skins are then prepared for tanning by the usual methods. The wool is extracted and then dried. The wool thus obtained is of much less value because it has been affected by the chemicals.

The sweating process gives a better quality of wool and an inferior grade of leather, the skin being treated in order to save the wool, with the skin itself considered a by-product. When using the stripping process the object is to preserve the skin for leather, the wool being a by-product.

A New Method of Color Photography*

A One-Plate Process Without Pigment

The special features of the micro-spectra method of color photography are, first, that by its means pictures absolutely faithful in color, tone, and texture are obtainable by means purely optical without the intervention of any artificial coloring matter whatsoever, and secondly, that it is a one-plate process involving nothing more than everyday black and white photography. A single negative is taken on a panchromatic plate, a lantern slide is made from it and placed in the position of the negative, white light is projected through the apparatus, and the picture, after slight adjustment, flashes out in its true colors.

The theory of the process is a simple one. It consists in producing by optical means a surface composed of hundreds of complete but very narrow spectra, lying next to one another, the spectra being so close together as to render the individual colors indistinguishable to the unaided eye, so that the surface appears to be white. The photographic positive is used as a mask to block out or weaken those colors which are not wanted, the remainder combining to form the picture.

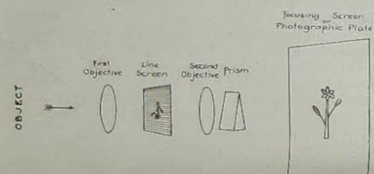


Fig. 1.—General Optical Arrangement Shown Diagrammatically.

The surface, composed of these contiguous narrow spectra, is produced by allowing white light to fall upon a fine line screen, of which the opaque lines are three times as wide as the clear interspaces, and forming an image on this screen by means of a lens with a prism just in front of it. The prism spreads each white line into a complete spectrum, and is so calculated that the spectra lie next each other on the focusing screen without interspace. If instead of white light falling upon the line screen we allow colored light to fall upon it, only those spectrum colors of which the line in question is composed appear on the focusing screen, the colors which are wholly or partially missing from the spectrum of white light being represented by spaces wholly or partially dark.

In taking the photograph the image of the colored object is projected by means of any ordinary objective lens on to the line screen, the image of which is in turn projected by the second lens with the prism in front of it on to the photographic plate placed in the position of the focusing screen. (Fig. 1 shows diagrammatically the general optical arrangement.) The plate must be approximately equally sensitive to all colors, so that the resulting negative is completely darkened when acted upon by any color in its full intensity, and partially darkened where the incident color is weakened. A lantern slide positive from this negative will, of course, show the reverse effect, being completely transparent where the color has acted with full intensity, of partial transparency where the color has acted less strongly, and opaque where the colors were missing, i. e., in those parts coincident in position with the spectrum colors of white light that were not present in the object photographed. When therefore this positive is placed in the exact position of the negative, and white light is projected through the apparatus, it acts as the desired mask to block out those colors that are not wanted, and the picture is reproduced in the original colors.

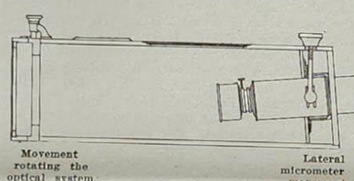
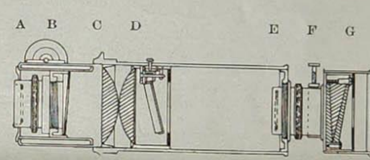


Fig. 2.—Section of Micro-Spectra Camera.

Like so many other scientific problems, however, while the theory was simple, in practice difficulties in the way of the construction of the necessary apparatus (Figs. 2 and 3) arose at every turn, and matters were further complicated by the necessity of keeping the camera within portable limits. To indicate one of the main sources of difficulty, an ordinary glass prism produces a spectrum widely extended in the violet and blue region and crowded up at the yellow and red end, an effect very detrimental to the proper rendering of the latter colors. This was overcome by the use of a compound prism specially computed to give a spectrum in which the colors are evenly distributed, as in a grating spectrum. The introduction, however, of a thick prism of this kind introduced aberrations of all kinds, both in the images of the object and of the spectra, which had to be successively overcome. It was, for example, found necessary to place the line screen (which has 372 lines per inch) at a slant to bring the spectra all over the field sharply into focus; a cylindrical lens is used in front of the prism to correct for astigmatism; the front of the camera is placed at the proper angle to prevent wedge distortion; a narrow prism behind the first objective brings the object sharply into focus, and so on. The objectives used in the camera are two 75 millimeters, Zeiss micro-planars. A field lens is interposed between the first objective and the line screen to direct the light toward the second objective. The whole optical system can be slightly rotated by means of a milled head on the left-hand side of the camera in front; at the back is another milled head securing slight lateral movement, and a lever above the viewing screen (not shown in Fig. 1) permits of a slight backward or forward movement of one half millimeter. These three movements are necessary to enable the lantern plate to be brought to the exact position of the negative, but correct registration is easily secured in a few seconds—the readings can, moreover, be noted on the positive.



A, Zeiss 75 millimeters, micro-planar objective on focussing mount; *B*, spectacle prism; *C*, field lens; *D*, line screen or grating in adjustable frame; *E*, 75 millimeters micro-planar objective; *F*, compound prism; *G*, cylinder spectacle lens, 125-inch focus.

Fig. 3.—Section of Optical System.

Besides the method of viewing the picture on the focussing screen of the camera, which requires a strong artificial light source, the pictures may also be viewed direct on the line screen by means of a magnifying eyepiece, for which purpose ordinary daylight or a weak illuminant suffices. This method in practise does not, however, yield *quite* such good results. The pictures may also be projected in a size of 3-4 feet diameter on a lantern screen.

Until the advent of a really rapid and satisfactory bleach-out paper, there is no possibility of recording the photograph on paper in colors, and since they can only be viewed in or by means of the camera itself, and the latter (which costs somewhere about $300 at present) will always be a somewhat expensive apparatus, even if the optical and mechanical parts can be further simplified, the process is scarcely one that is likely to become general. That indeed was recognized from the start of the experiments. Nevertheless, given the camera, the process is undoubtedly a simple method of color photography to work, and this should encourage many others to take up the new process.

* Reproduced from *Nature*.

Wireless Telegraphy in Railway-ferry Service

By special arrangement between the Prussian and Swedish Railway Departments, the Sassnitz-Trelleborg ferry line, the most recent railway connection across the Baltic, has been equipped with wireless.

The plant installed at Sassnitz Harbor comprises two isolated girder masts 132 feet in height, between which a standard T-antenna has been stretched out. At Trelleborg a standard "umbrella antenna" carried by a girder tower 149 feet in height has been installed.

Electrical energy for feeding the two stationary plants is derived from the existing direct-current systems.

The German ferry-boats "Preussen" and "Deutschland" as well as those placed under Swedish management ("Konung Gustaf V." and "Drottning Viktoria") are equipped with Telefunken stations designed for one kilowatt primary energy, the German boats being fitted with L-antennas and the Swedish with standard T-antennas.

A special point was made of excluding as far as possible any risk of interference by the many wireless stations working in the Baltic. To this effect under normal conditions a wave length of 1,485 feet is used, which is employed only exceptionally by other stations. This in connection with intermediary circuit receivers, has so far insured an absolute freedom from disturbance. In order further to increase the safety of operation, the stations have been calculated so amply as to allow the service to be maintained with one-fourth of the available vibration energy.

The installation of this wireless plant greatly facilitates the whole railway-ferry service. The two stations of Sassnitz and Trelleborg are in fact in a position to keep one another informed of any delay in the arrival of trains, of goods trains to be expected and many other things, while the ferry-boats themselves are able immediately to inform the railway stations or other ships of any unforeseen difficulty met under way, such as fogs or ice, and the resulting delay.

A remarkable case recently occurred on a trip from Trelleborg to Sassnitz: The ferry-boat, at about an hour's distance from Sassnitz, met with massive pack-ice obstructing her course and therefore had to sail backward, choosing another course. Owing to a dense fog falling at the same time, she lost all means of orientation so that the captain finally had to inquire by wireless at Sassnitz station, whether the ship's whistle was heard there, the answer being that the whistle was well to be heard. This showed the ship to be near her destination, and in fact she shortly afterward arrived at Sassnitz Harbor with 1½ hours' delay.

Tests of a Simple Engine*

Taking Steam at Less Than Atmospheric Pressure

By R. C. Carpenter[1]

[The problem of the direct utilization of the radiant energy received from the sun is one whose importance can hardly be overestimated. Our readers will remember an account of Mr. Frank Shuman's experimental solar engine plant recently published in the SCIENTIFIC AMERICAN.[2] *We now bring an interesting account of some tests performed on a low-pressure engine of the type used by Mr. Shuman. The results will perhaps appear somewhat surprising to many engineers, for it is found that such an engine may be operated with remarkable economy.*—ED.]

So far as the writer can ascertain, there are very few data available as to the economy of reciprocating engines when operating with less than atmospheric pressure, although numerous tests have been made of nearly all types of engines under the usual conditions of steam pressure and vacuum. A considerable amount of data is to be found as to the results of steam-turbine tests, especially when of large size, operating with steam of low pressure. The impression generally prevails that the steam turbine produces much higher economy than the steam engine when operating with steam of less than atmospheric pressure.

The investigation, the results of which are given here, cannot be said to prove that the general opinion as stated above is erroneous, but it does tend to indicate that the reciprocating piston engine of small clearances can be operated with low steam pressures and high vacuum with remarkable economy.

The particular engine which was investigated was of the four-valve type and with cam-operated valve mechanism arranged to open and close with great rapidity. The total clearance space was about 1 per cent of the piston displacement. The valves were located so as to make the losses due to clearance a minimum. The results obtained in the investigations could not, in my opinion, have been produced by any engine built ten years ago.

The engine in question was 24 inches in diameter with 24-inch stroke. It was double acting with admission-valve seats on the barrel of the cylinder near the end, and exhaust-valve seats in the heads. This engine was developed to furnish power from steam generated by the heat of the sun in plate boilers which presented a large absorption surface and were designed by F. Shuman.[3] Its general features were conceived by Mr. Shuman. The engineering features were designed and developed by E. P. Haines.

The engine was developed to meet a special demand for a steam motor of small power that would give the highest possible economy with low steam pressure and a high vacuum. Its design and construction were undertaken by Mr. Shuman after he had thoroughly investigated the possibilities of obtaining a commercial engine or turbine which would meet his requirements. The best guaranteed performance for a 25-horse-power steam turbine which he could obtain from any builder was about 60 pounds per brake horse-power per hour with steam of atmospheric pressure and a vacuum of about 28 inches. No such turbine has been built and in the proposals the cost of development would have fallen principally on Mr. Shuman had one been built. As the motor was to be employed for driving a pump, the reciprocating engine at moderate speed possessed many advantages over the turbine. Mr. Haines was quite certain from his preliminary studies that he could construct an engine of about 20 horse-power capacity which would produce a brake horse-power with less than 40 pounds of steam per hour. Several attempts were made before final success was attained; in one of which attempts the entire cylinder and head were lined with soapstone in order to reduce the heat losses. Although this experiment was very expensive, it did not accomplish the desired result. Mr. Shuman only proved by that experiment what was already well known to scientific men, namely, that the principal loss of heat in the steam engine is due to the deposit and re-evaporation of a film of water on the interior walls and not to the loss of heat through a good conducting material.

The Engine.—In general appearance the engine was not greatly different from other engines of similar size, except that its working parts were light and it was provided with a rather long connecting rod. It had an overhung crank and an outboard bearing. Its general appearance is shown in Fig. 1. It could be turned readily by hand, showing that the friction loss was small.

The general arrangement of the valve-driving system and the valves can be seen from Figs. 2, 3 and 4. A followed by numerals indicates parts of the admission-valve system, and E followed by numerals represents parts of the exhaust-valve system. Two eccentrics were used which drove rocker arms, one of which A, Fig. 4, operated the steam valves, and the other E the exhaust valves. A cross-section of the admission valve and its driving linkage is shown in Fig. 2. Generally speaking, the valves were constructed so as to reduce the clearance space to the lowest possible limit.

The steam-admission valves, two in number, were of the slide-valve type, arranged to move parallel to the axis of the cylinder on a curved seat concentric with the cylinder. The steam-valve stems were driven by cams A_8, lifting A_6, Fig. 3, against the action of a spring. The oscillation vibrated the bell-crank lever of Fig. 2, which motion was communicated by links to the valve A_{10}, Fig. 2, and gave it a sliding motion on its seat. This design afforded steam ports with an opening 20 per cent of the piston area. These are on the top part of the barrel of the cylinder near each end and are provided by this construction with extremely short passages into the cylinder, thus making a small clearance loss.

The exhaust valves in this construction are especially novel; they consist of thin steel plates situated inside the cylinder heads and are vibrated in a plane perpendicular to the axis of the cylinder. Such valves are extremely unusual in the construction of steam engines and their operation was studied with a great deal of interest. In structure the valve was a flat thin disk provided with slots which were made to register with corresponding openings in the seat by the action of the valve-moving mechanism. It worked smoothly during the test; it was tight and its continued use apparently increased its tightness. The fact that it was very thin and that it was held in position by the pressure inside the cylinder, doubtless explains why the results were so good.

The exhaust valve is shown at E_1, Fig. 2, from which it will be noted that the area of the exhaust ports when open is very large. It amounts to 35 per cent of the piston area. The exhaust valves are vibrated by connecting to the eccentric E, Fig. 4, through the medium of rocker arms, links and cams shown in Figs. 4, 3 and 2.

The steam pipe is shown in the upper left-hand corner of Fig. 2, where it joins on to the steam chest. The exhaust-steam pipe is shown beneath the cylinders in Figs. 2 and 3.

The Test.—The test of this plant was conducted at Tacony, Pa., by Prof. W. M. Sawdon and myself. Because of the fact that the steam pressure was very low and that the work was done almost exclusively with less than atmospheric pressure, the method of testing which had to be adopted was quite unusual.

The engine was arranged to exhaust into a surface condenser connected to a vertical air pump. The water of condensation was delivered by a special hotwell pump into one of two tanks, which were placed on weighing scales and provided with suitable pipe connections and valves so that one could be filling while the other was emptying. The hotwell pump was provided with a governor for maintaining a constant level in the hotwell. Observations of the water level were also taken by means of a glass gage, and a correction applied for differences of level whenever necessary.

The engine took its immediate steam supply from a receiver 24x42 inches. The receiver was supplied with live steam from a low-pressure solar boiler situated in another building and some distance away, and it also received the exhaust steam from the air pump which produced the vacuum on the system. The live-steam connection from the boiler was provided with a valve by means of which the pressure was maintained constant by hand regulation. The main supply pipe was exposed to the weather, which was quite cold at the time of the test; as a result a considerable amount of water discharged into the receiver from both sources of steam supply, the height of which was determined by a glass gage and was regulated by a valve on a drain pipe. During some tests it was sometimes desirable to drain the receiver when the pressure was less than atmospheric; this was accomplished by connecting the drain pipe to an auxiliary receiver, which was connected to the suction side of the air pump and thereby kept under vacuum.

The steam pressure was measured by a U-tube mercury manometer attached to the steam pipe near the steam chest. This was kept as nearly constant as possible by hand regulation of the live-steam valve controlling the admission of steam into the large receiver. The vacuum was measured by a cistern mercury manometer connected to the condenser.

The temperature of the steam was taken by a thermometer placed in the steam pipe near the cylinder. The temperature of the exhaust was taken by a thermometer well in the exhaust near the cylinder. In general, all thermometers and pressure gages were very carefully compared with standards before and after the test, and the results corrected as necessary.

In order to guard against any water vapor in the discharge from the air pump which should have been charged against the engine, it was condensed, by discharging through a long pipe extending some distance outside the building. It then passed through a trap, was weighed and considered as steam consumed by the engine.

A gasometer was also placed in the air-pump discharge and so arranged that the volume of air pumped in a given length of time could be measured.

Quality determinations of the steam entering the cylinder were necessary in order to obtain accurate results, for the reason that the steam supplied to the main receiver, as already noted, contained a considerable amount of moisture. This problem was a very unusual one, as it required the determination of the moisture in the steam supplied at atmospheric, or less than atmospheric, pressure. In the tests made, the steam pressure varied from slightly above atmospheric pressure to about 7 pounds below.

The scheme of arranging a calorimeter for working under such conditions was quite original and was worked out in detail by Prof. Sawdon. The results which were

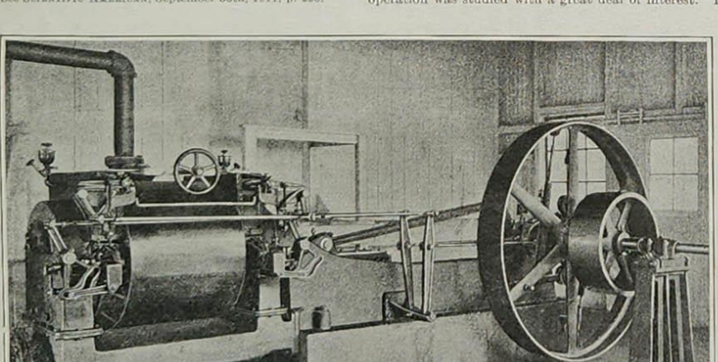


Fig. 1.—The 20 Horse-power Shuman-Haines Low-Pressure Steam Turbine.

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*A paper from the Engineering Research Department of Sibley College, printed in *Sibley Journal of Engineering*, May, 1912.

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[2] September 30th, 1911, p. 291.

[3] See SCIENTIFIC AMERICAN, September 30th, 1911, p. 290.

Many engineers hold that the air washer has a number of advantages over the dry filter for most purposes. The usual form of washer depends for its action upon bringing the air into more or less intimate contact with water first in the form of a spray, and secondly in the form of a film on metal plates.

The advantages of the air washer over the dry filter are: that it is compact, it is practically self-cleaning, it not only removes solid matter efficiently but also extracts a large proportion of the soluble gases such as sulphur dioxide, carbon dioxide and evil-smelling vapors.

That these odors may be removed most completely has been demonstrated by installation in the vicinity of rendering works and packing houses where the air outside would be nauseating while in the buildings ventilated with washed air the odor could not be detected. In such locations, of course, the water must be continuously changed, otherwise it would become saturated and ill smelling.

In the first attempts to wash air a coke screen was used, over which running water was allowed to trickle. But this device proved unsatisfactory because it either occupied too much space or else offered too great a resistance. It also very quickly became foul with impurities and therefore formed a source of contamination. The present types of air washers have a spray system for supplying the water, usually requiring some form of nozzle and a centrifugal pump for supplying the water under head. There is a washing chamber provided in which the air is brought in contact with the water spray and an eliminator for the removal of the water from the air.

There is also employed a settling tank for holding the supply of water which is re-circulated and a strainer or filter for preventing the coarser dirt from entering the spray system.

Most of the air washers differ from one another largely in construction of the spray nozzles, and in the design of the eliminator, the two most essential elements. The "Acme" washer is designed with an eliminator composed of four rows of separate vertical plates or baffles. The baffle plates are about six inches wide and spaced about six inches apart in the row. Each baffle is provided with a projection or lip for retaining the water which impinges on the plate. The baffles in one row are staggered with reference to, and placed at right angles to the baffles in the next row. The nozzles discharge the water in the form of a vertical sheet which is afterward broken up into drops by the impact of the air current and the nozzles are cleaned by a hand-operated flushing device.

The McCreary washer is distinguished from other types by its "S" shape spray chamber which forces the air to pass through three sets of sprays, while the Webster washer employs horizontal baffle plates instead of vertical. It also differs from all others in using a single spray head at the top of the washer which discharges downward, giving a "spray and rain effect."

In the construction of the Kinealy washer there are horizontal baffles in the eliminator similar to those of the Webster, but nozzles similar in type to those in the Acme are used, provided with an automatic cleaning device. In the design of the Carrier washer and humidifier the spray nozzles used are arranged so that the water enters a small circular chamber tangentially, which gives it a whirling or centrifugal action. The outlet or discharge opening is in the axis of rotation, placed at the end of a conical approach. This greatly increases the whirling speed of the water at the point of discharge and delivers it as a minutely divided or atomized spray that offers an enormous surface for evaporation and cleaning.

The eliminators are usually built of galvanized iron, but may be copper, and are placed in vertical position across the discharge end of the spray chamber. Each eliminator plate is made of a single sheet so stamped as to form several corrugations, three of which have projecting lips. The plates are held together with galvanized angles at the top and bottom and at intervals throughout the height, so as to keep them evenly spaced. All the rivets and bolts used in the construction are galvanized.

The action of the eliminator is two-fold. The first portion of the eliminator is designed especially for washing effect and is not provided with flutters so that the water is permitted to pass from one connection to the next without obstruction. The second portion is provided with projecting lips to form gutters which complete the elimination of moisture. The plates are spaced only slightly over an inch apart thus sub-dividing the air very completely and affording an enormous washing surface.

The free moisture together with moisture-laden dirt is removed in the eliminator by the combined action of centrifugal force and impact. A distinguishing feature employed in this washer is the row of flushing sprays placed at the top of the eliminators which continually floods the whole of the eliminator surface. This greatly increases the effectiveness of the washing surface and prevents the plates from becoming foul.

All forms of air washers do a certain amount of humidifying, depending on the degree of contact of air with water, but it is clear that none of them as ordinarily used as washers will give a complete saturation.

As regards the theory of humidifying, it is a well known principle in physics that the vapor pressure or tension of a confined liquid increases with its temperature according to a definite law. It is also known that a volatile liquid will vaporize in air at any temperature and atmospheric pressure, and that the maximum density of this gaseous product will depend entirely on the temperature regardless of the presence of other gases or vapors.

In passing from the liquid to the gaseous state a great amount of heat is absorbed. In general the heat of vaporization is greater the lower the temperature. The density or moisture-holding capacity increases at a far more rapid rate than the temperature. The actual weight of water vapor per cubic foot is termed the absolute humidity and the saturation temperature corresponding to this density is called the dew point.

As saturated water vapor either alone or in admixture with air is raised in temperature without additional evaporation of water, it becomes superheated. The degree of superheat determines what is known as the relative humidity of the air. The relative humidity is expressed as a ratio of actual vapor density to the density of saturated vapor at the same temperature, i. e., it is the ratio of what air does hold to what it could hold at the same temperature.

When a superheated vapor is brought into contact with the liquid it immediately loses its superheat, partly through evaporation and partly by increase of vapor pressure. In dry air, which is merely a mixture of air and superheated water vapor, the heat of vaporization is taken from the air from the superheated vapor and from the water itself, when the saturation is completed the air and the water will be at the same temperature, which

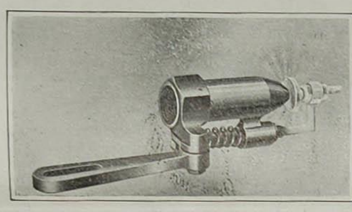


Fig. 3.—Spray Nozzle for use in humidifying the air.

is obviously between the initial temperature and the dew point.

Water exposed to dry air and unaffected by any source of heat will remain at a constant temperature as it evaporates, which is somewhat below the temperature of the air. This temperature is the same as that which the air will attain where it becomes saturated—this is known as the wet bulb temperature, observed by covering a thermometer bulb with a wet cloth.

The difference between this wet bulb temperature and the actual air temperature is called the wet-bulb depression. This is a direct measure of the moisture-absorbing capacity of the air. For each degree depression of the wet-bulb temperature a pound of air has capacity to absorb 1.4 grains moisture.

The designer of the Carrier humidifier has shown how the above theory applies in a very interesting way to the practical operation of air washers and humidifiers and to humidity control. He points out the fact that the cooling effect of air washers and humidifiers when the water is re-circulated is due solely to evaporation and is always in exact proportion to the wet-bulb depression of the air entering.

In a humidifier which has full saturating efficiency the air is cooled exactly to the wet-bulb temperature, while in the ordinary washers the air is cooled only from 60 to 85 per cent of the wet-bulb depression, according to the intimacy of contact between water and air. The spray water always remains at the wet-bulb temperature, and the wet-bulb temperature of the air remains constant regardless of the degree of saturation so long as no heat is added or substracted.

To cool without the addition of any moisture, the water used in the washer must be somewhat below the dew point of the incoming air. By carrying the temperature still lower and increasing the amount of water the washer may be used as a dehumidifier.

The effect of the washer in reducing humidity is similar to that of the jet condenser. The eliminator plates remove the condensed moisture effectively.

Humidity control is of vital importance and it is clear that humidity may be controlled in several ways, as by use of some hygroscopic substance such as wool, hair or silk or by controlling the absolute humidity or dew point with reference to the room temperature; also by the use of a differential thermostat having two elements, one subjected to wet-bulb temperature and the other to the dry-bulb temperature.

The first method is said to be too unreliable to be of much value in accurate work, while the second method of control can be made exceedingly accurate and is well adapted to regulating where there is a change in absolute humidity in the room to be conditioned.

The essential elements are two rods of hard rubber attached to a frame. These rods are arranged horizontally one above the other and the lower one is covered with a cloth which dips in a reservoir of water. This cloth serves as a wick and keeps the rod continually moist. These two expansible rods operate conjointly through a series of levers upon an air valve.

In order that this instrument may operate to maintain a constant percentage of humidity over a range of temperature it is essential that it should produce no movement of the air valve so long as the humidity is constant. These two rods expand in opposite directions and the dry element is provided with an adjustable leverage so that any desired ratio of action may be secured.

The simplest form of this control is that employed in public buildings for winter use. Here the air is saturated, delivered to the room where a higher temperature is maintained, at the temperature of the air washer, and then by varying either temperature and keeping the other constant any desired percentage of humidity may be obtained.

If there is maintained a saturated temperature of 50 degrees at the apparatus and 70 degrees in the room, there will be a relative humidity of 50 per cent; if the dew point at the apparatus is lowered to 40 degrees, still holding the room temperature at 70 degrees, there will be 34 per cent of the humidity in the room as the result. With a dew point at the apparatus of 61 degrees maintaining one room at 70 degrees, another at 75 degrees, and a third at 80 degrees, there would be 75, 64 and 55 per cent of humidity in these rooms respectively.

There was placed in operation an apparatus of this nature in the Central District Printing and Telegraph Company's building at Pittsburg, the air being tempered by direct contact with a heated water spray. The temperature of the spray is so controlled by means of a thermostat as to maintain a constant air temperature past the eliminator plates. The temperature of saturation is ordinarily maintained at 40 degrees. The air is then drawn through the fan and passed through the tempering coils, whence it is forced into the building. This method of fixed dew point regulation is only adaptable for winter use and is employed chiefly in public buildings.

It is impossible to maintain a uniform temperature throughout the summer in textile mills and therefore here it becomes necessary to vary the temperature of the dew point. This fact is taken advantage of in the control of humidity by means of the differential thermostat. This maintains a constant difference between the dew point and the temperature of the room and thereby regulates the humidity regardless of the room temperature.

This thermostat is placed at the apparatus directly back of the eliminator plates and is subjected to the current of saturated air.

Air conditioning must sooner or later be generally adopted in coal mining. The numerous and disastrous explosions that have occurred during the past winter are sufficient evidence that further precautions should be taken. To say that three-fourths of these could have been prevented by proper conditioning of the air supply in the mine is no exaggeration. This, as statistics will confirm, would have saved hundreds of lives and millions of dollars. A large part of these mine explosions were caused by dust, which has accumulated owing to the dryness of the mines.

In the mine the temperature remains uniformly between 55 and 60 degrees winter and summer. It is quite noticeable that there are seldom any explosions during the summer months when the absolute humidity is high. Whenever the dew point of the external air is above the temperature of the mine, moisture is deposited on the walls of the mine. However, when the outside dew point is below 55 degrees the air remains unsaturated and the mine becomes dusty.

In extremely cold weather the moisture contents of the air is very low, and the air when heated in the mine to approximately 55 degrees has an exceedingly low per cent of humidity. This causes the walls to dry so rapidly that it is impossible to keep them moist by any of the usual means of spraying. By use of proper air conditioning apparatus in connection with the air supply, summer conditions may be reproduced in the mines without any appearance of fog, or other objectionable features, and the mines may thus be kept in a perfectly safe condition.

Paint as a Protection Against Rust

According to a note published in *Cosmos* the German chemists Liebreich and Spitzer have been conducting some experiments with regard to the protection afforded to iron against rusting by a coat of paint. They come to the conclusion, which is somewhat surprising at first sight, that better results are obtained by the application of a single coat than by painting with two or more coats. The explanation which they offer for this somewhat remarkable observation, is that a single coat is more elastic and less liable to scaling off or cracking than a double coat, and thus affords more perfect protection from atmospheric influences.

Mendelism*

Experiments in Hybridization and Its Great Practical Value

By A. D. Darbishire, M.A.

Perhaps the most interesting, certainly the most sensational, chapter in the history of biology, when it comes to be written, will be that which deals with the discovery of Mendel's papers and with the fruit which that discovery has borne. We are already in possession of all the material for the former topic; and the first instalment of the fruit which has already been harvested augurs well for the quality of what is to come.

In 1865, a man absolutely unknown to the biological world, Gregor Johann Mendel, read before a meeting of the Natural History Society of Brunn a paper on his experiments with peas, entitled "Experiments with Plant Hybrids." To-day no name is better known to biologists than that of Mendel. And yet, when he died in 1884, he was as obscure as when he read his famous paper. Indeed it was not until sixteen years after his death that Mendel suddenly burst from obscurity into fame.

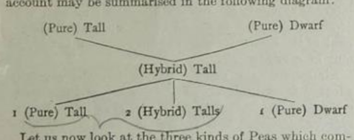
In 1900 Mendel's experiments with peas were repeated, and his results confirmed, independently by De Vries in Amsterdam, Correns in Leipzig, and Tschermak in Vienna.

We must now make it our business to become familiar with the facts which Mendel discovered, and with the interpretation which he put upon them. Mendel found that varieties of the culinary pea, *Pisum sativum*, could be classified according to a number of constant, true-breeding characteristics, such as the form of the plant, whether normal, (i.e. tall) or dwarf; or such as the color of the cotyledons of the seeds, whether yellow or green; and so forth.

Mendel crossed a Tall with a Dwarf. The resulting hybrid was invariably a Tall. Tallness, therefore, he called the *dominant* character and dwarfness the *recessive*.

These hybrids were allowed to self-fertilize (the normal process in *Pisum*), and seeds gathered from them gave, when grown, 1064 plants, of which 787 were tall and 277 dwarf; that is to say, the hybrid Talls produced Talls and Dwarfs in the proportion of 2.84 to 1, or roughly 3 to 1.

The seeds of these plants were sown, and it was found that all the Dwarfs bred true, while of every three Talls, one produced only Talls, the other two giving rise to Talls and Dwarfs in the proportion 3 to 1. The foregoing account may be summarised in the following diagram:



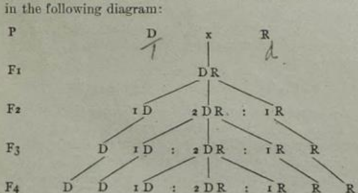
Let us now look at the three kinds of Peas which compose the generation in which Pure Talls, Hybrid Talls, and Pure Dwarfs appear in the proportion 1:2:1. We already know that all the Dwarfs breed true, that a third of the Talls breed true, while the rest of the Talls produce Talls and Dwarfs in the proportion 3 to 1. This proportion—3 to 1—is made up in the same way as the same proportion in the preceding generation, namely, 1 Pure Tall; 2 Hybrid Talls; and 1 Pure Dwarf. All these Dwarfs breed true; all the Pure Talls breed true; and the Hybrid Talls produce Talls and Dwarfs in the proportion 3 to 1. And so on.

There are two sets of symbols which are very convenient in describing these phonomena.

The first set describes the different kinds of individuals; the second the generations. D denotes the dominant form (in the case we have been discussing, the Tall), R the recessive (the Dwarf), and D R the hybrid.

P denotes the parental generation; F1, the result of crossing the two parent forms, in our case, the Hybrid Tall; F2 denotes the next generation, i.e. that in which the dwarfs reappear in the proportion 25 per cent.

We may now summarize the Mendelian phenomenon in the following diagram:



What is the cause of this beautifully regular and definite phenomenon? Mendel answered the question in this ingenious way. He believed that the germ-cell of the hybrid pea did not represent a mixture of tallness and dwarfness, but that a germ-cell represented *either* a tall or a dwarf, and, moreover, that half of the germ cells represented tall and half of them dwarfs. Let us see what is the result of the union, say, a hundred male germ-cells, or pollen cells, with a hundred female germ-cells, or egg-cells. Before we proceed, let us make certain of two points which are essential to the argument. Mendel believed that a pure-breeding tall pea contained only tall-representing germ-cells, in fact, that the reason that it bred true was that it did contain them; and that the dwarf contained only dwarf-representing germ-cells. Mendel had also found that the result of a union between a "tall" germ-cell and a "dwarf" one was a hybrid which bore the tall character. Now let us return to our argument.

Fifty of the hundred pollen-cells would be "tall," and fifty "dwarf." Let us consider the "talls" first. As half of the eggs-cells are "tall" and half "dwarf," the "tall" pollen-cell has an equal chance of meeting a "tall" and a "dwarf" egg-cell. So that twenty-five of the "tall" pollen-cells would meet "tall" egg-cells, and twenty-five would meet "dwarf" ones; and the resulting unions would be (writing T for Tall, and D for Dwarf):

25 T T
25 T D

Similarly twenty-five of the fifty "dwarf" egg-cells would meet "talls" and twenty-five "dwarfs," or briefly:

25 D T
25 D D

The total result therefore is:

25 T T
25 T D
25 D T
25 D D

Now we already know that the result of the union of a "tall" with a "dwarf" germ-cell is a hybrid which is tall, and Mendel found that it made no difference whether the tall character was carried by the male parent and the dwarf by the female, or *vice versa*. So that the above result can be written:

25 T T (Pure Talls)
50 T D (or D T) (Hybrid Talls)
25 D D (Pure Dwarf)

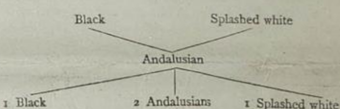
The result of the random union of two sets of germ-cells each set consisting of 50 per cent. of germ-cells bearing the Recessive and of 50 per cent. bearing the Dominant character, can be admirably illustrated by drawing one counter at random from a hat containing fifty Red and fifty White counters, and another from another hat with similar contents, and by placing the three kinds of pairs in three separate rows on the table, according to whether they are R W, R R, or W W. The larger the number of trials you make the closer will the approximation to the proportion of 25 R R, 50 R W, 25 W W be. Counters are worse than marbles for illustrating this, by reason of the difficulty of thoroughly shuffling them. But they are better than them, because the phenomenon of dominance and the proportion 3 : 1 can be illustrated with them, the former by merely making it a rule to put the red counter on the top of the white when a red and a white are drawn together, the latter by superposing the upper counter in every pair so carefully that the lower one is invisible. If this is done effectively there will be seen, at any rate from a slight distance, to be 75 per cent red counters and 25 per cent white. But if you jog the table the difference between the previously apparently identical reds will be revealed. It is also very easy to illustrate subsequent results with the counters. The result of mating the hybrids in F2 can be illustrated in exactly the same way as that of mating the F1 hybrids. And it is readily seen that it is no more possible to get anything but Dwarfs from Dwarfs in F2 than it is possible to get anything but pairs of white counters by drawing from two hats each containing nothing but white ones, and that it is no more possible to get anything but Talls from those Talls, i.e. the pure ones, which resulted from the union of like gametes than to get anything but pairs of reds from drawings from two hats containing only reds.

The animal or plant resulting from the union of two germ cells or gametes—and all animals and plants which reproduce sexually result from such a union—is called a *zygote;* that resulting from the union of like gametes or germ-cells is called a *homozygote;* that from the union of unlike gametes a *heterozygote.*

The heterozygote in the case which we have been considering as an example was only distinguishable from the dominant homozygote by the fact that when allowed to self-fertilize it produced Dwarfs as well as Talls. But sometimes the result of crossing the two pure strains is different from either of them, that is to say, the heterozygote has a character peculiar to itself. This makes it possible to distinguish between the heterozygotes and the dominant homozygotes in F2 otherwise than by breeding from them.

The phenomenon may be illustrated by the famous case of the Andalusian fowl. If you buy a pair of these birds from the very best source you will find that they will not breed true, but that they will produce besides the Andalusians blacks and splashed whites, and that on the average the three forms will be produced in the proportion 1 black, 2 Andalusians, 1 splashed white. If you were not acquainted with Mendelian phenomena, but were guided by the principles of heredity which were universally held in pre-Mendelian days (and still held by those who are not Mendelians), you would sell the blacks and whites for eating and breed from the Andalusians, in the belief that, as they at least, to your own personal knowledge, had an Andalusian father and mother, they would be more likely to breed true than a pair of Andalusians of unknown and, as you would expect from the result of mating them, of mixed parentage. Your anticipation would not be fulfilled. Your Andalusians would again produce blacks, Andalusians, and splashed whites in the proportion 1:2:1. But if you were acquainted with Mendelian phenomena you would immediately suspect that the Andalusians was a heterozygote form, and that the two homozygote forms which by their union gave rise to it were the blacks and the splashed whites. This is indeed the case. Mate the black and the splashed white, and you get nothing but Andalusians. The obvious plan, therefore, instead of selling the blacks and whites to the poulterer and keeping the Andalusians to breed from, and then only getting 50 per cent of what you want, is to sell the Andalusians to fanciers, keep the blacks and whites, and get 100 per cent of Andalusians by crossing them, making occasional matings of Andalusians to keep up the supply of blacks and whites.

This case is summarized in the following diagram:



Let us now return to the Peas. We have referred in detail to only one pair of characters, namely, Tall and Dwarf. Mendel dealt with six other pairs of characters, namely:

1. The shape of the ripe seeds, which were either round or wrinkled.
2. The color of the ripe cotyledons in the seed, which were either yellow or green.
3. The color of the seed coat, which was either white or gray (with or without purple spots).
4. The texture of the ripe pods, which was either hard and inflated or soft and constricted between the seeds.
5. The color of the unripe pods, which was either green or yellow.
6. The arrangement of the flowers on the stem. The flowers either came off normally at the nodes along the stem, or they were situate in a bunch at the top of the stem; this latter is the so-called Mummy habit.

The two members of each of these pairs of character stand to one another in the relation of dominant and recessive. In the above list the dominant member of each pair is written first. The two characters which form such a pair are called *allelomorphs;* and green is said to be allelomorphic to—i.e., forms the other member of a pair with—yellow. Similarly yellow is allelomorphic to green.

We have so far, in considering the results of crossing an animal or a plant, paid attention only to a single pair of allelomorphs, tall and dwarf, black and splashed white. We must now ask ourselves, What is the relation between character belonging to different allelomorphic pairs? And the answer broadly speaking, is that in the case of some characters there is no relation, while in the case of others there is; or, to amplify the answer, in the case of some characters the members of distinct allelomorphic pairs exercise a very definite effect on one another, while in the case of others they are entirely independent of one another. We will deal with the latter case first, because it is simpler.

What the result of mating a green round with a yellow wrinkled pea will be, can be answered by reference to the table above, in which the dominant member of a pair is written first. The result will be a yellow round one. What the result of allowing these to self-fertilize will be can be predicted from the result of making drawings of two counters from each of two hats, which contain equal numbers of green and yellow, red and white counters.

The number and nature of the possible combinations

*Abstracted from *Science Progress.*

is given by the number and contents of the squares in the table.

Y and G stand both for yellow and green counters and "yellow" and "green" germ-cells; R and W stand both for red and white counters and "round" and "wrinkled" germ-cells. The four pairs of letters along the top of the table represent the four kinds of male gametes; the pairs along the side the four kinds of female ones; the squares represent zygotes. Let us consider the results of their union, beginning at the top left-hand square. (In the following account Y is to be read as yellow, G as green, R as round, and W as wrinkled.) Here we have to do with union between two Y R gametes. The result is a pure Y R zygote. In the square to the right of it, it is a case of a union between a Y R egg-cell and a Y W pollen-cell; the result is a Y R zygote, which is a homozygote as regards color and a heterozygote as regards shape. In the next square to the right a Y R gamete meets a G R

	YR	YW	GR	GW
YR	YR×YR. 1 YR	YR×YW. 2 YR	YR×GR. 3 YR	YR×GW. 4 YR
YW	YW×YR 5 YR	YW×YW 6 YW	YW×GR. 7 YR	YW×GW 8 YW
GR	GR×YR 9 YR	GR×YW 10 YR	GR×GR 11 GR	GR×GW 12 GR
GW	GW×YR 13 YR	GW×YW 14 YW	GW×GR 15 GR	GW×GW 16 GW

gamete; the result is again a Y R zygote, which differs from the last in that it is homozygote as regards shape and heterozygote as regards color. In the last square on the top line a Y R gamete meets a G W one; the result is a Y R which differs from any of the preceding ones by being heterozygotes both as regards color and shape. And so on throughout the table. The nature of the sixteen possible kinds of unions of gametes is written in small letters in the sixteen squares of the table. The characters of the resulting zygotes are written in large letters. When this explanation is being illustrated with counters, the nature of the zygote in each case is given by making it a rule always to put a yellow on the top of a green counter and a red on the top of a white.

The result therefore of allowing our Y R hybrid (produced by Y W and G R) to self-fertilize should be:

9 Yellow round (squares 1, 2, 3, 4, 5, 7, 9, 10, and 13).
3 Yellow wrinkled (squares 6, 8, and 14).
3 Green round (squares 11, 12, and 15).
1 Green wrinkled (square 16).

Or, briefly, 9 Y R, 3 Y W, 3 G R, 1 G W in every sixteen peas.

Of the 9 Y R, only 1 (square 1) is homozygous in both respects, and should produce only Y Rs. Two Y Rs are homozygous in color only, but heterozygous in shape (viz., squares 2 and 5); they should produce only yellow, but both "Rounds" and "Wrinkleds." Two Y Rs are homozygous in shape, but heterozygous in color (viz., squares 3 and 9); they should produce only rounds, but both "Yellows" and "Greens." The remaining 4 (squares 4, 7, 10, and 13) are heterozygous both in color and in shape, and should produce all 4 kinds—Y R, Y W, G R, and G W.

On the 3 Y W, 1 (square 6) is homozygous in both shape and color, while the remaining 2 (squares 8 and 14) are homozygous in shape only. Similarly with the 3 G Rs, that in square 11 is homozygous in both respects, the other 2 (squares 12 and 16) being homozygous in color only. It will, of course, be noted that the character in respect of which all the 3 Y Ws and all the 3 G Rs are homozygous is a recessive one, namely, wrinkledness in Y W and greenness in G R.

There is only 1 G W zygote which, since both its characters are recessive, is therefore homozygous in both respects.

A very close approximation to the result 9 Y R, 3 Y W, 3 G R, 1 G W has been obtained in experiments by Mendel, Bateson, Hurst, and myself. And the various types of Y R, Y W, and G R have also been recognized.

Another point of view from which the proportion 9 : 3 : 3 : 1 may be regarded is from that of the zygotes solely. If we have a generation which displays the two characters of one pair Y and G in the proportion 3 Y to 1 G in every 4, and the two characters of another pair R and W in the proportion 3 R to 1 W in every 4, and if we further suppose that the two pairs are independent of one another, we should expect that in every 16 (= 4 × 4) 9 (= 3 × 3) would be Y and R, 3 (= 3 × 1) Y and W, 3 (= 3 × 1) G and R, and 1 (= 1 × 1) G and W. And we find that this is so, which shows that the two pairs are independent of one another.

Having become familiar with the signification of the 9 : 3 : 3 : 1 proportion, let us proceed to the discussion of other results which can only be interpreted in the light of it. We need not leave the Pea for illustration. If we ask a corn-dealer for a pennyworth of Maple or Partridge Peas, he will give us a kind of pea the seed-coat of which at first glance appears a uniform brown, but on closer inspection is seen to have a ground color of a pale brown, on which is a very beautiful mottling, consisting of anastomosing tracts of a rich brown color. This type of coloration is called mapling. Another type of coloration is that which is often seen on (though it is not necessarily associated with) the kind of pea which is much grown and eaten on the Continent, and known as the Sugar Pea. In this type of coloration there are minute spots (discernible by the naked eye) of slightly varying sizes and of a rich purple color on a greenish gray background. The former type will be referred to as "maple" and the latter as "purple spot."

When a pea with a maple seed-coat is crossed with one with a purple spotted coat, the result is a pea on whose seed-coat both mapling and purple spots exist. This suggests that maple and purple-spot are not allelomorphic to one another, but belong to separate pairs which are supposed to be maple (M) and not-maple (nM), and purple spot (P) and not-purple spot (nP). This sounds very much like a logical exercise, a matter of words and not of things. But the reality of it is shown by breeding from the hybrids; for by doing this we actually get peas, which we can touch and see, which exhibit neither mapling nor purple spotting. We get, in fact, the following four types of peas in the proportions given by the numbers which precede them:

9 M P, 3 M, 3 P, 1 gray.

If we write this in a form analogous to—

9 Y R, 3 Y W, 3 G R, G W—

we should have:

9 M P, 3 M nP, 3 P nM, 1 nP nM.

The nP nM is gray because all these colors are on a back-ground of pale gray. This proportion shows that we are dealing with two independent pairs of characters, viz.:

1. Maple and not-maple.
2. Purple spot and not-purple spot.

Now we come to those cases in which one of the characters of a pair of allelomorphs is not independent of a character in another pair.

We will cross a pea with a pale gray seed-coat, such as that which formed the background for the purple and the maple (many field peas exhibit no more than this gray color), with a pea with no color at all in its seed-coat, as is the case in a great number of the peas grown for the table. The result is a gray-seeded pea *on which there are purple spots*, which existed in neither parent. Heretofore this would have been labeled as an example of reversion and the matter would have been regarded as settled, or at any rate done with. But to call a thing reversion does not make one any wiser about it. Mendelism has provided a reasonable explanation of reversion in this case. Let us see how. The result of breeding from these gray-coated purple-spotted hybrids provided the clue. There were produced 9 gray with purple spots, 3 gray, and 4 white.

What does this mean? The 9 : 3 : 3 : 1 proportion suggests an explanation. It is supposed here, as in the case of the cross between the maple and the purple spot, we are dealing with two pairs of allelomorphs, namely, (1) gray (G), and not-gray (nG), and (2) purple spot (P) and not-purple spot (nP). The gray pea exhibits the dominant gray character (G) of that pair. The white pea possesses—and here we come to the case of the interdependence of characters in separate pairs—the dominant purple spotting (P) of that pair; *but the purple spotting is not exhibited because one of its properties is that it cannot be manifested unless associated with the gray coat.* Bearing this theory in mind, let us write the 9 : 3 : 3 : 1 scheme for the two pair of allelomorphs G and nG, P and nP. It will be:

9 G P, 3 G nP, 3 P nG, 1 nP nG.

But we see that in the 3 P nG the purple spot is there, but the gray coat is not. Therefore *ex hypothesi* it will not be manifested and these three seeds will appear white, which gives the proportion 9 gray with purple spots, 3 gray and 4 white.

The possession by the hybrid of a character which neither of its parents possesses is accounted for by supposing that that character (in this case purple spotting) depends for its manifestation on two factors (in this case P and G), one of which exists in one parent and the other in the other. This Mendelian hypothesis therefore enables us to account for the reversion and for the otherwise meaningless proportion 9 : 3 : 4; or perhaps we should not say more than that the facts are consistent with the truth of this theory.

Mendelian inheritance is by no means confined to color characters, as we shall shortly see. Perhaps one of the most striking instances of this is that studied by von Guaita, Weldon, and myself, the waltzing habit in mice. The waltzing habit characterizes a race of mice known as Japanese waltzing mice, which have pink eyes and small patches of fawn on the shoulders and rump. A waltzing mouse does not always waltz, but can always be distinguished immediately from a normal mouse. The waltzing itself consists in merely spinning round and round very swiftly in one spot on all-fours. It is not in the least like waltzing. It is simply running round in a circle sometimes at a very great pace for several minutes at a time, so that all that you can see is a sort of nebulous ring of mouse. They do not always go round in the same direction, but sometimes in a right-handed direction, sometimes in a left. But when it is not waltzing, a waltzing mouse is immediately recognizable by the appearance of complete lack of control over the movements of its head, which is every now and again thrown back into an apparently very uncomfortable and useless attitude. A waltzing mouse also has the habit of running or rather shuffling backward, waving his head vigorously from side to side the while.

Probably the waltzing feature arose as a sport which was carefully preserved and bred from. Waltzing is, in fact, a very good example of the kind of character that can arise in a tame breed, and be preserved because it tickles the fancy of man. Nature does not tolerate curiosities of this kind for a moment, and promptly eliminates them. The abnormality is due, not, as was originally believed, to the absence or atrophy of one of the semicircular canals, which have been demonstrated to be all there, but to a deficiency in their nerve supply. The waltzing is a constant character of the race; the children of waltzing mice mated together being all waltzers.

When such a waltzing mouse is mated with a normal mouse—with an ordinary white mouse, for example—the hybrid obtained is always *normal*, like the white mouse. Waltzing, therefore, is recessive, in the Mendelian sense, to normality of progression. In F2 we should expect the waltzing to reappear in the proportion of 25 per cent of the whole fraternity. Reappear it certainly does, but not quite in the proportion expected. The number of waltzers, indeed, falls below 20 per cent, in the many hundreds of F2 mice which I have raised. I do not think that this deficiency is due to any complication of the process of segregation in the germ-cells, but believe it is merely due to the greater mortality which almost certainly takes place among waltzing individuals than among normal ones between the time when they are born and the age—from ten days to two weeks—when the characters of the mice are first registered. Waltzers are much more delicate than normal mice; and it is likely that this delicacy is more fatal in youth (perhaps even before birth) than in middle age.

The mice afford an excellent example of reversion. The Japanese waltzing mouse is almost an albino, and would be were it not for the patches of fawn-colored fur on the shoulders and haunches. It has pink eyes. It was crossed with an albino mouse. The result, where the albino used was a pure-bred one, was a mouse hardly distinguishable at first sight from the common house mouse. A closer inspection reveals the lighter color of the belly. Their eyes are jet black. And this is the most remarkable feature of the cross—the production of a black-eyed form from two parent forms both of which had pink eyes. These hybrids are not merely wild in their coloration, but are always noticeably healthier, stronger, and wilder than their albino parent, and infinitely more so than their waltzing parent. As already stated, they never waltz. When they are mated together they produce a generation which is composed of the three color catagories we have just mentioned in the proportions indicated by the percentages prefixed to them, viz., 25 per cent pink eye and colored coat (that of the Japanese waltzer), 50 per cent dark eye and colored coat (that of the hybrid), and 25 per cent pink eye and colorless coat (i. e. complete absence of pigment or albinism). The distribution of waltzing over these various color categories is interesting. It is distributed, as it were, at random, that is to say, the waltzing character is not necessarily associated with that color category with which it was associated in the pure waltzer, but may be associated with any of the three color categories. So that we get in F2, besides waltzers colored like their pure grandparents, waltzers with the black eyes and the gray coat of the house mouse, and albino waltzers. It may be noted in passing that these albino waltzers correspond to the green wrinkled peas we have already discussed, that is to say, they represent the association in F2 of the recessive character of one parent with the recessive character of the other parent in one individual, which, since both characters it bears are recessive, may be counted on to breed true. It does.

Another illustration of a character other than color is that which has been studied by Mr. R. H. Biffen. One of the most disastrous pestilences which affect the wheat is the fungoid pest known as Yellow Rust (*Puccinia glumarum*). Some varieties of wheat are more susceptible to it than others; for example, the variety Michigan Bronze is hardly ever free from it. Another variety grown by Mr. Biffen may be regarded as practically immune, for, although it was grown for four years in close proximity to the most rust-stricken varieties, it was not affected by the disease. This immune variety was crossed with Michigan Bronze. The hybrids were all so badly affected by the disease that one could not find an area an eighth of an inch square unattacked by the rust. No difference in respect of their susceptibility to the disease could be discerned between the hybrid and Michigan Bronze. But the hybrid did differ from it by the fact that whereas the susceptible parent hardly set a grain, the hybrid gave a moderate crop.

"Every available grain was sown in plots alongside the parent varieties, part on land which had been exhausted on a previous crop of wheat, and part on land which had carried a crop of clover the previous season and consequently was in high condition. The difference in cultivation, however, made no difference in the results of the experiment. The rust was late in appearing that season, but again every plant of the susceptible parent was stricken, and all of the immune type escaped entirely. The hybrid plots were badly attacked, and when the epidemic seemed to be well advanced, the plants were sorted into two groups, namely, those attacked, and those showing no signs of the disease even on the withering basal leaves. On some plots the diseased plants were cut out, leaving those free from infection for a subsequent examination. A few individuals, which had escaped the attack at the early stage, became infected later, and these were then added to the total of susceptible plants. The statistics showed that 1,609 diseased plants were present and 523 immune, or a ratio of 3.07:1. There cannot, I believe, be any question that these latter were really immune, for they were surrounded by plants covered in rust, whose leaves were continually rubbing against them. Further, if a variety is susceptible, no plant of it under field conditions ever appears to escape."

Mr. Biffen concludes with the following remark: "Of the problems this opens up to the pathologist, nothing need be said here: for the present we are concerned with plant improvement, and it need only be noted that, according to the report of the International Phytological Bureau in 1890, the attacks of rust cost Germany some $100,000,000. Such figures give one some idea of the stakes the plant-breeder can now play for, and, thanks to the work of Mendel, with the reasonable certainty of winning."

But it is not merely by the discovery of facts of this kind that Mendelism is of service to the breeder of animals and plants.

Mendel and his followers have already put into the hands of breeders general principles of the greatest value. For example, those whose business is to breed cattle or carnations, or whose hobby is to breed fancy mice or sweet peas, and strive to improve their strains by crossing, are likely to be disappointed if they expect anything new in their first crosses. What could be more discouraging than to obtain a house mouse by crossing the delicate little waltzing mouse with the albino? And yet I have raised an entirely new color, lilac, as it is called, by mating these hybrids together. Similarly in sweet peas the production of the original wild type of that flower by crossing two of the most beautiful modern strains would not tempt one to repeat the experiment. Mendelian principles drive home the lesson that we must expect nothing in the way of novelty from the first generation, and that it is on the next one that we must concentrate our attention.

Another extremely valuable instrument which Mendel has put into the hand of the breeder is the power of effecting the combination in one strain of desirable characters existing in separate strains, with great swiftness and precision. If the two characters we wish to combine are recessive ones, our task is an easy one, for we can effect their association in 1 individual in every 16 in the F2 generation. If, however, it is a dominant one, we will have to wait till the following generation in order to determine which of the individuals bearing the dominant character are heterozygotes and which homozygotes.

Meat Saved Pays Cost of Electric Cooking*

That in a 9-pound leg of mutton as much as 1½ pounds of meat may be saved by cooking in an electric oven, compared with cooking the same joint by gas or coal, was pointed out by Mr. J. D. A. Cross, Chicago, in a paper read by him before the Wisconsin Electrical Association, January 19th.

A number of careful and independent experiments in England, said Mr. Cross, have shown that there is a shrinkage of from 25 to 35 per cent in the weight of meat cooked by coal or gas, whereas the same kind of food cooked to the same degree by electricity loses only 10 or 15 per cent of its original weight. Thus it is conceivable that even if coal or gas cost nothing it would be cheaper to use an electric oven and pay a comparatively high rate per kilowatt-hour for electricity, for the loss due to electric cooking is so slight compared with that sustained when gas and coal ovens are employed that a very considerable saving is effected on the butcher's bill.

Table I, prepared by Mr. K. B. Matthews, an English electric heating engineer, shows a compilation of a number of experiments made with various kinds of heat for cooking.

*By courtesy of the *Electrical World*.

TABLE I.—RESULTS FROM ELECTRICAL COOKING.

Joint.	Weight before cooking.		Weight after cooking.		Type of oven.	Loss of Weight		Loss per cent.
	Lb.	Oz.	Lb.	Oz.		Lb.	Oz.	
Ribs of beef	5	7	3	12	Coal	1	11	31.0
Leg of mutton	8	8	5	13	Coal	2	11	31.7
Shoulder of mutton	6	13	5	1	Coal	1	12	25.7
Leg of mutton	8	4	6	0	Gas	2	4	28.1
Leg of mutton	8	0	7	12	Elect'y	1	4	13.1
Shoulder of mutton	4	12	4	2	Elect'y	0	10	13.1
Ribs of beef	9	1	7	6	Elect'y	1	11	18.6
Leg of mutton	9	1	7	10	Elect'y	1	7	15.8
Shoulder of mutton	5	10	5	0	Elect'y	0	10	11.1

Tables II and III show the relative quantities of meat to be purchased in order to serve a given amount when the cooking is done with electricity, coal and gas, respectively.

TABLE II.—COOKING BEEF BY ELECTRICITY, COAL AND GAS, RESPECTIVELY.

Weight of Cooked Joint.	Weight to be ordered from butchers when cooking is to be done by						Saving of meat and money when electricity is used instead of					
	Electricity.		Coal.		Gas.		Coal.			Gas.		
Lb.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Value.	Lb.	Oz.	Value.
4	4	8	5	11	5	14	1	3	$0.28	1	6	$0.32
5	5	11	7	3	7	6	1	8	0.36	1	11	0.40
6	6	13	8	9	8	13	1	12	0.42	2	0	0.46
7	7	9	10	0	10	5	2	1	0.50	2	6	0.56
8	9	2	11	7	11	13	2	5	0.56	2	11	0.64
9	10	4	12	4	13	4	2	10	0.62	3	0	0.72
10	11	6	14	5	14	11	2	15	0.70	3	5	0.80
11	12	8	15	11	16	3	3	3	0.76	3	11	0.88
12	13	10	17	2	17	11	3	8	0.84	4	1	0.98

TABLE III.—COOKING MUTTON BY ELECTRICITY, COAL, AND GAS, RESPECTIVELY.

Weight of Cooked Joint.	Weight to be ordered from butchers when cooking is to be done by						Saving of meat and money when electricity is used instead of					
	Electricity.		Coal.		Gas.		Coal.			Gas.		
Lb.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Value.	Lb.	Oz.	Value.
4	4	8	5	7	5	8	0	15	$0.20	1	0	$0.20
5	5	11	6	13	6	15	1	2	0.24	1	4	0.25
6	6	13	8	2	3	5	1	5	0.26	1	8	0.30
7	7	15	9	7	9	11	1	8	0.30	1	12	0.36
8	9	2	10	13	11	2	1	11	0.34	2	0	0.40
9	10	4	12	2	12	8	1	14	0.38	2	4	0.46
10	11	6	13	8	13	15	2	2	0.42	2	9	0.52
11	12	8	14	14	15	5	2	6	0.48	2	13	0.56
12	13	10	15	4	16	11	2	10	0.54	3	1	0.62

Novel Scent Bottle

For the purpose of disseminating perfumes continuously without risk of spilling the liquid, a French inventor has devised a small glass tube, having at each end an orifice, to which is fitted a short tube of almost capillary bore, open at both ends and extending nearly to the middle of the larger tube. It will be evident from an examination of Fig. 2 that if a small quantity of liquid perfume is introduced into the tube by aspiration no

Fig. 1.—Perfume tube inclosed in imitation cigar.

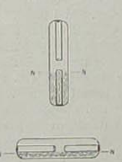


Fig. 2.—Sections of tube, with liquid indicated by shading

leakage can occur in any position of the tube, while the scented vapor can always escape freely through both capillary tubes. One of these novel scent bottles, carried in the pocket and heated by the warmth of the body, diffuses a strong fragrance and becomes exhausted in a few days. The device may also be employed, alone or in combination with a mouthpiece, such as the imitation cigar shown in Fig. 1, for the inhalation of turpentine, guiacol, and other volatile medicaments.

Stopping for Sweating Casks.—Vaseline, 1 part; paraffine, 1 part, are melted together and as much dry pipe clay mixed in as will produce a stiff paste, which is made homogeneous by kneading.

The Influence of Ozone on Ventilation

The article by Messrs. Hill and Flac on this subject, which appeared in last week's issue of the Supplement, was the report of a paper read by the authors before the Society of Arts, and originally published in the Journal of that Society.

Through a regrettable oversight due credit to this source was not given at the time, and we hasten to rectify the omission.

Science Notes

Rapid Drying for Negatives.—We read in *Cosmos* that Messrs. Lumiere & Seyewetz have worked out a new method for quickly drying negatives. The plate to be dried is plunged into a 90 per cent solution of potassium carbonate and is allowed to stay there for four or five minutes, after which it is dried with blotting paper and rubbed with a clean rag, to remove the adherent sodium carbonate solution. It is said that this method is much more satisfactory than drying with alcohol.

Fish Meal.—Fish is consumed not solely as food for the human population. It can also be fed in proper doses to cattle. Experiments in this direction have been made in Norway and Great Britain. It is found that pigs take this food with considerable relish, and also cows and calves consume it. The following, according to the *Revue Scientifique*, is a method of preparing the product. In Norway the cod and herring are principally used. The codfish are dried first in the air, then in the oven, and finally the mass is ground, the resulting product containing, on an average 50 to 60 per cent albuminoids, 1 to 2 per cent fat and 24 to 28 per cent of calcium phosphate. The herrings are made into meal by first boiling them and then passing them through a press. The product obtained from fresh fish contains 60 to 70 per cent of albuminoids, 10 to 12 per cent of fat and 8 to 18 per cent of calcium phosphate. In England and Scotland fish meal is obtained from waste from all sorts of fish, which is first treated with steam and then dried and ground.

Metabolism in Mental Work.—Although it has long been realized in a general way that mental work must be accompanied by an increased consumption of living tissue, hitherto it has been difficult or impossible to demonstrate definitely that such an increase actually does take place during mental activity. Dr. Lehmann, writing in *Die Umschau* reports on some experiments which he has carried out and which seem to definitely establish this point. He draws attention to the fact that the failure which has attended efforts hitherto to investigate this matter must be ascribed to the fact that in order to obtain satisfactory results the person under experiment must be absolutely inactive physically; otherwise, the influence of mental work is completely masked by the effects of physical exertion. He therefore arranges his experiments in such a manner that the subject is absolutely motionless during the period of observation. He is then given some simple mental task, such as a series of additions of multiplications, to do, and the amount of carbon dioxide eliminated per second is measured. The results obtained were entirely concordant among themselves and showed a distinct increase in the elimination of carbon dioxide. Furthermore, as one would only expect, it was found that during the earlier stages of the work, for a given amount of work, the rate of production of carbon dioxide is less than during the later stages, showing that the effort which has to be made to do a certain amount of work increases as a person becomes fatigued. It is also found that for a given type of work and for a given person, under specified conditions, the increase in the production of carbon dioxide is approximately constant, though it differs from person to person.

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highly interesting exceptions. It was, in fact, extraordinarily difficult to get very short sparks. With a constant gas pressure there was, in fact, a certain length between terminals with which the discharge would pass more easily than with any other length of gap, whether longer or shorter. Similarly with a constant distance between terminals there was some particular gas pressure at which the discharge passed most easily. If this pressure were either raised or lowered from this optimum value the discharge got through with greater difficulty.

To illustrate the first peculiarity the lecturer employed the discharge tube represented in Fig. 4. Here the two terminals are brought in as indicated, the space between their opposing ends being only ½ mm. An alternative path for the discharge was provided round the spiral tube shown, its length being about ½ m. On coupling up the tube with an induction coil the lecturer showed that it was but rarely that a discharge passed across the ½-mm. gap, but selected in general the path 100 times as long.

In short, the speaker proceeded, the potential required to produce a spark between two terminals depended on the quantity of gas which intervened. If this were constant, it mattered not whether the pressure were low and the distance great or the pressure high and the distance short, the potential needed was constant so long as the quantity of intervening gas was constant. Hence a very short spark might correspond

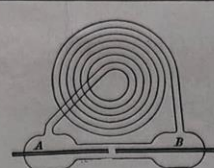

Fig. 4

to a very small quantity of gas, and a discharge would be facilitated either by raising the pressure or increasing the distance between the terminals.

To illustrate this the lecturer coupled up a discharge tube to an induction coil, and placed an ordinary spark gap in parallel with the discharge tube. At starting the pressure in the discharge tube was relatively high, and the whole of the discharge selected the spark gap for preference. The vacuum in the discharge tube was then improved by absorbing the gases in it by charcoal cooled with liquid air. As the exhaustion proceeded a point was reached at which the whole of the discharge passed through the tube and ceased across the spark gap, but on carrying the exhaustion still further the discharge in the tube ceased and the whole of the current passed again across the spark gap.

In a second experiment the barometric vacuum at the top of a long column of mercury was utilized as a discharge tube. A cathode floating on the mercury could be raised or lowered by raising the level of the mercury. The terminals of the discharge tube thus formed were coupled as before in parallel, with an alternative path for the spark. At starting the distance between the electrodes of the tube was great and all the discharge took the alternative path. With a certain length between electrodes, however, the discharge passed wholly through the tube and none across the alternative spark gap, but on still further raising the level of the mercury this gap came into action again and the discharge in the tube ceased.

In concluding his lecture the speaker exhibited a tube which had at one time belonged to De la Rue, and showed exceedingly well the striation often observed in the positive column of a discharge tube.

In this tube the positive column extended nearly from top to bottom and showed patches or layers alternately bright and dark, and nearly equally spaced throughout its whole length. Positive columns of this kind could, the speaker stated, be obtained of almost any length—in his own laboratory he had got them 50 feet or 60 feet long. The explanation of the striae had, he said, been the subject of a good deal of discussion, with which he proposed to deal in his next lecture.

[TO BE CONTINUED]

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Prejudice and the Principle of Relativity

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

In the SCIENTIFIC AMERICAN SUPPLEMENT for June 30, 1917, there appeared an article entitled "The Principle of Relativity," by Alph. Berget, translated from the *Larousse Mensuel*. The writer of this article is evidently prejudiced against everything German. He directly and uncompromisingly attacks the Principle, and ridicules German science and scientists in general. His assertions are positive, and are supported by little or no line of scientific argument; there is no consideration of, or refutation of, arguments *for* the Principle; from first to last the fact is emphasized that the theory has been developed by Germans; it is strongly prejudiced throughout.

Now if there is one place in which prejudice and personal feelings must be altogether dispensed with, it is in the domain of Science. Science is universal, not the property of any one nation; all scientists have the common aim of unravelling the mysteries of the universe; all additions to knowledge, by whomsoever made, are welcome and valuable. All considerations must be fair and impartial. If M. Berget does not accept the Principle of Relativity, why doesn't he attack it in a decent, scientific manner? On the other hand, if he wishes to attack the Germans, why doesn't he choose some field other than that of Science in which to do so? Let us preserve the true Scientific attitude in spite of present world conditions.

That German science is nothing to be treated lightly should be realized from the accomplishments of Germany, and her wonderful industrial efficiency. However wrongly Germany may have applied her knowledge there is no reason for us to discount the value to be placed upon her monumental contributions to Science.

M. Berget's article having been called forth probably by prejudice, it is perhaps natural that his arguments are not particularly convincing when considered in a scientific way. He objects to the firm way[1] in which adherents of the Principle of Relativity uphold it; but he makes the same error himself. He says: "If certain savants regard this theory. . . . firmly established in science, there are numerous others, and no mean ones, who look upon it as a philosophic subtlety, and entirely reject it, basing this upon the inevitable necessity it involves of absolutely denying the existence of the ether." Now there *are* savants, "and no mean ones," *both* German and *non-German*, on *each* side: in a case of this kind, why should any one so positively assert either side to be right? The theory may be of little immediate consequence so far as every-day practical affairs are concerned, but its importance to pure science can hardly be overestimated;[2] even though it should have no physical truth, its cultivation is of the utmost importance to mathematics.[3]

[1]Somewhat exaggerated: See Cunningham, "The Principle of Relativity," *Nature*, 93:378-379, 1914.
[2]*Engineering*, 102:132-134, 1916, SCIENTIFIC AMERICAN SUPPLEMENT, Nov. 4, p. 291, 1916
[3]*Engineering*, 102:297-300, 1916,

M. Berget gives no account of the growth of the theory, of the recent modified, "generalized" form, or of the many instances where it so beautifully removes outstanding difficulties[4] and clears up thought. He dwells chiefly upon the unusualness of the conclusions to which the theory leads, and the changes in thought which it necessitates. At the outset he gathers together all the most startling conclusions, and impresses the reader with them; then he gives, briefly, and not in a clear, detailed manner, the things which led to the formulation of the Principle. But we cannot assert a thing to be wrong because it is strange to us. The scientist must frequently change his way of thinking as new discoveries arise. I think M. Berget somewhat exaggerates the extent of the revolution which the acceptance of the Principle necessitates, however. His paper is an example of the very *à priori* type of affirmation to which he objects.

He states that no one should have gone ahead with mathematical investigations just because it had not yet been possible to detect the motion of the earth relative to the ether; that is, we should never develop hypotheses and follow out their consequences so that we may test them out, and perhaps incidentally be led to new and fruitful lines of inquiry! The experimental evidence upon which the main lines of the Principle rest cannot be regarded too lightly, however.

The main and most extensive of M. Berget's arguments is that quoted above, having to do with the question of the ether. Now this is the old, original objection which has been urged upon us by everyone who ever opposed Relativity, and it has been successfully met a number of times.[5] The Principle of Relativity *does not deny* the existence of an objective ether.

If M. Berget accepts the electron theory of matter, why should he consider it absurd for a moving body to change its dimensions, and for energy to possess inertia?[6] If he is familiar with the recent work in the Quantum theory and related subjects, why should he be so opposed to the idea of an atomic structure of energy, supposing the ether does happen to be non-existent?[7] Also, according to Berget, because we can conceive in our imagination of a velocity greater than that of light, then it must be possible for that velocity to exist.

The object of this communication is not to assert the truth of the Principle of Relativity (although personally I favor it), for there is evidence on both sides, but to point out the weakness of Berget's arguments; and to plead for the consideration of scientific questions in a scientific way, leaving prejudice aside.

EDGAR WOOLARD.

Boulder, Colorado.

[4]Especially the case of the motion of Mercury's perihelion: See *Nature*, 98:328-330, 1916; *The Astrophysical Journal* for May, 1917. For a presentation of both the "older" and the "generalized" relativity theories and an answer to objections, see Einstein, "Zum Relativitäts-Problem," *Scientia*, 15:337-348; 1914 This is reviewed in "*Revue Générale des Science*," 25:622-623, 1914.
[5]E. Cunningham, "Principle of Relativity," pp. 193-204, 1914; Cunningham, "The Principle of Relativity"; *Nature*, 93:408-410, 1914; E. Cunningham, "Relativity and the Electron Theory," pp. 87-94, 1915. *Nature*, 93:171, 1914. Lorentz, "Considérations Elémentaires Sur le Principe de Relativité," *Revue Générale des Sciences*, 25:179-186, 1914.
[6]See Comstock and Troland, "Nature of Matter and Electricity," 1917.
[7]*Scientific Monthly*, 4:509-534, June, 1917; *Science*, N.S., 4:5473, May 18, 1916.

True Greenheart is Not Poisonous

By C. D. Mell

THE wood of the true British Guiana greenheart employed so extensively in the English shipyards and in the construction of lock and dock gates, piers, etc., has frequently been stated to possess poisonous properties. Some authors not familiar, however, with the physical properties and chemical constituents of the wood, and who may never have seen or handled it, claim that blood poisoning has been known to result from abrasions of the skin caused by greenheart splinters. It is claimed that such cases have been reported among the men employed in shipyards in England where greenheart is used. Poisoning is said to result from slivers or splinters getting into the hands of workmen. Even inhaling the dust resulting from sawing, planing and scraping greenheart wood is believed by some to cause serious stomach and intestinal disorders.

Large quantities of greenheart timbers have been handled in this country and also in the Canal Zone and no deleterious results have been reported, nor has any injurious effects of this wood been observed in the country of its origin. In the mills and shops of this country where greenheart wood is used, it is a daily occurrence for men to get slivers into their hands and yet not a single case of illness has ever been reported. The laborers in the forests of British Guiana, who have been engaged in felling, squaring, hauling and rafting greenheart all their lives know nothing at all about the alleged poisonous properties of this wood. Yet, it seems that the men in the country where greenheart wood has been cut and exported for over 100 years, should have been the first to discover the fact, if the wood were poisonous.

Those who have looked into this subject are now fully convinced that true greenheart is not poisonous. Just how it came to be understood to be toxic in its properties was due perhaps to the fact that there is another wood from the same general region that is sometimes called greenheart or more often known as Surinam greenheart, because the bulk, if not all of it, came from Surinam, a Dutch colony in northern part of South America, bordering British Guiana, the home of true greenheart. The Surinam variety which is entirely different from the British Guiana kind, is known to be poisonous, and it was without doubt this wood that was occasionally mixed with logs of the true kind and may have caused ill effects.

Dr. Radlkofer informs us that the Surinam greenheart contains toxic properties that have been found useful as a fish poison, and a number of other chemists have isolated from Surinam greenheart wood an alkaloid called lapachol. Dr. Sam. C. Hooker, Brooklyn, N. Y., has made a very careful study of this alkaloid which he extracted from the pulverized wood of Surinam greenheart. He has recently examined two authentic samples of the true greenheart from British Guiana and lapachol was not present in either of them. Although a number of investigators claim that lapachol is found in true greenheart, it may be taken for granted that these chemists did not have authentic material of the true kind, but had the wood of Surinam kind. However, the fact that there have been no cases of poisoning from true greenheart reported in this country, nor in the source of origin is conclusive proof that the wood is not poisonous.

Heredity and Sex*

Mendelism and Some of Its Recent Developments

By Frank E. Lutz, Ph.D., Associate Curator, Invertibrate Zoölogy

THE history of science is as full of episodes replete with "human interest" as is the history of nations. Not the least of these is the story of Gregor Mendel, a peasant, later a monk, and finally Abbot at Brünn, but now known not for his theology or his kindly deeds to his fellows, but for his patient and successful work in his avocation—the study of heredity. The principal material which he used in this study was the common pea, and his results were published in an obscure journal in 1865. Darwin knew of his work but failed to appreciate its significance. In fact, it remained unnoticed until eighteen years after Mendel had died when, independently but simultaneously, it was brought to our attention, together with important confirmations, by three noted botanists: De Vries, Correns, and Tschermak. Its rediscovery has not only given us a theory of heredity which has revolutionized the practical breeding of plants and lower animals, but also it has given a new impetus to the experimental study of evolution and, through the "eugenics" movement, bids fair to play an important part in the development of human society. It is fitting, therefore, that the American Museum should arrange exhibits illustrating the principles of Mendelism. In the Darwin hall of the American Museum, features of the Mendelian law of heredity are shown by means of peas and rats, while in the insect hall not only Mendelism, but also the later developments of Mendelism—its relation to the mechanism of the germ cell and to sex—are illustrated.

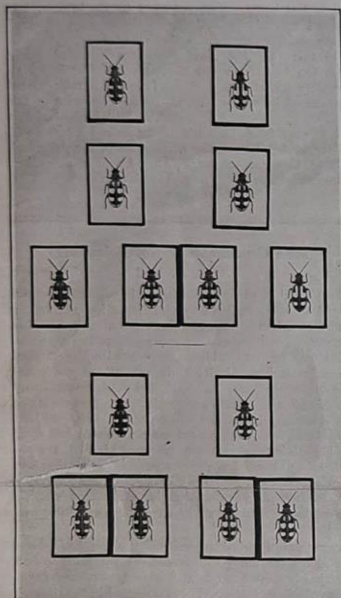

Fig. 1—Illustration of simple Mendelism

Inheritance of color pattern in the common asparagus bettle (*Crioceris asparagi*). The upper experiment shows the result of mating a beetle having spots small and separate with one having spots large and joined. The offspring are hybrids, unlike either parent, but if mated with one another half their offspring will be hybrids, one-fourth pure-blooded and like the original female ancestor, and one-fourth pure-blooded and like the original male ancestor. If one of these pure-blooded offspring now mates with a hybrid, the resulting offspring will be half hybrid and half pure-blooded, as shown in the lower experiment.

As an illustration of Medelism in its simplest form we may take the following: The commoner of the two beetles—both undesirable immigrants from Europe—which feed upon our asparagus is *Crioceris asparagi*. It is a small green creature with cream-colored markings. In some individuals these markings consist of three small spots on each wing cover; in other these spots are larger, and the two front ones on each side are joined. Now, if an asparagus beetle having the spots small and separate mates with one having the spots large and joined, the offspring (the "hybrids" or, as this generation is called, F_1) will have the spots large but not joined. If these hybrids mate, the next generation (F_2) will, in the long run, consist of one individual with spots small and separate to two with spots large and separate (hybrids) to one with spots large and joined. This is shown in the insect hall and in the figure 1. Half of the F_2 generation are hybrids, and if mated with similar hybrids will give offspring in these F_2 proportions, 1:2:1. The rest are pure. If spots-small-and-separate be mated with spots-small-and-separate all the offspring will have the spots small and separate, no matter what the previous ancestors were. Likewise spots-joined mated with spots-joined can give only spots-joined.

Although this case has not been as thoroughly studied as the others to be mentioned here, it is cited first because it shows clearly which are hybrids. In the others the law of dominance is so prominent that the simplicity of Mendelism is obscured. Let us analyze this case by means of symbols. We will let *S* stand for spots small and separate and *J* for spots joined. As every individual is made up of two parts, maternal and paternal, we will indicate individuals by two letters. The beetles with which we started are therefore *SS* and *JJ*. The former produces germ cells each one of which carries the factor *S*, and each of the germ cells of the latter carries *J*. United, these make a hybrid individual, *SJ*. Now the essential point is that a given germ cell can carry the factor for only one condition of a given character. Therefore hybrid asparagus beetles produce two kinds of germ cells, one bearing *S* and the other *J*. There are equal numbers of each kind. An *S* sperm has equal chances of fertilizing an *S* and a *J* egg, giving equal numbers of *SS* and *SJ* offspring. There are just as many *J* sperm, and they have equal chances of fertilizing an *S* and a *J* egg and therefore we should get a similar number of *SJ* and *JJ* offspring. The total would be one *SS* to two *SJ* to one *JJ*. "Q. E. D."

A further test consists in mating pure individuals with hybrids. *SS* produces only *S* germ cells, and *SJ* equal numbers of *S* and *J* germ cells. Therefore, there will be an equal number of the combinations, *SS* and *SJ*. See Fig. 1.

The ordinary "sour fly" or pomice fly (*Drosophila ampelophila*) has been used more than any other species of animal or plant in the experimental study of inheritance. The two examples used in the insect hall and shown in Fig. 3 are illustrations of simple Mendelism plus the law of dominance. This is a very slight complication and consists merely in the fact that when two characters are joined in the hybrid only one (the "dominant" one) is evident. The "recessive" character is there however, and half of the germ cells produced by such a hybrid bear only the recessive character. If a pomice fly having aborted wings of a certain kind be mated with a pure normal-winged fly, all the offspring (hybrids, or F_1) will have normal wings, for normal wing is dominant and aborted wing is recessive. If these hybrids be mated together we shall get in the F_2 generation, *one* pure normal-winged to *two* hybrid (but having normal wings), to *one* pure aborted-winged. More briefly, the ratio is *three* normal-winged to *one* aborted-winged. Although the eye car not distinguish between the two kinds o normal-winged F_2, breeding shows tha they exist in the proportions just men tioned. In the second illustration, norma body color is dominant and black is recessive

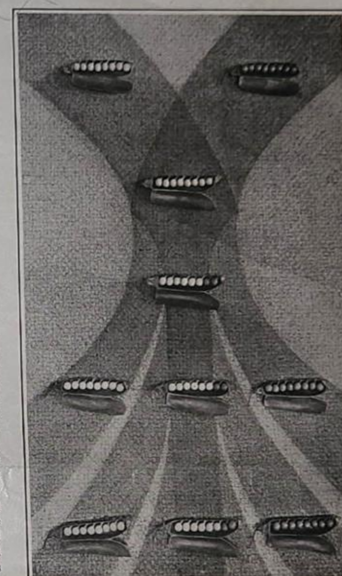

Fig. 2—Inheritance of color in peas

Mendel's classic experiments were made with the common garden pea (*Pisum sativum*). When peas of yellow seed color were crossed with those of green seed color, the peas of the resulting plants were all yellow. When these yellow peas were mated together the peas of the resulting plants were one-fourth pure yellow seed color, two-fourths yellow hybrids, and one-fourth pure green. Of these the pure yellows and greens bred true, the hybrids continuing to give half hybrids and half pures as before.

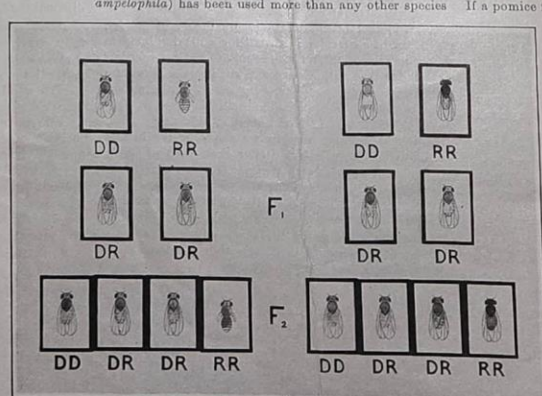

Fig.3—The law of dominance

Inheritance of wing length (left) and of color (right) in the pomice fly. When two characters are joined in a hybrid, only one (the dominant one) is evident. Normal wing is dominant to aborted wing and light to dark color, so the offspring from a pure normal and an aborted-winged fly will all have normal wings. The recessive character is present however, in half the germ cells of each hybrid, and their mating will produce one pure dominant to two hybrids to one pure recessive, the pure dominant and both the hybrids having normal wings. Similarly in the color series.

Mendel used peas in his own exper ments, and in Fig. 2 is shown part of th exhibit in the Darwin hall illustrating thes The pair of characters concerned is yello seed color (dominant) and green seed col (recessive). In order that this case m be understood in its relation to the zoölo ical illustrations, it should be noted th seeds are really young next-generati plants. In this exhibit the fact is e phasized that the extracted dominants a recessives of F_2 and subsequent gene tions, *i.e.*, the pure offspring of hyb parents, are really pure. If mated, e to its kind, they carry on their str indefinitely.

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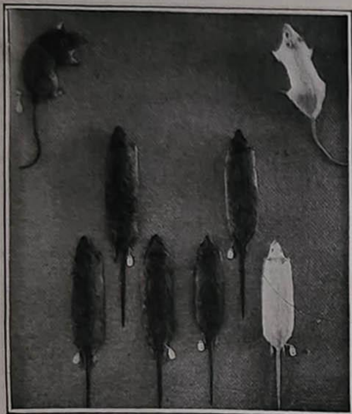


Fig. 4—Mendelism in rats

If a pure gray rat be mated with a white rat the offspring will all be gray, for gray is dominant and white is recessive. In the next generation there will be three grays to one white; the white and one of the grays are pure and will breed true; the other two grays are hybrids.

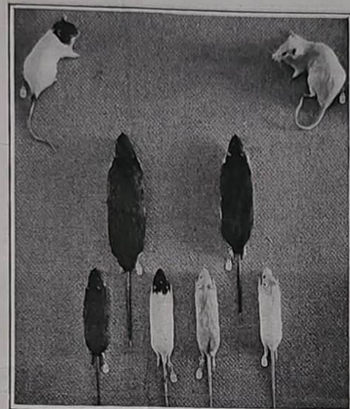


Fig. 5—Duplex inheritance in rats

The two pairs of characters here involved are black *versus* yellow, and self-colored *versus* hooded, black and self-colored being dominant, respectively, to yellow and hooded. The first-generation offspring are all gray hybrids, each with four different kinds of germ cells, which produce in the following generation four kinds of individuals, as in the case of the pomice flies. One only of each kind is shown.

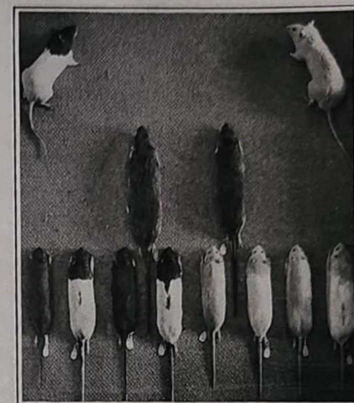


Fig. 6—Inheritance of three pairs of characters

Where three pairs of characters are concerned in a cross there will be eight classes of individuals in the second generation of offspring. The pairs of characters concerned above are black and cream-colored, yellow and cream-colored, and self-colored and hooded (the condition in which all pigmentation is concentrated near the head). Black, yellow and self-colored are the dominants. The eight classes of offspring (of which only samples are shown) are: black-yellow-self (gray), black-yellow-hooded (white with gray hood), black-cream-self (black), black-cream-hooded (black hood), cream-yellow-self (yellow), cream-yellow-hooded (yellow hood), cream-cream-self (cream) and cream-cream-hooded (cream hood).

As illustrations of Mendelism in vertebrates, experiments with the wild, gray and domesticated "fancy" rats[1] are exhibited in the Darwin hall. If a pure gray rat be mated with a white rat the offspring will all be gray, for gray is dominant while white is recessive, and in the F_2 generation there will be three grays to one white (see Fig. 4). This white, however, will be pure. Suppose a breeder had only one white rat, but wished to establish a strain. He could mate it with a wild gray, and although the hybrids would all be gray, he could get *pure* white individuals either by mating the original white with one of its hybrid offspring, or by mating hybrids with hybrids. In the former case he would get 50 per cent hybrids to 50 per cent pure white (see the asparagus beetle illustration) and in the latter 75 per cent grays (one-third of them pure gray) to 25 per cent pure white.

Let us go a step further and consider what happens if there are two independent pairs of characters. In this connection compare Fig. 3 *with Fig. 7. In Fig. 7 it is seen that one of the parents has aborted wings and dark body color while the other is normal with* respect to each of these characters. Since light body color and normal wing are dominant, all of the F_1 generation are light and have normal wings. In the F_2 generation one-fourth of the offspring have aborted wings, one-fourth have dark body color, while three-fourths have long wings and three-fourths have light body color. However, there are four different combinations in the ratio of *nine* light-normal to *three* light-aborted to *three* dark-normal to *one* dark-aborted. Those acquainted with the laws of chance will see that this is the ratio to be expected if twelve light and four dark (3:1) be independent from, and combined in a random fashion, with twelve long and four aborted. The germinal analysis may be given as follows, L standing for light color, d for dark color, N for normal wing and a for aborted wing: The recessive condition of the characters is indicated by the small letters. The one parent, $LLNN$, produces germ cells which are all LN. The germ cells of the other parent, $ddaa$, are all da. Therefore the offspring will all be $LdNa$. These offspring, male and female, will each produce four kinds, (in equal numbers) of germ cells: LN, La, dN and da. Suppose the combinations of letters just given to be eggs, and combine them in a random fashion with the four kinds of sperm: LN, La, dN and da. LN sperm, fertilizing the various kinds of eggs, would produce equal numbers of $LLNN$, $LLNa$, $LdNN$ and $LdNa$ individuals. Writing out in like fashion the combinations for the other kinds of sperm and adding the results together, we find we have

$$1\ LLNN+2LLNa+2LdNN+4LdNa=9 \text{ light-normal,}$$
$$1\ LLaa+2Ldaa= 3 \text{ light-aborted,}$$
$$1\ ddNN+2\ ddNa= 3 \text{ dark-normal,}$$
$$1\ ddaa= 1 \text{ dark-aborted.}$$

In the case of the rats (Fig. 5) only a sample of each class of F_2 individuals is shown. The ratio is nine black-self-colored to three black-hooded to three yellow-self-colored to one yellow-hooded, for black is dominant over yellow and self-colored over hooded.

There is, theoretically, no end to the number of pairs of characters which may be concerned in any one cross, but the principles are the same: a given germ cell carries but one of each pair, and where both members of a pair come together in the union of two germ cells to form an individual, one of the characters usually dominates over the other. If three pairs of characters are concerned there will be, typically, eight classes of offspring, in the F_2 generation. This is seen in the third exhibit (Fig. 6) illustrating inheritance of color and pattern in rats where, again, only samples of the various classes are shown. Frequently, as in the case of the rats, the breeder is able, by crossing known varieties, to get new or hitherto unknown varieties in F_2; that is, new combinations are made. The exhibit in the American Museum showing inheritance of flower color in sweet peas, is complicated by the fact that not only are there three pairs of characters, but also that color of any kind, that is any kind but white, can occur only when certain members of two of these pairs come together. One of the white parents had one of these characters and the other had the second; union by crossing gave colored offspring.

Fig. 7—Inheritance of two pairs of characters

Since light body color and normal wing are dominant characters, all of the first-generation offspring, from mating a light normal-winged with a dark aborted-winged individual, will be light with normal wings. These hybrids, however, will each produce in equal numbers, four different kinds of germ cells. In the third generation there will therefore be four different kinds of individuals, in the ratio of nine light-normal to three light-aborted to three dark-normal to one dark abo:ted.

Before passing on to the explanation of what may be called the mechanism of Mendelism, a word should be said for the benefit of those who may have read or heard the Mendelian principles given in terms of presence or absence of characters. We may say that a fly's eye is red in the presence of the factor for red, and white in its absence, or we may speak of the pair of characters as red and white. It has seemed better to use the latter alternative here, but the presence-and-absence way of putting it works out well in certain cases and has given rise to some interesting speculations. Thus, Professor Bateson has suggested that all organic evolution has been brought about by the successive dropping out of characters. This seems hard to believe, but certainly the origin of many varieties, whose origin we think we have seen, can be neatly explained in that way.

In order to understand the mechanism of Mendelian inheritance it will be necessary to explain some of the details of cell structure. The bodies of all the higher animals and plants are made up of cells, which are frequently looked upon as units of body structure. The lowest animals and plants consist of but one of these cells. The germ cells, egg or sperm, are merely some of these cells split off from the main mass of body cells, and differentiated so that they may unite and form a new mass of body cells, the new individual. In some cases the egg cell can carry on this process without uniting with the sperm, but in the vast majority of cases among higher animals and plants such union is normally necessary. Within these cells are bodies called chromosomes, the name being given because they stain deeply when treated with certain reagents. The chromosomes have for some time been supposed to be the bearers of heritable characters, and this supposition has now become almost a certainty by reason of Mendelian studies, especially those with the pomice fly, *Drosophila ampelophila*. We are, as yet, in the dark concerning the exact method by which these characters are transmitted, so that "bearers of heritable characters" is in great part a figure of speech, but, at any rate, these characters are somehow bound up with special chromosomes.

Most, and probably all, organisms have a definite number of these chromosomes, although the number is

[1]The rats shown are largely from the important experiments of Professor W. E. Castle, of Harvard, who kindly outlined this portion of the exhibit. The rest of the rats were obtained from the New York Zoological Park through the courtesy of Mr. Ditmars.

not always the same in both sexes. In the pomice fly the number is the same (eight) in each sex, but one of the chromosomes (the "Y") of the male seems to carry maleness and not, as far as is known, any other character. When it is present the individual is a male. It is, however, paired in the body cells of the males with a chromosome which does carry factors for certain body characters, and this other chromosome may be called X. In each of the female body cells there is a pair of these X chromosomes but no Y. When a body cell destined to become a germ cell differentiates, the result of the rather complicated process may be stated simply by saying that it breaks in two, making two nearly similar cells. In the case of the male, the Y chromosome goes to one half, *i. e.*, to one sperm, and the X chromosome to the other. Each egg has an X chromosome. If a sperm having a Y chromosome enters an egg, the union will have one X and one Y and the resulting individual will be a male. However, if a sperm having an X chromosome enters an egg, the union will have X paired with X; there will be no Y and the resulting individual will be a female. Since the chances are equal that an egg will be fertilized by a Y-bearing sperm or by an X-bearing sperm the determination of sex is a random matter; it depends upon which sperm enters and not at all upon the mother; and the number of each sex will, in the long run, be equal. All this is, of course, subject to amendment by further investigation, and too sweeping generalizations should not be made, but it, or a similar relation, seems to hold for other strictly bisexual animals and it is the only explanation for the following, among other, facts:

A few pomice flies were found having white eyes instead of red. This white condition is recessive to red but in inheritance the proportions are not those of simple Mendelism. In what has gone before nothing was said about sex, because characters which have been previously mentioned occur without regard to it. This particular eye color however, is one of a number of characters which are "sex linked." If a white-eyed male be mated with a pure red-eyed female (see Fig. 8), all the offspring, both male and female, will have red eyes. If these offspring be mated with one another, all the females of the next generation will have red eyes, but half of the males will have white eyes and only half will have red eyes. On the other hand, if a red-eyed male be mated with a white-eyed female (see Fig. 9), all the male offspring will have white eyes and all the female offspring will have red eyes. This is what has been called "criss-cross" inheritance—the sons being like their mother and the daughters like their father. If these offspring be mated with one another, half of the male and half of the female offspring will have white eyes, the remainder having red eyes.

The explanation is as follows: This pair of characters, red eye *versus* white eye, is associated with the X, or sex, chromosome. In the first case mentioned the female was pure with respect to this eye-color character; that is, *both of the X chromosomes carried the factor for red* eye color (see Fig. 8). The male, since it showed the recessive character, must have been pure with respect to white eye color and, furthermore, all males are necessarily pure with respect to this particular pair of eye colors, and also with respect to all other sex-linked characters, since they have but one X chromosome, and since that chromosome, like any other, can bear the factor for only one of a pair of characters. All of the eggs, in this mating, carried the factor for red eye color. Half of the sperm carried the factor for white eye color and the other half had no factor concerned with this pair of characters. If a sperm bearing the factor for white eye color united with an egg, the offspring would be a hybrid since it contained factors for both eye colors, but, since red is dominant over white in this case, this individual would show the red color. It would also be a female, since the union which produced it was with a sperm having an X chromosome. If a sperm not bearing the X chromosome (that is, one with the Y) united with one of the eggs, all of which bore the factor for red eye color, the result would be a male pure with respect to red eye color, since the only factor concerned with this pair of characters came with the egg and was red. In other words, all the females of this generation had red eyes and were hybrids with respect to eye color, while all the males had red eyes and were pure with respect to eye color. Half of the eggs which go to produce the next generation bear the factor for red eye color, and the other half bear the factor for white eye color. Half of the sperm have X chromosomes bearing the factor for red eye color, and the other half have no X chromosomes, and thus have no influence upon eye color. Taking up the first class of sperm, namely, those bearing the X chromosomes: they will, when uniting with an egg, produce female individuals and, since half of the eyes have the factor for red while the other half have the factor for white, half of the resulting females will be pure red, while the other half will be hybrid, but will have red eyes because red is

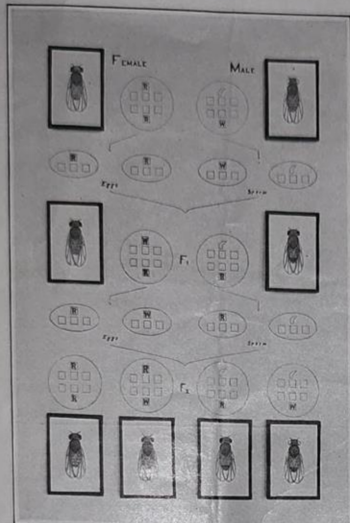


Fig. 8—Sex-Linked Inheritance

White eye color in the pomice fly is one of a number of characters which are sex-linked. The diagram represents the chromosomes of the pomice fly, circles referring to body cells and ovals to germ cells. The sex chromosomes are shown above and below the ordinary chromosomes (see text), the factor for eye color which each one carries being indicated by an initial. The odd-shaped figure is the "Y" chromosome. When this is present the individual is a male.

dominant over white. In other words, all of the females of this generation show red eyes. When the sperm lacking X chromosomes unites with the eggs, half of which have the factor for red in their X chromosomes and the other half white, the result will be males, half of which will be pure red and the other half of which will be pure white. This gives us the result stated above; namely, all the females and half of the males red-eyed while the other half of the males are white-eyed. This case may perhaps be more readily understood by reference to Fig. 8, and Fig. 9 shows the details of the second case mentioned above, which involves what is known as "criss-cross" inheritance.

The relatively complicated "sex-linked" inheritance just explained became simple when the explanation was

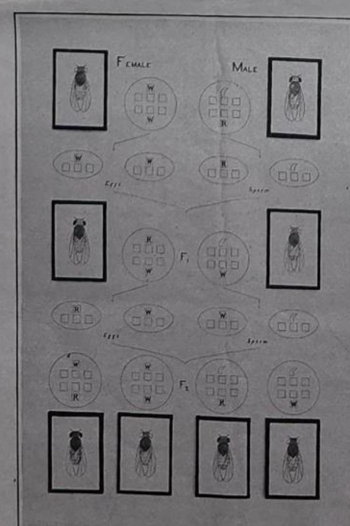


Fig. 9—Criss-cross sex-linked inheritance

If a red-eyed male be mated with a white-eyed female, all the male offspring will have white eyes and all the female offspring red eyes; if these be mated with one another, half of the male and half of the female offspring will have white eyes, the remainder having red eyes.

found, and comes near to demonstrating that there is a relation between heritable characters and chromosomes. It would probably be carrying scientific scepticism too far to continue doubting that it is a causal relation. Ordinary Mendelian characters, that is, those which come out in F_2 in the 3:1 ratio, are related to or borne by the ordinary chromosomes, that is, those chromosomes which are alike and paired in each sex. The interested reader may make diagrams, similar to the ones given here, which will show the mechanism graphically. Now that we think we know where the something which transmits a given character lies in the germ cell, we begin to wonder harder than ever what that something is and how it does it. A number of big steps have been taken in the explanation of heredity and, although the goal is still far ahead, by looking back over the ground already covered we are encouraged to believe that it will finally be reached.

Electric and Hydraulic Transmission

Dealing with the subject of Hydraulic Transmission before the Institution of Automobile Engineers, London, Mr. F. Leigh Martineau said that "an apt comparison could be drawn between a hydraulic transmission and an electric transmission, as the two are similar in many respects. In an electric transmission the essential elements are: (1) The prime mover driving—(2) a generator; (3) a conductor system; (4) an electric motor operating—(5) the driving wheels. So in a hydraulic transmission these elements become:—(1) The prime mover driving—(2) a pump; (3) a pipe system; (4) a hydraulic motor operating—(5) the driving wheels. Their operations may be compared as follows: In the former, the prime mover drives the generator and converts its energy into "electric energy," which is conveyed by the conductor system to the electric motor, where it is reconverted for use at the driving wheels. In the latter case, the prime mover drives the pump and converts its energy into "pressure energy," which is conveyed by the pipe system to the motor, where it is reconverted for use at the road wheels. The claims in favor of electric transmission, however, are, that it is usually more economical, is easily applied at considerable distances from the source of energy supply, and requires considerably less attention than the hydraulic system in regard to upkeep.

However, Mr. Martineau's main interest was with the different types of hydraulic transmission in manufacturing processes of one kind or another. For this purpose the author held that the radial rotating plunger and the axial rotating plunger types of pumps were best suited, because, he declared, experience seemed to show "that for hydraulic transmission to be effective in practice it is necessary to run at high pressure and with small volume, so that the hydraulic losses may be as low as possible, and the oil by this means kept cool; this will increase the mechanical and slip losses, but the net result will be better, and such heating as occurs will be as much in metal of high conductivity as in oil of low conductivity." While with the radial rotary pumps good material and workmanship are essential, they present the advantage of being easily and cheaply produced in quantities, having very few parts, and most of the work on them being cylindrical, can be carried out by grinding.

As regards hydraulic transmission for automobiles, especially of the heavy tractor and other heavy vehicle types, Mr. Martineau has great hopes for the future. He does not consider that it need be heavier than gear transmission, for "it must be remembered that as a rule the fly-wheel clutch, gear box, and countershaft brake can be totally eliminated from the chassis and replaced by two units in one case, which is mostly revolving weight, and will perform all the functions of the parts mentioned, with the added advantages of being able to make use of the whole of the engine power all the time during acceleration, using all the engine power at its most efficient speed on inclines, and having at command an absolutely steady retarding effect which converts surplus energy into heat without causing wear. By using high quality materials and good design the weight of such a transmission can be the same as its equivalent gear box, etc." He thought that there should not be any increase of cost. The question of complication had to be considered from the point of view of the manufacturer and the user. "The manufacturer," he argued, "will have fewer unlike parts to produce, but will have to make more like parts per car; this would seem to indicate simplicity and not complication from his point of view. The user has less to look after and no adjustments or adjustable parts to look after, but he has to keep the case full of oil to a certain mark, and that is all; this does not appear to show complication from his point of view."—*The Practical Engineer.*

"The forms and relations between the two parts, C and B, may be greatly modified, with the general result of a preponderance of repulsive action when the alternating currents circulate.

"Fig. 13 shows the part, B, of an internally tapered or coned form, and C of an externally coned form, wound on an iron wire bundle, I. The action in Fig. 12 may be said to be analogous to that of a plain solenoid with its core, except that repulsion, and not attraction, is produced; while that of Fig. 13 is more

FIG. 12.

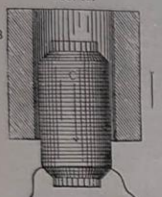
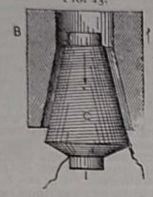


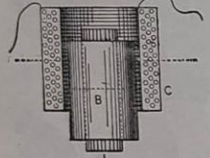
FIG. 13.



like the action of tapered or conically wound solenoids and taper cores. Of course, it is unnecessary that both be tapered. The effect of such shaping is simply to modify the range of action and the amount of repulsive effort existing at different parts of the range.

"In Fig. 14 the arrangement is modified so that the

FIG. 14.

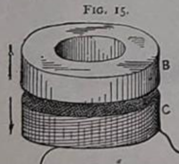


coil, C, is outside, and the closed band or circuit, B, inside and around the core, I. Electro-inductive repulsion is produced as before.

"It will be evident that the repulsive actions will not be mechanically manifested by axial movement or effect, *when the electrical middles of the coils or circuits are coincident.* In cylindrical coils, in which the current is uniformly distributed through all the parts of the conductor section, what I here term the electrical middle, or the center of gravity of the ampère turns of the coils, will be the plane at right angles to its axis at its middle, that of B and C in Fig. 14 being indicated by a dotted line. To repeat, then, when the centers or center planes of the conductors (Fig. 14) coincide, no indication of electro-inductive repulsion is given, because it is mutually balanced in all directions; but when the coils are displaced, a repulsion is manifested, which reaches a maximum at a position depending on the peculiarities of proportion and distribution of current at any time in the two circuits or conductors.

"In Fig. 15, B represents a copper ring and C an annular coil placed parallel thereto; and an iron core

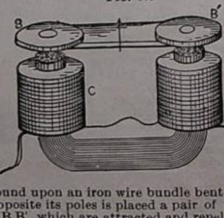
FIG. 15.



or wire bundle, placed in the common axis of the two coils, shows the repulsive action when an alternating current is passed through C. B may be simply a disk or plate of any form, without greatly affecting the nature of the action produced. It may also be composed of a pile of copper washers or a coil of wire, as before indicated.

"An arrangement of parts somewhat analogous to that of a horseshoe electro-magnet and armature is shown in Fig. 16. The alternating current coils, C C',

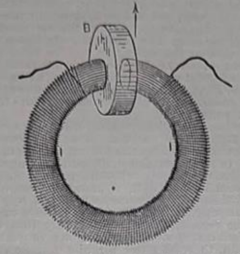
FIG. 16.



are wound upon an iron wire bundle bent into U-form, and opposite its poles is placed a pair of thick copper disks, B B', which are attracted and repelled, but with an excess of repulsion depending on their form, thickness, etc.

"If the iron core takes the form of that shown by I I, Fig. 17, such as a cut ring with the coil, C, wound thereon, the insertion of a heavy copper plate, B, into the slot or divided portion of the ring will be opposed by a repulsive effort when alternating currents pass in C. This was the first form of device in which I noticed the phenomenon of repulsive preponderance in question. The tendency is to thrust the plate, B, out of the slat in the ring, excepting only when its center is coincident with the magnetic axis

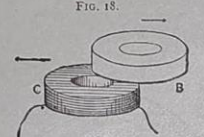
FIG. 17.



joining the poles of the ring between which B is placed.

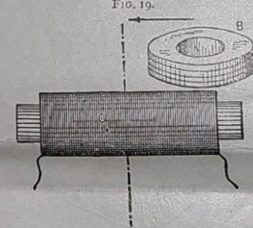
"If the axes of the conductors (Fig. 15) are not coincident, but displaced, as in Fig. 18, then, besides a sim-

FIG. 18.



ple repulsion apart, there is a lateral component or tendency, as indicated by the arrows. Akin to this is the experiment illustrated in Fig. 19. Here the conductor, B, is placed with its plane at right angles to

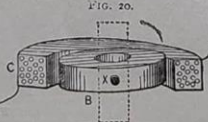
FIG. 19.



that of C, wound on a wire bundle. The part, B, tends to move toward the center of the coil, C, so that its axis will be in the middle plane of C, transverse to the core, as indicated by the dotted line. This leads us at once to another class of actions, *i. e.*, deflective actions.

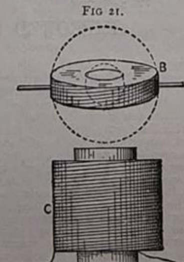
"When one of the conductors, as B (Fig. 20), is com-

FIG. 20.



posed of a disk or, better, of a pile of thin copper disks, or of a closed coil of wire, is mounted on an axis, X, transverse to the axis of coil, C, through which coil the alternating current passes, a deflection of B to the position indicated by dotted lines will take place, unless the plane of B is at the start exactly coincident with that of C. If slightly inclined at the start, deflection will be caused as stated. It matters not whether the coil, C, incloses the part, B, or be inclosed by it, or whether the coil, C, be pivoted, and B fixed, or both be pivoted. In Fig. 21 the coil, C, surrounds an iron

FIG. 21.



wire core, and B is pivoted above it, as shown. It is deflected, as before, to the position indicated in dotted lines.*

"It is important to remark here that, in cases where deflection is to be obtained, as in Figs. 20 and 21, B had best be made of a pile of thin washers or a closed coil of insulated wire, instead of a solid ring. This avoids the lessening of effect which would come from the induction of currents in the ring, B, in other directions than parallel to its circumference."

(*To be continued.*)

* This deflection by an alternating current of a copper disk suspended within a coil with its plane inclined to the plane of the coils, I myself noticed independently, in March, 1887, and subsequently described a copper disk galvanoscope for alternating currents, based on this fact (see *The Electrician*, May 6, 1887). I did not, at the time, know how thoroughly Prof. Thomson had explored the phenomena, but the substantial explanation of it had already occurred to me.

THE CHEMISTRY OF GOUT.

AT the last meeting of the London Medical and Chirurgical Society an important contribution to our knowledge of the chemical changes occurring in the tissues of gouty persons was brought before the Society by Sir William Roberts, in the form of a very elaborate paper on the subject.

In bringing forward the subject Sir William Roberts referred to a recent paper of his, in which he had shown that in the physiological state uric acid existed in the blood and urine exclusively as quadrurates, and that when it appeared in any other form this was due to abnormal changes in the quadrurates. In that paper he had traced the changes which the quadrurate underwent in urine—changes leading up to the separation of free uric acid in gravel. In the present paper he proceeded to consider the changes which the quadrurate underwent in the blood—changes leading up to the deposition of free uric acid in gout. These latter changes were intimately connected with the property possessed by the quadrurates of taking up in alkaline solutions an additional atom of base—thereby becoming converted into biurates. A knowledge of this reaction enabled us to present a coherent view of the succession of events which culminated in a gouty paroxysm. Normally, the uric acid, which circulated in the blood as quadrurate, was at once removed unchanged by the kidneys.

But in the gouty state—either from defective kidney action or from some other cause—the quadrurate lingered unduly in the blood; circulating then in a medium rich in sodium carbonate, it was gradually transformed into sodium biurate, which was almost insoluble in blood serum and probably, for this reason, was difficult of removal by the kidneys. Under these new conditions sodium biurate accumulated more and more in the blood, and, when the accumulation reached a certain point, was precipitated in the crystalline form in the joints and elsewhere, thereby determining the occurrence of a fit of the gout. Sir William Roberts said he based this view upon a study of the reactions of blood serum and synovia with uric acid and the urates.

In the case of blood serum these depended essentially on the saline ingredients; the sodium salts exceeded all the other salts put together in the ratio of seven to one, and a solution of 0·5 per cent. of sodium choride and 0·2 per cent. of sodium carbonate was a fairly exact imitation of blood serum so far as concerned its saline ingredients. Experimentally, it was found that such a solution behaved with uric acid and the urates in the same manner as blood serum *itself*, and in the same manner as a solution composed of all the salines of the serum in their due proportion. The behavior of uric acid and the urates with this standard solution was then studied in detail and the results checked, by comparing them with those obtained with blood serum under similar circumstances. The author found that sodium biurate dissolved in water at 100° F. in the proportion of 1 in 1,100, but that it was almost insoluble in the standard solution and in blood serum, and no addition of potassium, lithium, or magnesium salts—whether alkaline or neutral—made the slightest difference. The solvent power of the standard solution was found to depend exclusively on the sum of sodium salts contained in it, and the degree of alkalescence had not the least influence; the nearer the standard solution approached to pure water, the higher became its power of dissolving sodium biurate, and *vice versa*. The solubility of gouty deposits was tested by suspending gouty articulations, encrusted with uratic deposits, in a large volume of blood serum; the deposits remained unchanged even after immersion for many months. Uric acid itself dissolved freely (as a quadrurate) in the standard solution—and also both in blood serum and synovia—but after an interval of a few hours or a few days it was again precipitated, often somewhat suddenly, in the form of crystalline needles of sodium biurate exactly resembling those found in gouty deposits. The author held that this reaction was analogous to the phenomena of the gouty paroxysm.

In gout, he considered that the blood became increasingly charged with uric acid, until, after a certain period of incubation, sudden precipitation of sodium biurate occurred and the "fit" of gout took place; then followed a process of recovery with restoration of the blood to a purer state. In the experimental process a similar succession of events was observed: solution of uric acid in the medium as quadrurate; gradual conversion of quadrurate into biurate (stage of maturation); deposit of the biurate in the crystalline form (stage of precipitation); restoration of the medium to comparative purity. With regard to the conditions which hastened or retarded the processes which culminated in the precipitation of sodium biurate, the following results were arrived at:

1. Precipitation occurred earlier in synovia than in blood serum.
2. Increased alkalescence of the media favored the stage of solution, but did not retard the stages of maturation and precipitation.
3. The addition of sodium salts hastened maturation and precipitation.
4. The addition of potassium, lithium or magnesium salts had no effect either way—except potassium chloride, which retarded maturation.
5. Maturation was hastened and precipitation occurred earlier at 100° F. than at the temperature of the room.
6. The proportion of uric acid in solution was the circumstance which exercised the most decisive influence on the speed of maturation, and on the time of advent and copiousness of precipitation.

If the proportion of uric acid in solution were 1 in 2,500 or over, there was observed in the middle period of maturation, on the second or third day, a copious critical precipitation; but if the proportions were 1 in 4,000 or under, the precipitation was throughout scanty and gradual, and postponed to the twelfth or fourteenth day. Dr. George Harley remarked that when Sir Alfred Garrod proved that gout was due to the existence of uric acid in the system, a distinct advance in our knowledge was made. A further advance was made when it was shown that an acute attack of gout was due to the deposition of uric acid in the articular cartilages. Later on, it was shown that the deposits were not due to inflammation of the joints, but that the deposits caused the inflammation around the joints which was known as gout. Sir William Roberts' present paper was a contribution to the chemistry of gout, and Dr. Harley urged that, through chemistry, a new pathology would be founded in which all morbid changes would be proved to be due to chemical action. Dr. Haig observed that Sir William Roberts' paper afforded a chemical explanation which he had long wanted. He had found that alkalies increased the excretion of uric acid, and Sir William Roberts had shown that increased alkalescence favored the state of solution of uric acid. Similarly, acids lessened the amount of uric acid excreted. Sir William Roberts then replied, and remarked that he had confined himself to certain chemical results, and had drawn no conclusion as to the profounder theories of gout. There was something in gout beyond the chemistry of the urates; it was, in essence, a mode of nutrition, associated with an error, which was uric acid. There was a colloidal form of uric acid, as well as the crystalline form, and the action of the two forms also differed. He believed that if an attack were imminent, a patient ought not to take mineral waters containing soda and lime, except very sparingly at first. Dr. Herman Weber had, for many years, warned his patients on this point. Sir William Roberts said he thought it possible that most of the good done at mineral springs was due to the water taken, and not to the salts it contained.—*Medical Record.*

SEWER VENTILATION.

SUCCESSFUL as have been the works of sanitary engineers in most respects, it must be admitted that they have hitherto failed to solve the apparently difficult problem of sewer ventilation, and untold numbers of sewer gratings, constantly emitting offensive and dangerous vapors into the roads of every sewered town and village under the breathing organs of the population, unpleasantly proclaim the fact; it is therefore universally felt that the subject is one demanding the earnest attention of sanitary authorities and their responsible officers.

An interesting experiment in sewer ventilation is now being made by the Portsmouth corporation on one of the main sewers of the borough, under Mr. Murch, the borough engineer. The drainage committee ordered the experiment to be made some months ago, upon the advice of Mr. Boulnois, president of the Association of Municipal and Sanitary Engineers, the late borough engineer of Portsmouth, who, we understand, holds a favorable opinion of the invention; but, owing to his appointment as city engineer of Liverpool, he has been obliged to leave the investigation and reports upon the system, as far as Portsmouth is concerned, to be made by his successor. The section of main sewer chosen for the experiment, and which borders on the Canoe Lake at Southsea, was selected by Mr. Boulnois as being in need of ventilation, and therefore as imposing a severe test upon the invention, the object of which is not only to ventilate the sewers, but, at the same time, to obviate the nuisance and danger to the public health which arise from the foul emanations escaping from the sewer gratings in the roads. Although all sewered towns suffer alike, the importance of the question as affecting the prosperity of a watering place like Southsea cannot be overestimated, especially as a low-level main sewer of this borough passes all along the sea front from Portsmouth to Eastney.

Mr. Archibald Ford, Asso. Mem. Inst. C. E., the consulting engineer to the Fareham Union Rural Sanitary Authority, and Mr. E. G. Wright, ventilating engineer of Portsmouth, are the joint inventors and patentees of the arrangement adopted; the pith of which consists in the provision to the sewer of a special air passage which is disjointed at intervals, and by means of which the air currents are separated from the sewerage flowing along the sewer; the friction of the water on the air current being thus obviated, the air current is found to be under certain control as to its direction, whatever may be the volume or velocity of the sewerage flow; and, further, the powerfully disturbing influence to systematic sewer ventilation which Mr. Santo Crimp's important experiments have shown to be caused by the varying force and direction of the winds is obviated, as the only connections to the outer air are at the uptake and downtake shafts, which are directly connected to the "special air passage," and not to the sewer; the carefully noted records, extending over three months (which we have had the opportunity of examining), conclusively show that the only effect of the wind, whatever the direction, was that as its force increased, the ventilation of the sewer in the required direction was proportionately greater. Referring to our illustrations of the system, Fig. 1 shows a form of the "special air passage" as applicable to large sewers, and Fig. 2 to pipe sewers.

The application to the Portsmouth main sewer, which is 4 feet diameter and about 10 feet below the surface, is similar to Fig. 1; the system, as it is being adopted for the complete sewerage of a new building estate on Portsdown Hill, Cosham, Hants, is with the "patent ventilating pipe," similar to Fig. 2.

In the application to the Portsmouth main sewer the "special air passage" is formed of galvanized steel tubes, averaging 5½ inches diameter and 2 feet 6 inches long, which are suspended from the crown of the sewer, and secured firmly thereto by a simple arrangement speially devised by the patentees.

The air passage is carried along the top of the sewer (just clear of the headway) for a distance of 100 yards, and at the lowest end it is connected to a "downtake shaft" 6 in. in diameter (of the same material as the tubes fitted in an existing manhole), and the out-air connection with this shaft is from the pit under the ordinary road grating, so arranged that all air passing down through the grating must pass into the air passage. At the higher end (which, however, is only slightly higher) the air passage is connected by a 9 in. stoneware pipe to a dwarf brick ventilating shaft arranged to facilitate the taking of records, this shaft standing on land at the side of the road about 40 ft. laterally from the line of sewer; the arrangement is, in fact, similar to that now usually adopted for ventilating house drains, viz., a length of pipe with an uptake and a downtake shaft, but in this system the pipe is disjointed at intervals, as shown, and the air current, instead of relying upon the comparatively feeble motive power caused by the difference in the height of the uptake and downtake shafts only, is provided for by the more powerful and certain action of a small jet of water, fitted in and discharging down the downtake shaft, the jet obtaining its supply under pressure from the adjoining water main.

Carefully taken records show that with a jet consuming only 23 gallons of water an hour (as recorded by meter), a uniform and constant down current of air is maintained in the downtake shaft with striking uniformity, at velocities varying with the pressure in the water main from 330 to 390 ft. per minute (as recorded by Negretti & Zambra's anemometer); this is equivalent to from about 4,000 to 4,500 cubic ft. fresh external air passing regularly and continuously into the air passage, and distributed thereby along the sewer every hour, diluting the sewer air and forcing it in calm weather in its diluted state, at a rate varying from 1,716 to 2,492 cubic ft. per hour, out of the uptake shaft, which, taking into account the depths of the sewage (which have varied when the experiments were taken from 15 to 30 inches), represents approximately—and with little variation—the entire change of the air of the hundred yards of sewer once in every hour.

The records, which had extended over the period since January last, covering some boisterous days, show that the best results have been obtained in the most windy weather, and that on no single occasion has the direction or force of the wind, or other atmospheric conditions, interfered with the perfect and continuous action of the system of ventilation; an automatic ventilating action, indeed, appears to result from the arrangement, as, except in the calmest weather, it is shown that the system acted without resort to the water jet. The consumption of water is, however, so trifling that if its use, in conjunction with the special air passage, so certainly prevents the escape of the sewer ventilation as these experiments show, we imagine that sanitary authorities would gladly avail themselves of such a generally available and cheap means to secure such important results, and especially as the inventors show that the water can be further utilized for flushing the sewers by collecting it in automatic flushing tanks, which tanks, they suggest, can be built to existing sewers, under the dirt pit of the road gratings, without disturbing the road surface.

Regarding the water consumption, the results at Portsmouth show that for each cubic foot of water consumed, 1,246 cubic ft. of air can be introduced into and carried for a considerable distance along the air passage, but in the application to small sewers less water would, we understand, be sufficient; and even possibly more striking and economical results may be obtained. These important experiments point to the conclusion that while the section of sewer to which the system has been applied is thoroughly ventilated by the systematic introduction of fresh external air, and stagnation of the sewer air is thereby prevented, the important point—viz., the prevention of the escape of sewer air at the road surface grating—has been absolutely secured; and they also show that the fresh air can be made to pass regularly and uniformly down road gratings, and the diluted sewer air out of the uptake shaft, which, of iron or other suitable material, similar to those already existing in many towns, can be carried up the front or back of buildings, or in other places adapted for the purpose; such pipes could, of course, have their outlets above the strata or zone of the atmosphere which must be breathed by the populations of our towns and villages.

There is no reason, that we can see, why in any special case provisions might not be made for the escaping diluted sewer air to pass through heat and flame obtained from gas in the upper part of the uptake shaft, but a continual change of the sewer air and the oxidizing power of the outer air on numerous points of outlet, judiciously selected, would, no doubt, render the general adoption of such additional provisions unnecessary.

A complete installation of the system, with the "patent ventilating sewer pipe," and specially arranged manholes and automatic flushing tanks, designed by Mr. Archibald Ford, C.E., one of the inventors, is, we understand, now approaching completion on a building estate at Cosham, Hants, and we hope to be able, in due course, to give the results of the arrangements, which, we gather, are especially designed to secure a continuous flushing of the sewers with fresh air every hour and with water about three times a day, while all the road gratings are to act as downtakes for fresh air; we may also be able to illustrate and explain what, under a general term, we may call the "double tube system of ventilation," as the inventors propose to apply it to drains and soil pipes in connection with the drainage of public institutions and houses.

We may content ourselves now by saying that, so applied, the inventors claim the following advantage to result, viz., the protection of the fresh air inlet from the escape of sewer or drain air, by the prevention of a reversal of air currents in the drains and soil pipes on discharge from the house fittings, and also the prevention of the unsealing of water closet and similar traps.

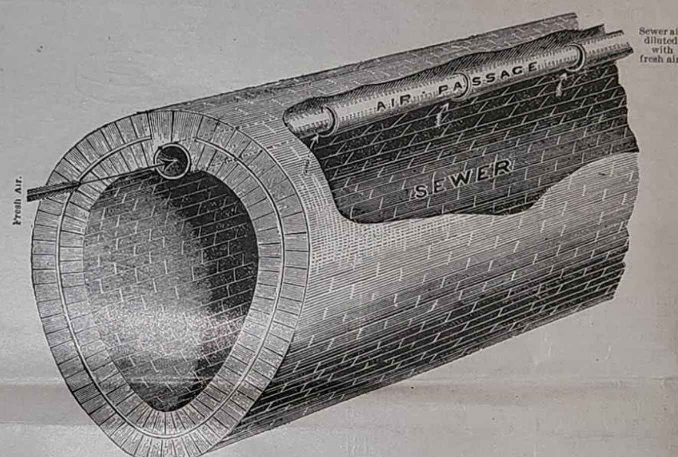


FIG. 1.

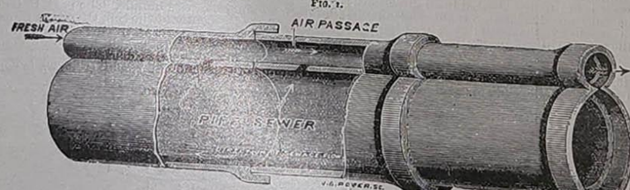


FIG. 2.—ELEVATION.

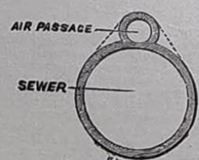


FIG. 3.—SECTION.

IMPROVED SEWER VENTILATION.

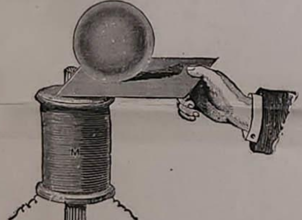
stead of one, and it will be found that they may each "shade" a portion of the pole, and if made to overlap, they will pull each other round and revolve in opposite directions when the alternating pole acts upon them.

This principle of "shading" a portion of the magnetic pole, and hence causing an unsymmetrical distribution of induced currents in a conducting body capable of revolution on a pivot, has been developed by Prof. Thomson in many extraordinary ways.

FIG. 25.

Floating, for instance, a hollow sphere of copper on the surface of water in a glass vessel, he places this over an alternating magnetic pole. If the pole is placed directly under the sphere, the electromagnet action would, as before explained, result in a repulsive force acting upon the disk. If, however, a sheet of copper is placed half over the pole so as to "shade" a portion of the copper sphere, the currents induced in it are unsymmetrically situated with respect to its center, and react upon the current induced in the plate. Hence, the electromagnet action resolves itself into a torque or couple, causing the ball to spin rapidly upon its center and take up a rapid rotation. So considerable is the rotational force brought to bear that the ball will rotate when merely laid on a sheet of copper, even overcoming the friction of such rotation on its equatorial line, provided that the ball and supporting plate are so held over an alternating pole that the plate shields a portion of the sphere (Fig. 26). Given this principle

FIG. 26.

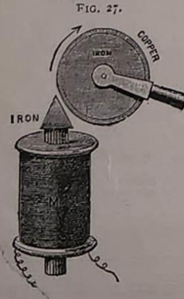


that by properly "shading" a pole from a portion of a solid body capable of revolution round a line or axis, it is easy to see that countless forms of electromotor can be designed.

A sort of anemometer with copper disks for cups, resembling the cross of a Crookes' radiometer, can be set in rapid rotation by an alternating pole, if a copper screen is placed so as to shade one side of it.

This unsymmetrical development of the induced currents can be produced by a suitable disposition of the magnetic pole alone. Thus we may place a cone or wedge of iron on the alternating pole, and hold near it a copper ring mounted so as to be able to revolve (Fig. 27). The copper cylinder or wheel revolves rapidly under the action of the periodic field, and its direction of motion is such that it seems to be blown around by a blast from the end of the magnetic cone. Prof. Thomson has constructed a curious electrical gyroscope as follows: A vertical pivot projects from the center of an alternating pole (Fig. 29), upon which is pivoted a horizontal rod bearing a counterpoise, and a copper wheel, preferably with an iron core attached to it, gyroscope fashion, by means of a copper frame. The copper frame is placed in an inclined position with respect to the horizontal. Under these circumstances a vigorous rotation is communicated to the gyroscope wheel when the alternating field acts upon it. The copper frame shields one side of the wheel more than the other, and, as a result, the induced currents in the copper wheel are unsymmetrically placed with respect to its axes of rotation, and it experiences a violent torque.

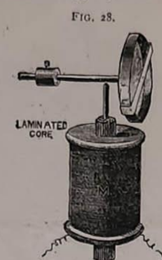
FIG. 27.



These experiments can, by a little ingenuity, be endlessly multiplied when once the fundamental principle is grasped. Bodies can be made to rotate and move, taking their movements from the magnetized space in which they are placed, and without being supplied with current from an external source.

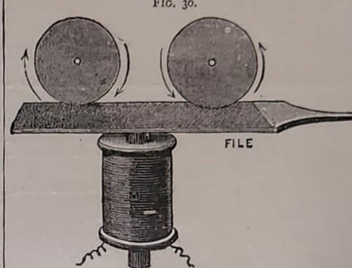
Prof. Thomson has, however, studied some curious cases of magnetic motion, in which rotations are obtained when iron or copper pivoted disks are placed

FIG. 28.



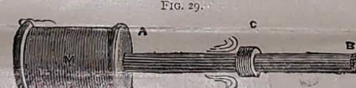
near to iron or steel bars, in which the propagation of magnetism is throttled by closed circuits. If a longitudinally laminated iron bar has a closed copper band or coil placed round it at one point, and if such a bar is made magnetic by a periodic current traversing a magnetizing coil embracing another part, this structure becomes capable of rotating iron or copper disks held near it. The explanation of this effect is probably to be found in the fact that the closed embracing coil tends to throw off the magnetic lines of force laterally at that point. Consider a bar (Fig. 29), A B, in which lines of magnetic force are being established in the direction from A to B. That is to say, let magnetic induction be increasing in the bar in a direction from A to B, at C let there be a closed coil embracing the bar, the magnetic induction during its period of increase is setting up in this circuit an electromotive force which establishes in the circuit a current whose lines of force are opposed to the primary induction inside the coil, and, therefore, in the iron included in the coil, but in the same direction outside the coil, and, therefore, outside the iron. The result is as if the lines of primary magnetic induction in the iron were shed off laterally and escaped round the coil. When the magnetic induction in the iron, due to the magnetizing coil, is made periodic, this action will create a kind of lateral pulsation of the magnetic lines of force in the neighborhood of the closed coil. If, then, a movable conductor is held near such a magnetically throttled bar, it will be subjected to a displacement of lines of magnetic force through it laterally, and will hence have eddy electric currents generated up in it. These currents, persisting into the period of reversal of the field in virtue of self-induction in the conductor, will cause the portion of the conductor in which they are set up to be continuously repelled, and hence to take up a motion of rotation. A ring of cast iron, having a closed coil wound on it at one point, is held so that another point on its circumference, 90° removed from the closed coil, is on the pole of an alternating magnet. An iron disk, centrally pivoted and held concentric with the ring, is rotated when the magnet is energized by an alternating current. It is not even necessary to have a closed coil on one part of the active magnetic bar, provided that this bar is not laminated, or, better still, is made of hard steel. In these cases there is a lag in magnetization, due to either eddy currents set up in the bar or to hysteresis, and the result is a lateral escape of lines of force out of the bar. When it is held with one extremity on an alternating magnetic pole, there is in these cases an action which is a true "magnetic self-induction." In the case of electric circuits, if we join in parallel two circuits, one having very small ohmic resistance and very high self-induction, and the other very large ohmic resistance and small self-induction, a sudden flow of current chiefly selects the path of least self-induction for its flow during the variable period, although during its steady period it will chiefly flow by the path of smallest ohmic resistance; so in the case of a magnetic and conductive circuit of low magnetic and electric resistance (iron), shunted by a path of high magnetic and electric resistance (air), rapid variations of magnetic induction bring about a state of things in which the magnetic induction seems to chiefly select the path not of least but of greatest magnetic resistance during the variable period. Time will not permit me to develop at greater length the analogies of the magnetic and electric circuits under the conditions of rapidly periodic magnetic induction and electric current; but there are many suggestive ideas which arise when we place before our minds the notion of a magnetic self-induction which is the consequence of a time element coming into action in the setting up of induction in a magnetic and conductive circuit, and due to the production of electric eddy currents, just as the electro-magnetic or ordinary self-induction is the consequence of the time element coming into action in the setting up of an electric current, and due to the production of a surrounding magnetic field. Just as the rise of current strength under an impressed electromotive force, acting in a conducting circuit, is retarded by linking that conductive circuit with a magnetic circuit, so the rise of magnetic induction under an impressed magnetizing force acting on a magnetic circuit is retarded by linking that magnetic circuit with an electric conducting circuit. I am under the impression that Mr. Oliver Heaviside has developed these notions in a mathematical form, but am unable at the moment to place my hands upon the results. The effect, however, of a bar of unlaminated iron when surrounded by a magnetizing coil at one end, and traversed by a periodic current, is to cause rotation in copper or iron pivoted disks held near it, or when such a bar of non-laminated iron is abutted on the pole of an alternating magnet. A bar of steel, even if not laminated, is able to cause brisk rotations in copper or iron disks under the same circumstances. With hardened steel the action is more marked. Here the hysteresis retards the propagation of the magnetic wave. By laying a large file flatwise against the alternating magnet pole at about the middle of the file, disks of copper or iron may be kept revolving if held over those portions of the file which project from the pole of the magnet (Fig. 30). In this case the magnetic retardation

FIG. 30.



in the bar is brought about by its own physical structure, and not by embracing it with a closed conducting circuit. The result is, however, the same in kind; there is a sluggishness in the establishment of the magnetic induction on the steel or iron under the action of magnetizing force, which partly depends on the eddy currents in the mass of metal and partly on hysteresis. As a consequence, we have a periodic lateral displacement of the field. The question of a magnetic leakage dependent on a retardation of induction deserves special attention in the case of commercial alternate current transformers. Time will not permit me to enlarge on it here to any great extent; but I may observe that in the design of closed iron circuit transformers this magnetic leakage should not be neglected.

FIG. 29.



In a closed iron circuit embraced at one part by a magnetizing coil, and subjected to rapidly reversed magnetic force, the magnetic induction does not confine itself wholly to the path of least magnetic resistance, viz., the iron path, but takes a short circuit in part across the interior air space. This waste field may in badly designed transformers be something considerable. I believe that an important point to hold in view in transformer construction is to subject the iron circuit uniformly to the magnetizing force, by embracing all portions of the iron circuit with primary windings, and not locating the windings simply at one part. There is then a tendency to check the production of waste field by the lateral bulging out of the magnetic lines of force from the iron. In Fig. 31 is a diagram illustrating the arrangement of primary and secondary coils most favorable for the production of waste field, and in Fig. 32 the arrangement least favorable for the same.

FIG. 31.

FIG. 32.

The foregoing experiments are of such a nature as obviously to force on us the thought that useful and perhaps important applications can be made in electromagnetic machinery. Professor Elihu Thomson has, as you can imagine, not been slow to do this; for in him is united both a keen scientific sagacity and that clear mental vision which enables him to pursue to its logical issue in practice the consequences of scientific discovery. He has already applied these principles to the construction of alternating current indicators, alternating current arc lamps, regulating devices for alternating currents, and to rotary motors for such currents. For current indicators, a pivoted or suspended copper band or ring, composed of thin washers piled together and insulated from one another, and made to carry a pointer or index, has been placed in the axis of a coil conveying alternating currents, whose amount or potential is to be indicated. Gravity or a spring is used to bring the index to the zero of a divided scale, at which time the plane of the copper ring or band makes an angle of say 15 to 20 degrees with the plane of the coil. This angle is increased by deflection more or less great, according to the current traversing the coil. The instrument can be calibrated for set conditions of use. Time would not permit of a full description of these arrangements as made up to the present.

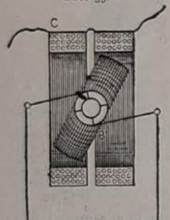
In arc lamps the magnet for forming the arc can be composed of a closed conductor, a coil for the passage of current, and an iron wire core. The repulsive action upon the closed conductor lifts and regulates the carbons in much the same way that electro-magnets do, when continuous currents are used. The electro-inductive repulsive action has also been applied to regulating devices for alternating currents, with the details of which I cannot now deal.

For the construction of an alternating current motor, which can be started from a state of rest, the principle has also been applied, and it may here be remarked that a number of designs of such motors is practicable.

One of the simplest is as follows:

The coils, C, Fig. 33, are traversed by an alternating

FIG. 33.

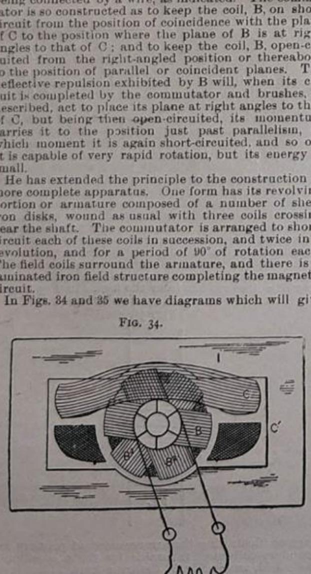


current, and are placed over a coil, B, mounted upon a horizontal axis transverse to the axis of the coil, C. The terminals of the coil, B, which is wound with insulated wire, are carried to the commutator, the brushes being connected by a wire, as indicated. The commutator is so constructed as to keep the coil, B, on short circuit from the position of coincidence with the plane of C to the position where the plane of B is at right angles to that of C; and to keep the coil, B, open-circuited from the right-angled position or thereabout to the position of parallel or coincident planes. The deflective repulsion exhibited by B will, when its circuit is completed by the commutator and brushes, as described, act to place its plane at right angles to that of C, but being then open-circuited, its momentum carries it to the position just past parallelism, at which moment it is again short-circuited, and so on. It is capable of very rapid rotation, but its energy is small.

He has extended the principle to the construction of more complete apparatus. One form has its revolving portion or armature composed of a number of sheet iron disks, wound as usual with three coils crossing near the shaft. The commutator is arranged to short-circuit each of these coils in succession, and twice in a revolution, and for a period of 90° of rotation each. The field coils surround the armature, and there is a laminated iron field structure completing the magnetic circuit.

In Figs. 34 and 35 we have diagrams which will give

FIG. 34.

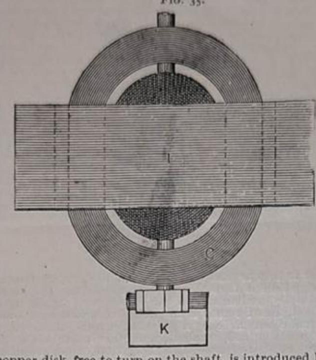


an idea of the construction of the motor referred to. C C' are the field coils or inducing coils, which alone are put into the actuating alternating circuit. I I is a mass of laminated iron, in the interior of which the armature revolves with its three coils, B, B', B', wound on a core of sheet iron disks. The commutator short-circuits the armature coils in succession in the proper positions to utilize the repulsive effect set up by the currents which are induced in them by the alternations in the field coils. The motor has no dead point, and will start from a state of rest and give out considerable power, but with what efficiency is not yet known.

A curious property of the machine is that at a certain speed, depending on the rapidity of the alternations in the coil, C, a continuous current passes from one commutator brush to the other, and it thus performs the function of converting some electric energy from an alternating to a continuous form.

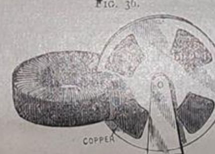
A small motor of a curious type has been made, utilizing the principle of "shading" the pole by closed circuits. A laminated ring (Fig. 36) is wound over with wire, but has a slot cut through it, driving the ring, and causing it to present two pole faces opposite to each other on the cut part. Each pole is arranged by a set of closed copper bands to be "shaded." A

FIG. 35.



copper disk, free to turn on the shaft, is introduced by one edge into the air gap in the magnet, and turns rapidly when the magnet is excited. A silver coin held just at the edge of the air gap, in such an alternating magnet with shaded poles, is drawn into the interpolar space and propelled with some force through the same; but a lead disk or coin of base metal is not acted

FIG. 36.



upon nearly by the same force, owing to its inferior conductivity.

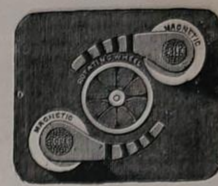
I have left myself but little time to speak of numerous applications of these principles in alternating current meters. The well known meter of Mr. Schallenberger was described to you here quite recently by Professor Forbes. There is, however, a new form of meter, designed by Messrs. Wright and Ferranti, which exhibits in a most beautiful manner a practical application of some of these principles which have briefly occupied our attention. In Fig. 37, we have a diagram of this meter. It consists in its latest form of a pair of vertical electro-magnets—magnets having divided iron cores. To the poles of these magnets are attached curved horns of divided iron, which lie in a horizontal plane.

These curved horns are magnetically throttled at intervals along their length with copper bands. The curved horns embrace a circular space, in which can revolve a light copper or iron shallow cylinder of thin metal.

This cylindrical band forms the periphery of a light wheel capable of rotation on a vertical axis. Geared to this axis is a counting mechanism. The axis also carries a vane, having mica blades. The electro-magnetic principle may be briefly described thus:

The throttling of the curved iron horns causes the rapidly reversed magnetism to take the form of a lateral diffusion of lines of force from the sides of the horns. In effect a series of oppositely named magnetic poles travels along the horn from the base, where it is in contact with the top of the electro-magnet, to the tip. These poles are represented by a series of bunches of lines of force setting out laterally from the sides of the horn, and traveling up it. The lateral passage of these lines of force through the metal band which forms the rim of the movable wheel generates in it eddy currents. These are continually repelled by the

FIGS. 37 AND 38.



moving field producing them, and hence a motion of rotation is given to the wheel by the alternating magnetism of the magnetic poles. The speed of rotation, being retarded suitably by the vanes, can be made to be proportional to the current strength of the current exciting the magnets, and hence the total turns of the wheel in a given time to the total electric quantity flowing through the meter. A beautiful adaptation has here been made of the principles we have been briefly studying, and much more might be said in explanation, or rather in elucidation, of the action of this meter, did opportunity permit.

It would take me beyond the limits of the time during which I am permitted to trespass upon your attention, if I were to attempt to exhaust the list of electo-motor applications that have been made of these electro-magnetic repulsions. That is a subject important enough to deserve a separate treatment. In Berlin not long ago I saw a most ingenious form of self-starting alternating current motor, the invention of Herr Von Dolivo Dobrowolsky, in which the rotating portion was merely a solid iron cylinder, constituting a commutatorless armature, revolving in an alternating field, and which acted in a perfectly marvelous manner. The region of practical invention here opened is a very wide one, and I have therefore ventured to direct your thoughts to it to-night, confident that its character in this respect deserves all the attention it can obtain, and that a firm foundation for such work is laid in these interesting researches of Prof. Elihu Thomson.

THE LINEFF MAGNETIC CONDUCTOR.

THE Lineff conductor is the first in which advantage is successfully taken of the force of magnetism in closing the circuit in electric traction. The surface rails are laid in lengths of about 3 feet in a bed of asphalt, and as they are without any groove, and have their upper surface flush with the roadway, they cannot form any obstruction to traffic, either along or across the track. In point of fact, they are hardly to be distinguished from the roadway itself. Each of these rails is bolted by means of brass bolts and distance pieces to a piece of tee iron of equal length, so placed as to have its base on the same level as that of the surface rails, at a distance from it of about ¼ inch. The tee iron, being of lower height than the surface rail, does not appear at all on the roadway, being completely buried in the asphalt surrounding the whole. One end of the tee iron projects beyond the corre-

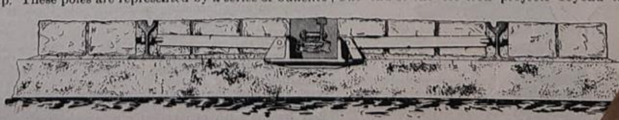


FIG. 1.

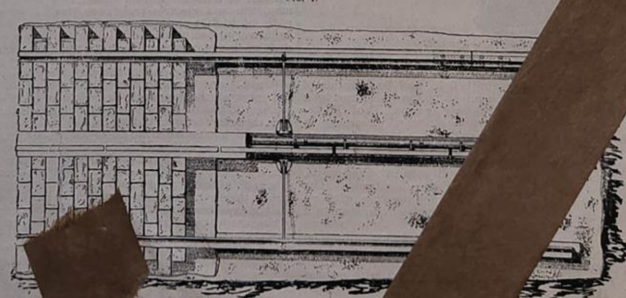


FIG. 2.

THE[…]EFF MAGNETIC CONDUC[…]AMWAYS.

to assume a stable electronic configuration in the crystalline space-lattice must exist there in the form of ions (CN^-).

The light will exhibit antagonistic properties only when the electro-positive element set free is photo-electrically sensitive in the spectrum of fluorescence of the solid or viscous medium.

According to this all the chemical properties of the radiations enumerated above must be considered as being due to the destructive action exerted upon the *negative ions* by corpuscles of a greater or less velocity (relation of the quantum), while the antagonistic properties of fluorescence (ultra-violet, visible, or infra-red) would be due to a photo-electric effect produced starting with normal *atoms*.

These reactions may be expressed by Perrin's equation:

$$\vec{Q} + P \rightarrow P' + \vec{Q'}$$

generalized by considering P and P′ to be the negative ion and the atom of the same electo-negative element; Q as the quantum given up to the ion through the reduction of velocity undergone by the rapid corpuscle; Q′ as that of the radiation of fluorescence equal to the work of ionization done by the atom P′.

Leonardo Da Vinci as an Inventor

Remarkable Achievements in Science and Invention of the Great Italian Artist

By A. A. Hopkins

AMONG the marking characteristics of the Renaissance—aside from a love of the antique world and an equally great devotion to the fine arts—were an unbounded curiosity, a thirst for fame, and a desire to develop and perfect the individual. This desire often resulted in men's engaging in many serious pursuits and studies which passed beyond the limits of dilettanteism. Leonardo da Vinci was a true son of the Renaissance in partaking of all these tendencies, and he was one of the few in all the race to whom it has been given to stand at one and the same time as the promoter and as the representative of a new civilization.

The materials for a definitive life of Leonardo are lacking; but from his manuscripts and sketches, and from the customary sources of information—documents both plastic and written—modern criticism with tireless patience has been enabled by synthesis to construct a tolerably accurate portrait of Leonardo the man, the artist, and the discoverer.

What astounds us most in reviewing the life work of this remarkable man is his versatility. Many of his predecessors had been so gifted that they could execute masterpieces in several of the arts, any one of which would have sufficed to make their author famous; many of his successors are so great that their achievements divide the suffrages of the world; but when universality of talents and effort are considered, all must stand aside in Leonardo's favor. He is not many-sided, he is all-sided—truly *"l'uomo universale."* During his lifetime (1452-1519) every human attainment was his, and nearly every honorable pursuit, barring the commercial, was followed by him with more or less success. He had a rare combination of gifts for an artist, uniting the artistic or creative, the mechanical or inventive, and the speculative. These first two phases of his personality are usually considered incompatible; but in Leonardo these prodigious faculties were nearly always maintained in perfect equilibrium; the artist and the savant did not displace each other. He was painter, sculptor, architect, poet, musician, philosopher, psychologist, author, critic, traveler, aeronaut, mathematician, physicist, chemist, geologist, mineralogist, zoölogist, botanist, geographer, meteorologist, astronomer, anatomist, physiologist, surveyor, topographer, engineer (civil, mechanical, mining, naval, and military), and inventor!

It must not be supposed that success always attended the results of this curious intellect's delving in the great storehouse of nature; on the contrary, he was often foiled, and many of his undertakings ended in failure. He was dreamy, procrastinating, a lover of courts, the lute, and improvisation; so that his temperament was largely responsible for his failure to execute or formulate works and theories which the brain had conceived. With fewer gifts, the harvest would perhaps have been greater. The real and apparent disorder in which he left the product of his meditations resulted in an ignoring of his real claim to be heard until the modern scholar cleared away the mists which surrounded his memory.

Though probably only a fraction of his writings and sketches have come down to us still they show that science had its renaissance in Italy one hundred years before Galileo. Leonardo was the connecting link between Archimedes and the modern world, and many of the discoveries which he made remained embalmed in masses of old papers, thus giving an opportunity for men of lesser caliber to rediscover these facts and give them to the world.

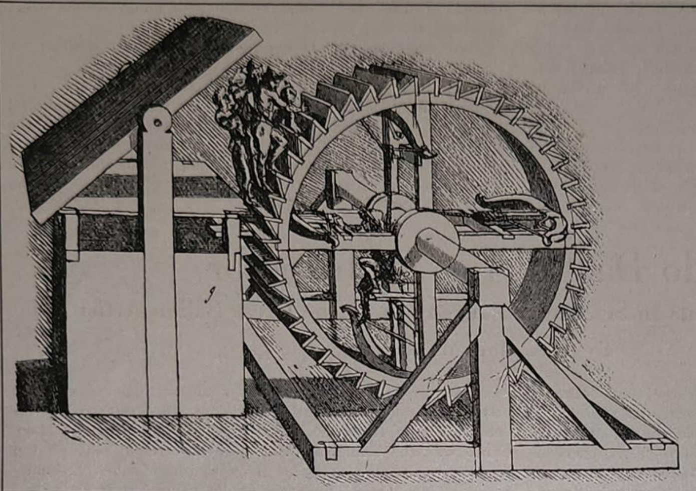
No other old master has left so many manuscripts; they consist of written memoranda with or without drawings, the latter often having no relation to the text. It is not strange when the encyclopædic nature of these writings is considered, that these manuscripts have been studied by specialists and societies of savants. The deciphering of these documents is rendered doubly difficult by Leonardo's extraordinary system of reversed writing; this matter has never been explained satisfactorily, as he wrote in the ordinary way when he chose. Still, from these bundles of old papers, the scholars who have studied them have found inedited chapter after chapter in the history of science.

Leonardo the artist—the painter, sculptor, and architect—does not come within the scope of the present article, which concerns only his scientific and mechanical achievements. It is but natural that a great thinker like him should have been fascinated and awed by the celestial world. He investigated the phenomena of the fixed stars and their luminosity. His pages concerning the moon bristle with original observations and ingenious theories. He accepted the spherical shape of the earth as an axiom; he believed also in the earth's rotation; and in a remarkable passage he says: "The sun does not move." He really forestalls Newton by indicating the universality of gravitation. He also knew of magnetic attraction, and the effect of the moon upon the tides.

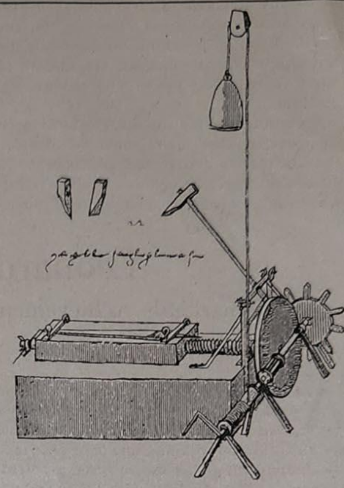
Leonardo was never tired of watching the clouds, and evidently meteorological phenomena had a fascination for him. He investigated the structure of hail, and invented the hygrometer. He also constructed instruments for measuring the flow of water and the speed of vessels.

The geological and physiographic problems of the history of our globe interested him. He seems to have had the correct theory of the elevation of continents and the true nature of fossil shells. The bulk of his writings on geography are devoted to water. He shows the true scientific spirit here, as elsewhere, in exhibiting patience and a reserve in dealing with facts which he has not himself observed.

Living as he did in the beautiful Val d' Arno with his myriads of wild flowers, it is little wonder that botanical questions should have attracted Leonardo. He collected plants, dried and pressed them; he established herbaria, and devised a method of obtaining leaf-prints which is in use today. His drawings of flowers and leaves are very numerous, and are of scientific accuracy. He studied vegetable physiology, the laws which determine the existence and multiplication of



MILITARY ENGINE DESIGNED BY LEONARDO, FORERUNNER OF THE MITRAILLEUSE



LEONARDO'S INGENIOUS FILE CUTTING MACHINE

plants. Long before the time of Grew and Malpighi he had discovered that it is possible to determine the age of a tree by means of its rings.

Vasari states that Leonardo studied anatomy under Marco Antonio delia Torre; and Leonardo's writings and drawings show that in the history of medicine he deserves a high place, his work bearing the stamp of much originality, as his drawings of anatomical subjects are ages removed from those in the medical works of his time. We have even reason to believe that he was acquainted with the circulation of the blood. He was the founder of the science of comparative anatomy; for, being struck with the analogies of the same organs in various animals, he proposed to make a systematic study of them, beginning with man, then the ape, etc. His studies led him to the unique conclusion that man is a quadruped, as the child walks on hands and feet!

He made great progress in mathematics and natural philosophy; we know that he was proficient enough in the former to assist the eminent mathematician, Paccioli. He is rather doubtfully accredited with the invention of the algebraical signs + and —. He calculated the method of finding the center of gravity of pyramids. He restored the laws of the lever; he knew the laws of impact and of friction, and the principle of virtual velocities; and he studied the time of the descent of bodies down inclined planes and circular arcs. He foreshadowed the undulatory theory of light and heat, applying the laws which govern the motion of waves to the theory of optics and acoustics.

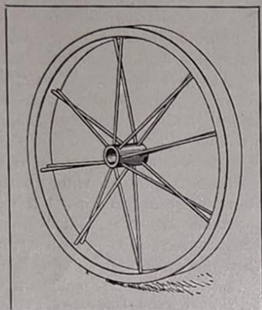
His famous "Treatise on Painting" is filled with remarkable sketches showing that he was familiar with the laws of light. It is believed by some critics that he invented the "camera obscura." It is thought that he divined the true action of the eye, the movement of the iris, and the duration of the image on the retina. He was acquainted with the facts of combustion and respiration. We owe the modern lamp chimney to him, as well as the glass water globes which are used to encircle lamps. He made curious figures out of the intestines of animals and filled them with heated air, so that they rose quickly; here was the germ of the Montgolfier balloon. Leonardo is believed to have surmised the molecular composition of water. He also devised terrible Greek fires.

Leonardo the engineer and inventor will have have a special interest to those who live in this inventive age. The rude tools of the laborer which were used by the men that Leonardo employed in carrying out his undertakings, exasperated him; and he made every effort to devise labor-saving inventions. Unfortunately, we do not know to what extent these various inventions were adopted. The position of a machine in the time of Leonardo was curious. In the petty cities and republics, machinery was the property of the State; and to betray its construction was a crime of *lèse-cite*, punishable by death. Rulers even declared wars in order to obtain the secret of a new industry; so it is little wonder that a genius like Leonardo should have been coveted by sovereigns.

In civil engineering Leonardo was so proficient that he was employed by such rulers as Cæsar Borgia. He understood the boring of tunnels and the cutting of canals, devising ingenious excavators which embanked the earth taken from the cutting. His arrangements of derricks, pulleys, screwjacks, and rolling cranes were of great interest. The obelisks in London and New York were set upright by the same means which Leonardo employed to raise a column. We possess a project by him for lifting up the Baptistry of Florence en masse and setting it on a new foundation. Bronze-casting he was also acquainted with, including piece-molding, while he had a rare knowledge of the physical properties of both metals and alloys. The few fragments on the resistance of beams which remain to us show that he was deeply versed in what we fondly consider a new science—the "strength of materials."

All his life long Leonardo seemed to be interested in water, which he describes as the "great carrier of nature." The drainage of marshes by siphons, the irrigation of land, the dredging of rivers and harbors by a rotary bucket-dredge, were planned out with infinite care for details. He devised ways for making useful a stream not navigable either by reason of too slight a depth or from liability of failure in time of drought. He proposed a series of diagonal dams with locks at the angle. Similar methods are today used on the Marne, the Seine, and other rivers. His plan for rendering the Arno navigable was rejected with scorn, but was carried out two hundred years later. He invented all kinds of water wheels, undershot, overshot, and breast; some of his wheels were placed horizontally, and the idea of the Fourneyron turbine originated with him. His schemes for raising water from a lower to a higher level are numerous and interesting and some of them are in use today. He also made sketches of swimming-machines, and he devised the precursor of the modern pneumatic life-preserver.

The stone-saw invented by Leonardo rendered quarrymen independent of natural cleavage, and saved untold time in smoothing. A similar saw is now in use at Carrara. Of the stone-saw we have over thirty rough sketches before the perspective drawing of the machine, shown in our engraving, was made. He was the true engineer, dashing off his ideas roughly at first, and afterward elaborating the machine in all its details. The file cutting machine is one of the most remarkable of his inventions. It was entirely automatic, power being provided by the descent of a weight. The file was held in place by clamps on a movable bed which brought the blank under the hammer, which delivered its blows by a tripping mechanism. A very similar machine is at present employed for the same purpose. He also designed a machine for boring out wooden pipes, as well as a saw for wood. His metal-planer does not seem to have been successful, though he had the correct idea.



LEONARDO'S SUSPENSION WHEEL

His rope-making machine possesses positive merit, while his drop forge press, door-spring, color-grinder, chimney-hood, odometer, nap-shearing machine, loom-calculations for textiles, and spinning machinery, are all remarkable. The suspension wheel invented by Leonardo is used today in the bicycle and automobile. It was a great improvement over the old "compression" wheel, the load carried upon the axle being suspended from the rim instead of being supported on the spokes which fall beneath the axle. The roasting jack which turns automatically by means of heated air is also due to him. His studies on windmills are very interesting.

Leonardo was undoubtedly the first aeronautical engineer and he may be regarded as an inventor of the helicopter and also of the basic flying machine, particularly of the one by which Lilienthal met his death. The treatment of this subject will be deferred to a later issue of the SCIENTIFIC AMERICAN MONTHLY, when it will be adequately treated with a number of highly interesting illustrations.

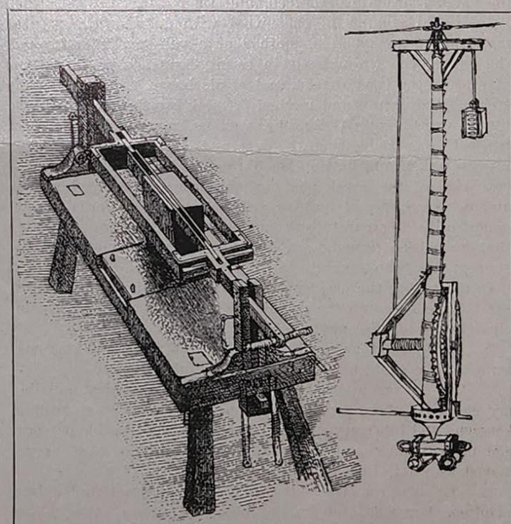
As a naval and military engineer Leonardo was truly terrible. In the memorable letter intended for the Duke of Milan, which is one of the curiosities of the Renaissance, he describes the various engines of war which he could fabricate, and the means by which he could overcome the enemy. Leonardo has left hundreds of sketches of catapults, ballista, gigantic cross-bows, breech-loading cannon, mitrailleuses, serpentine organs, and steam cannon. The breech-loading cannon antedated Leonardo, though he made substantial improvements in it. He devised breech-loading mitrailleuses for giving both a parallel and a fan-shaped fire. He it was who discovered the secret of the conical rifle-ball. The steam cannon invented by him consisted of a copper tube one-third of which was subjected to fire contained in an open basket. When the breech was very hot, water was introduced into the barrel; it was instantly vaporized, discharging the projectile with great force. The Serpollet boiler of today is built on the same plan. When it is said that Leonardo understood the principles of the very modern "built-up" gun, it may well be said that this might be called his greatest title to fame as an inventor. He has left minute sketches of guns reinforced by hoops shrunk on, of guns composed of sections welded on, and of wire guns. The latter are the most interesting. In Leonardo's designs the reel is shown around which the wire is wound. He also devised special machinery for drawing the metallic tape for use on the gun exactly to gage.

The brain whirls when the achievements of this remarkable man are reviewed. It is little wonder that the men of his time considered that there was something uncanny about him. It is not strange that Vasari should have used the word "divine" in speaking of him. Notwithstanding his performances in all the arts and sciences, he seems to have considered painting as his chief occupation in life. The artist-critic, Mr. Edwin H. Blashfield, expressed the thought with rare felicity when he wrote: "A man who had the whole book of nature open before him as the subject of his commentary, could leave a miniature here and there at most. His art was only the rubrication which made the text fairer to look at." It is perhaps fortunate that we, with our twentieth-century pride in recent victories of science, art, and invention, can look back four hundred years to the century of the "discovery of man," and see in the colossal form of Leonardo da Vinci the very incarnation of the aims and ends of the Renaissance, the springtime of the modern world.

TURNING LOSSES TO PROFITS

FORREST CRISSEY is the author of a little book entitled, "Laboratories That Turn Losses to Profits," and in it we find numerous examples of how laboratories have been able to accomplish this desirable purpose. Having often heard sarcastic comment on the small percentages of substances sometimes reported by a careful analyst, these being frequently regarded by the layman as unimportant, we cite two examples given by Mr. Crissey to emphasize again the real importance of traces.

On one occasion a dealer in molasses desired to please a distributing house and so substituted a better and more ex-



MARBLE SAWING MACHINE TRAVELING CRANE

pensive grade of molasses for one specified in a shipment which was to go to Newfoundland. Much to his surprise there was a great complaint from the consumers and an investigation was started. It seems that in Newfoundland molasses at that time was largely used for sweetening tea and they had been in the habit of buying molasses from Barbadoes where it is customary to employ only copper kettles in its manufacture. The dealer had substituted a finer quality of molasses from New Orleans and in Louisiana it is customary to boil molasses in iron kettles. Now when the merest trace of iron comes in contact with tannin a black precipitate forms, so when the users of the New Orleans molasses in Newfoundland sweetened their tea it turned black. There was no more than a trace of iron, but it was sufficient to do the damage.

Again an American manufacturer found it necessary to obtain manganese dioxime from a new source in order to fill a European order for dry batteries. Ordinarily the ore used comes from Russia and contains 80 or more per cent of manganese and one per cent or less of iron. An ore in South America was found which met this specification and was used in one million dry batteries which tested satisfactorily before shipment. Before long, however, the manufacturer received complaints and the European customer returned the shipment. Meanwhile the ore was subjected to a very careful analysis and found to contain from ten to fifteen one-hundredths of one per cent of copper. This copper was enough to do the damage for it had formed a delicate film over the zinc causing resistance to be increased to the point where the full electromotive force expected could not be delivered.

The little book is interestingly written and affords good reading to him who may still doubt the practicability of putting science on his payroll.

THE OIL SHALE INDUSTRY

THOSE who have been interested in the development of the oil shale industry would do well to read the article, "Problems of the Oil Shale Industry" by the state geologist of Colorado, R. D. George, in the December issue of *Chemical Age* (New York). In the January issue of the same publication there is a summary of the commercial development of chemical engineering in shale oil recovery which should be reviewed at the same time. This summary gives the names of the processes of which there are seventeen, and then continues with such details as the name of the owner with address, the type of material of construction, method of advancing shale through the retort, the through-put in twenty-four hours, dimensions of retorts, the type of feed, and of discharge, the size of shale treated, the nature and method of applying the fuel used, the temperature required in the various zones of the retort, method of withdrawing the gas and oil vapors during the process, when and how steam is used in the process, the present stage of the development of the process in each instance, and notes on special features. This summary affords a good opportunity for carefully comparing the different processes that have been brought out and for which in some instances support has been sought.

In discussing the problems of the oil shale industry, Professor George takes up the problem of retorting under five principal heads. These are:

"1. To convert as much as possible of the oil-making material of the shale into oil or other useful products.

"2. To secure a crude oil containing the largest possible percentage of the most valuable constituents, such as gasoline, keresene and lubricating oils, and the smallest possible percentage of worthless and harmful materials which must be removed as waste in refining.

"3. To secure a crude oil which is easily fractionated into gasoline, kerosene, lubricating oils and others, and which yields fractions of cuts which are easily refined.

"4. To secure as large a yield of ammonia and other valuable by-products as possible without sacrificing more desirable results.

"5. To reach the highest commercial efficiency without sacrificing the raw materials of the company or of the country."

After discussing these problems at some length he takes up those of refining and of by-products. Since a strong point is always made with reference to the by-products of the industry, the following is quoted from the article under discussion:

"Other By products.

"Much nonsense has been written about the many valuable by-products of oil shales. It is true that many commercial products can be made from the shales, but most of those commonly listed can be made more cheaply from other forms of raw materials. This is true of dyestuffs, medicinal salts and many other chemical substances.

"A substance resembling ichthyol has been made, but it is very doubtful that true ichthyol has been produced.

"Synthetic rubber has been much talked of but it is safe to say that nothing approaching a commercial process or a commercial quantity has been discovered.

"A substance resembling gilsonite and possibly suitable for a rubber filler may be separated from the tarry residues.

"Paraffin wax of high grade and readily marketable may be produced in commercial amount and profitably.

"Analyses of several samples of spent shale showed an average potash content of eighteen pounds per ton of spent shale. This is water-soluble, and could be leached out at little cost.

"The spent shale has been proclaimed a fertilizer, but it contains nothing of value in this way except the potash and it would be absurd to list it with fertilizers.

"It has also been talked of as raw cement material, and as brick material. It is of less than average value for either of these purposes.

"One advertiser of shale oil stock has found that it is the best of material for glass and porcelain making. This is nonsense.

"It is not even good road material and its disposition will present a problem.

"The tars, still carbons, or coke and the heavy residual oils will be utilized about the plants or converted into marketable products.

"Lubricating oils of the highest grade are made from the Scottish shale oils, and laboratory quantities of lubricating oils made from Colorado shale oils have been given extraordinary results when tested in actual use. They retain their viscosity or body at much higher temperatures than do oils of similar density and flash point made from well petroleum.

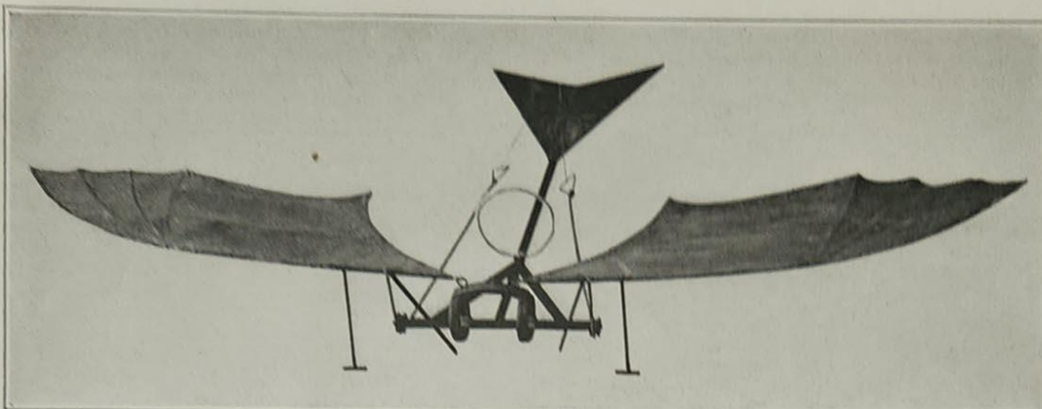
"Much information is being given out regarding the precious metal content of the spent shales. A large number of assays by thoroughly reliable and competent chemists and assayers, have failed to give a single return which could by any reasonable means be called commercial. Traces of gold were found in possibly one-half of the twenty-two tests made by the Colorado Geological Survey."

THE CRYSTAL STRUCTURE OF ICE

IN *Science* for September 24th 1920, Mr. D. M. Dennison of the Research Laboratory of the General Electric Company at Schenectady, makes a brief statement of the results of investigations on the crystal structure of ice.

X-ray photographs of ice were taken to determine its crystal structure following the method used by A. W. Hull. The lines on the film correspond to those of the hexagonal system. They show that ice has a lattice which is built up of two sets of right, triangular prisms interpenetrating one another in the following way. Consider the plane containing the bases of one of the sets of prisms. The molecules lie at the vertices of equilateral triangles of side 4.52 Ångströms. At a distance of 3.66 Ångströms above this plane lies the plane containing the bases of the second set of prisms. Here the molecules also lie at the vertices of equilateral triangles equal to those of the first set, but each molecule is situated directly above the center of one of the lower triangles. The other molecules of the crystal will lie directly above the molecules of the two planes just described at intervals of 7.32 Ångströms. The above values give an axial ratio of 1.62 in good agreement with the crystallographer's value of 1.617. From these data the number of molecules at each point has been calculated to be two.

This means that the molecule of ice must be of the form $(H_2O)_2$ or H_4O_2. The full data and calculations will be published in the *Physical Review*.



LEONARDO DA VINCI'S FLYING MACHINE A. D. 1490, FROM A MODEL IN THE U. S. NATIONAL MUSEUM AT WASHINGTON
Actual size: Length from tip to tip, 24 inches; beam, 12 inches. Total wing surface, 100 square inches.

Leonardo Da Vinci as Aviation Engineer

The Man Who First Suggested the Helicopter and the Motor to Drive Flying Machines

By Albert A. Hopkins

In the March issue of the SCIENTIFIC AMERICAN MONTHLY we touched briefly upon the achievements of Leonardo as a scientist and inventor. There was one subject—aviation—which was left for fuller treatment. This was necessary because of the immense number of drawings and great amount of data which have come down to us.

The following presentation is timely for two reasons: first, the U. S. National Museum has just recreated a model of Leonardo's approved flying machine, and second, there has been great attention recently given to the helicopter of which we have incontestable proof that Leonardo was the real inventor, as will be shown in this article.

The writer wishes at this point to thank Mr. John W. Lieb for coöperation in allowing his magnificent collection of facsimilies of Leonardo's manuscripts, works on Leonardo and other data to be drawn on freely and all the illustrations are from this source except the National Museum model. His own writings are quoted freely in the article as are also the writings of Mr. Edward McCurdy who published a classic article on the subject in the *Nineteenth Century* a few years ago.

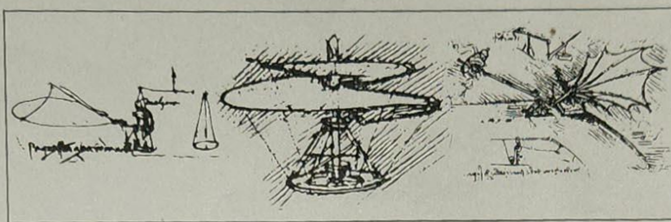
We do not know where Leonardo first obtained his idea of aerial flight, but we know he was occupied with the study of the exact workings of the forces of nature in every manifestation and of their application to human purposes. In the case of Leonardo, considered as the pioneer of the modern science of aviation, it is possible to define very narrowly the character of his researches and the nature of his conclusions. A sentence of Otto Lilienthal's, that great explorer in the realm of mechanical flight, who paid for his devotion with his life, expresses succinctly the measure of contempt which the practical inventor is apt to affect for the mere theorist however much he may be indebted to his researches: "To conceive of a flying machine is nothing, to construct one is something, but to make trial of it is everything." That Leonardo put his knowledge of theory to the proof is to be inferred from the only reference to these researches which is found in contemporary record. It occurs in the *De Subtilitate* of that somewhat empirical physician and philosopher, Jerome Cardan, who after including the invention of flight in a list of "the excellent arts which are hidden," continues: "It has turned out badly for the two who have recently made a trial of it: Leonardo da Vinci, of whom I have spoken, has attempted to fly, but he was not successful; he was a great painter." The laconic antithesis suggests—it almost summarizes—the attitude of contemporary criticism with regard to Leonardo's scientific and mechanical pursuits. The standpoint is the same as that of Vasari, who regarded them as deviations from those purposes which Leonardo alone could accomplish. The criticism has been justified by the march of events. One by one the mechanical and scientific problems to which a great part of Leonardo's creative power was devoted have been solved. He stands revealed as "the forerunner."

The researches on the science of flight which Leonardo's manuscripts contain are of themselves sufficient to reveal the unflagging zeal with which he devoted himself to the study of primary causes. The subject has given its name to one of the two of his treatises which exist in a more or less complete form (*Il Codice Sul Volo degli Uccelli*); but this would seem to be only an early draft of the results of his observations. It is also treated of in the *Codice Atlantico*, and in seven of the twelve Leonardo manuscripts which are now in Paris in the Library of the Institut de France. Some of these references consist of a few lines, or a diagram with a brief note in explanation, but many consist of pages or half-pages of closely written matter, the contents of which are far more voluminous than the writings of any other student of the subject down to Leonardo's time.

The material falls naturally into two groups, the first being a series of investigations of the laws which govern the power of flight as manifested in nature by birds and other winged creatures, the second consisting of deductions from these principles in the construction of a mechanism which should be capable of sustaining man and being worked by him. The interdependence of the two parts of the inquiry is stated with great succinctness in a passage in the *Codice Atlantico:*

"A bird is an instrument working according to mathematical law, which instrument it is within the capacity of man to reproduce with all its movements, but not with a corresponding degree of strength, though it is deficient only in the power of maintaining equilibrium. We may therefore say that such an instrument constructed by man is lacking in nothing except the life of the bird, and this life must needs be supplied from that of man.

"The life which resides in the bird's members will without doubt better conform to their needs than will that of man which is separated from them, and especially in the almost imperceptible movements which preserve equilibrium. But since we see that the bird is equipped for many obvious varieties of movements, we are able from this experience to deduce that the rudimentary of these movements will be capable of being comprehended by man's understanding, and that he will to a great extent be able to provide against the destruction of that instrument of which he has himself become the living principle and the propeller."



SUGGESTIONS FOR WEIGHING WIND PRESSURE

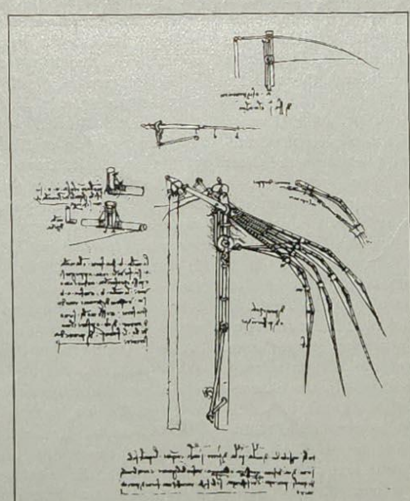
HELICOPTER OR FLYING MACHINE FOR RISING VERTICALLY

MACHINE FOR TESTING WINGS OF VARIOUS SHAPES

Flight is a natural phenomenon, and consequently its laws are to be deduced by observation of nature. In acting on this principle Leonardo followed the course marked out by Aristotle in the chapters on the flight of birds in the treatise "On the Method of Progression of Animals," with which treatise it is at least reasonable to suppose him to have been somewhat acquainted.

References to Aristotle in his manuscripts are more numerous than to any other classical writer, and a note in the *Codice Atlantico* allows us to infer that he either possessed or had access to translations in manuscript or works which had not then been printed.

"In order (he says) to give the true science of the movement of birds in the air, it is necessary to give first the science of the winds, which we shall prove by means of the movements of the water: this science is in itself obvious to the senses; it will serve as a ladder to arrive at the knowledge of winged creatures in the air and the wind."



MECHANISM FOR A VERTICAL FLYING MACHINE, DRIVEN BY CRANKS WITH SUPPLEMENTARY WING FLEXURE OR WARPING

And again:

"Of the bird's movement—in order to speak of this subject it is necessary that in the first book you treat of the nature of the resistance of the air; in the second the anatomy of the bird and of its feathers; in the third the action of these feathers in various of its movements; in the fourth the strength of the wings and tail without beating the wings with the help of the wind to serve as guide in various movements."

And again:

"Before writing about winged creatures, make a book about how inanimate things descend through the air without wind, and another about their descent with the wind."

In treating of the science of the winds he shows how the wind varies in power according to its altitude, as is proved by the fact that birds always fly low when the course of the wind is contrary. The movement of the wind is similar in all respects to that of the water. The rudder behind the ship is copied from the tail of birds; and swimming upon the water teaches men how birds float on the air.

He also defines the resistance of the air, and shows how there is as much pressure exerted by a substance against the air as by the air against the substance; and he shows how the fact of a bird remaining motionless on its wings in the air is due to an equilibrium of forces; and he illustrates how the air beneath the movable substance which descends in it is compressed and the air above it is rarefied.

In his designs we find worked out in small detail, particularly as to the wings and mechanisms for operating and balancing, flying machines with two and four wings, operated by one or more persons with and without mechanical propelling power. We find some driven by spring motors, some by the arms and legs of the operator while lying prone or standing upright. We also find interesting sketches for a screw flying machine or helicopter and a sketch with descriptive details of a parachute.

In reading over the following extract and comparing it with the latest theories of airplane design, we cannot but feel that Leonardo was certainly well aware of the principles underlying aerial flight, in this detail if in no other.

"*To Escape the Peril of Destruction When Flying.*—The destruction of such instruments can happen in two ways, of which the first is that the instrument may break apart; the second would be if the instrument turned itself on edge or nearly on edge, because it should always descend on a very oblique path and nearly on a horizontal line."

We do not know today how many of Leonardo da Vinci's sketches and drawings were actually original designs or inventions, or how many were merely sketches to aid his memory of things he had seen. We do know that some small portion of the material given by Leonardo was not original with him, he having specifically mentioned that this or that device or idea was previously used by such and such a people or individual.

It would appear to Mr. Lieb, however, from a study of the manuscripts from an engineering standpoint, that so many of the sketches contain detailed calculations of weights, power required, etc., and so many others contain practical hints, which are really shop instructions for construction and operation, and that many of them could not have been the result of mere observation of apparatus constructed by others, but must have been the result of practical experiment and experience with actual apparatus under working conditions, supporting the contention that a very large part of the sketches are original designs and represent machines actually constructed by him or under his direction.

The first model of a flying machine took the form of a pair of large wings worked by means of the arms, or arms and legs, and attached to the body by a band which passed beneath the armpits.

The type in nature which Leonardo selected to serve as a model was the bat, "because its membranes serve as an armor, or rather as a means of binding together the pieces of its armor, that is the framework of the wings." (*Sul Volo d. Uccelli.*) He admits that the wings of feathered creatures are more powerful in structure of bone and sinew, but attributes this to the fact that they are penetrable; that is, that the feathers are separated so that the air passes through them, whereas the bat is aided by its membrane, which is not penetrated by the air.

He has also shown that birds like the lark which fly high with the rising of their wings, because these are then pierced through with air, have their feathers spread out more widely than birds of prey which can only rise by a spiral or circular movement. He attempted, therefore, to combine both types by making the wing of the instrument like that of the lark as it rises and like that of the bat as it descends—or, as he calls it, "a method by which the wing is full of holes as it rises and closed up when it falls." This he did by attaching various shutters (*sportelli*) to the surface of the wing. A net connected the framework of the wing to the bamboo canes on which the shutters were fastened along their length on the one side, and on the other side were attached to them by cords at either end. The shutters had rims of cane and were covered over with taffeta, which had been either well soaped or rubbed with starch to render it airtight. As the wing rose the air would pass through the net, and force open the shutter to the extent allowed by the cords. As the wing descended the air below it would drive the shutter up against the net, and so close up the holes, and this would cause the wing to present a solid surface to the air beneath it. He considered that in proportion as the shutters were smaller so they were more useful.

In the second type the instrument has something of the appearance of the body of a huge dragon-fly, tapering slightly toward the tail, and the framework of the wings arched above the head resembles antennæ. Within the body the aeronaut lies at full length, face downward. His feet are in stirrups, which work the wings by means of cords, one of these causing them to fall and the other to rise. Round the neck is a leather band to which a cord is attached, described as "a rudder which is fixed with a band to the head at the place of the neck." The position of the instrument he states to be such that the wings in descending drop partly downward and partly backward, that is toward the feet of the man. The necessity of increasing the power of control led him so to change the mechanism that the wings were lowered by the force of both feet at one and the same time. By this means the downward pressure becomes twice as great and "you are able to delay and to maintain yourself in equilibrium by lowering one wing more rapidly than the other, according to necessity, as you see done by the kite and other birds."

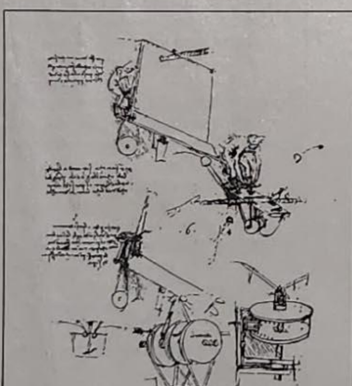
FLYING MACHINE USING ARMS AND LEGS, OPERATOR LYING PRONE, MANEUVERING TAIL BY OPERATOR'S HEAD

The raising of the wings will then, he says, either be by the force of a spring, or by the hand, or by drawing the feet toward you, the last being the best method, because then the hands are left free.

In a passage in the *Sul Volo degli Uccelli* he says that a man in a flying machine should be free from the waist downward to be able to balance as in a boat, so that his center of gravity may balance that of the machine.

With the various drawings of instruments are notes as to the materials of which the parts are to be constructed. Sometimes a word or more is written in the particular part itself, such as "staff of green pine," "fustian," "taffeta," "try first with leaves of chancery," which latter may be interpreted to mean a form of parchment. Two parts of the covering of a wing are described, one as of "fustian stuck over with feathers," the other of "starched taffeta," and "for the experiment," he continues, "you will use fine pasteboard."

The same forethought prompts a note that the machine should be tried over a lake, and that a long leather bottle

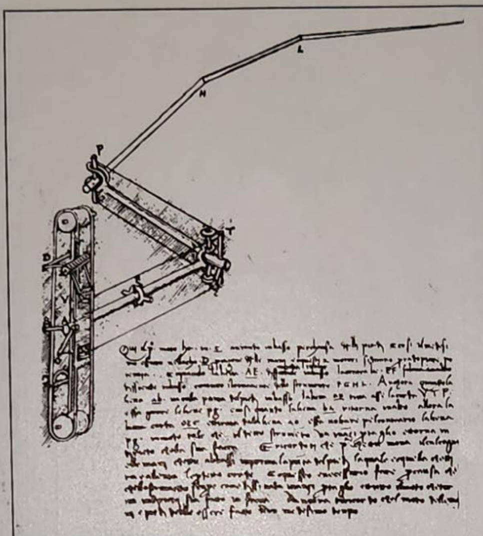


SKETCHES GIVING DETAILS OF THE MANUALLY OPERATED MECHANISM OF THE FLYING MACHINE

FOLDING LADDER WITH SHOCK ABSORBER FOR LANDING, SHOWING COLLAPSIBLE MECHANISM

A FOUR-WING FLYING MACHINE. OPERATOR STANDING, WITH HEMISPHERICAL BASE AND LANDING should be carried in the girdle as a safeguard against drowning in case of a fall; and again, in writing of another type of machine, he says: "Try the actual instrument in the water so that if you fall you will not do yourself any harm."

The various notes and drawings which relate to what was probably the latest type of the machine are among the most difficult to interpret. The machinery, although more compact, has become more complicated, and an attempt to define the practical value of the parts of it is only possible to the practised student of mechanics. A drawing of a man suspended by the waist, in an attitude as though swimming immediately below the drum round which the cord is turned, is apparently a preliminary to this latest type: the note below it describes how it may be worked either with one pair of wings or with two, and refers to a ladder or ladders of light thin pine at the base. These ladders are found only in the latest type of the instrument, and he defines their use as serving the purpose of legs when it is desired to rise above a plain, and so rendering it possible to beat the wings. He mentions the instance of the martin, which cannot raise itself by flying when settled on the ground, because it has short legs. A drawing shows how, after the ascent had been commenced, the ladders are to be drawn up so that they lie flat against the bottom of the instrument. They are made with curved ends in order, apparently, to lessen the risk of their becoming fixed in the ground.



DRIVING AND FLEXING MECHANISM FOR WINGS, WITH UNIVERSAL JOINT

"I conclude (he says) that standing upright is more useful than flat on one's face, because the machine can never turn upside down, and moreover the habit created by long use requires it thus. And the rising and falling of the movement will proceed from the lowering and raising of the two legs, and this is of great force, and the hands remain free, and if one had to be flat on one's face the legs in the fastenings of the thighs would have great difficulty in supporting themselves; and the feet have the first shock when it alights."

A drawing in MS. B of the Institute is the most complete representation of this type of the instrument. In it the figure of the man is seen standing on his feet, but bowed like Atlas under his burden.

Above him are two pairs of wings, which are worked by cords and pulleys controlled by his head and limbs. He is placed between two posts, which support a wheel at the top. Cords passed round it raise and lower the wings as the wheel moves. The posts descend to the base of a low basket-shaped car, where are pedals on which the man stands. These pedals are connected by cords with the wings. The car is resting on short ladders.

On a page of MS. B of the Institute is a drawing of a large screw constructed to revolve round a vertical axis. The notes at the side and below the drawing tell of the materials and dimensions, and reveal also the purpose which it was intended to serve.

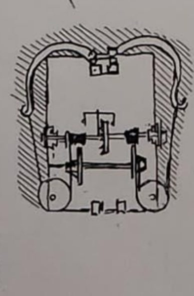
In its general outline this instrument has some resemblance to certain examples of the type known as helicopters. But both in this and in the earlier model, of which the general structure has somewhat more resemblance to certain types of the modern airplane, the only motive power to be discerned is derived directly from the strength of the human agent. The capacity of the instrument to overcome the resistance of the air is the capacity of his muscles to lift weights and to endure pressure, transferred to this particular purpose by the use of suitable implements. Numerous passages in the manuscripts show that Leonardo doubted the adequacy of this power to accomplish more than short experimental flights. He contrasted it with that reserve of power possessed by the larger birds, and he sought for a fresh source of motive power to supplement or take the place of that exerted by man.

M. Govi, who first called attention to the significance of these passages in a paper presented to the French Academie des Sciences, speaks of them as proving not only that Leonardo invented the screw-propeller, but that he had considered its application to aerial navigation, and that he had constructed small paper models for this purpose which were set in motion by fine bent steel wires.

The function of springs in the machinery of some of the flying machines is shown in two important drawings of a flying machine on a page of the *Codice Atlantico*. These show a machine of the vertical type with a planimetric sketch of the base, within which is written *fondamento del moto*. These, together with an elaborate study of the mechanism of the right wing represent the ultimate stage of the conception as found in the manuscripts —which stage is separated from those which preceded it by the addition of mechanical motive power. To this instrument the architect, Luca Beltrami, does not hesitate to apply the word "aeroplane."

"The apparatus consists of a rectangular horizontal plane, from the middle of the longer sides of which rise two vertical struts made firm by two sup-

A REAL "AIRPLANE," SHOWING IN DETAIL, MECHANISM OF SPRING MOTOR



"FONDAMENTO DEL MOTO"

[f]ollows: Straight air-operated shovels that throw over in a vertical plane. The Armstrong is an example of an operative machine of this type. Small revolving power shovels, operated by air engines or electric motors. The Hoar and Thew are typical. Machines with a digging element in front, delivering upon a conveyor that discharges into a car. These are represented by the Myers-Whaley, the Halby, and the McDermott.

FIG. 24. SLUSHING UNDERGROUND USING TAIL ROPE, JOPLIN DISTRICT

It is still a question whether or not the machine should be self-propelled. That would seem to depend upon the weight of the machine and whether electric motors are available for moving the machine from place to place. Self-propulsion necessarily involves a complexity of mechanism to be avoided if possible.

Continuously moving parts and continuously moving motors would seem to be conducive to wear and loss of power. A machine of the revolving shovel type operated by direct-acting air cylinders would appear to offer possibilities, but at the same time present many mechanical difficulties. But the field is big enough, the conditions are so variable, and the demand is so insistent that there is little doubt that several types of machine will be developed, giving the mine owner a reasonably wide latitude from which to pick and choose, and reducing the labor of underground loading, with what effect upon the cost sheet remains to be seen.

TEARING STRENGTH OF PAPER.

That there is no relation between the actual tearing strength or toughness of paper and the values obtained with the commonly-used paper testers is indicated by the results of recent experiments at the Forest Products Laboratory. The method of test, employing a Schopper tensile strength tester, demonstrated that the toughness of paper can be numerically measured, but that the pop test, breaking length, percentage stretch, and number of folds give very little information about this property.

The following table gives the tearing strength of various papers in grams as determined by the laboratory method and the value obtained in the commonly-used tests:

Kind of Paper	Weight of Ream 24x36	Pop Test	Breaking Length	Stretch	Folds	Tearing Strength
	Lbs.	Lbs. per Sq. Inch	Meters	Per Cent	No.	Grams
News sheet	28	8	2,915	1.0	1	17
Steamed groundwood (brittle)	34	14	4,584	1.5	5	21
Tough kraft (soft feel)	41	44	6,670	3.6	3,020	80
Hard kraft (tinny feel)	52	38	5,320	5.0	556	73
Litho (bleached) sulphate)	44	25	4,860	2.9	248	83
Bond (all rag)	38	37	5,[illegible]63	5.31	798	88
Ledger (all rag)	87	110	6,335	6.1	2,436	167

OUR OVERBUILT PETROLEUM-REFINERY CAPACITY.

Figures recently compiled by the Bureau of Mines, Department of the Interior, show that the petroleum-refinery capacity of the United States is considerably overbuilt. At the present time the refineries have a total rated capacity 50 per cent in excess of the refinable oil supplies, which will be near 80 per cent when the refineries now building are completed.

The oil runs to the refineries of the United States for the year 1919 were 361,520,153 barrels of crude oil, or, 990,466 barrels per day. In December, 1919, the refineries in operation had a daily capacity of 1,356,355 barrels per day, whereas, the daily run of crude oil to the stills was 1,046,052 barrels, indicating that they are running at only 73 per cent of their rated capacity.

It is evident that larger supplies of refinable crude oil are needed by the refineries which are now in active competition in the purchasing of crude oil in the open market. This competition for oil to keep the refineries in full operation has doubtless been one of the influences in the recent advances of crude oil in the United States. Crude oil in the Mid-

FIG. 25. EVANS SCRAPER IN USE IN A COAL MINE

Continent field, which produces some two-thirds of the refinable oil in the country, has advanced from $2.25 per barrel to $3.50 per barrel in the last few months.

A complete list of the refineries, their locations, and the daily capacities, has recently been compiled by H. F. Mason, Petroleum Economist of the Bureau, Washington, D. C.

within narrow temperature limits. The lower limit is, of course, that at which the bath solidifies. If the temperature is raised too much above the melting point of the bath, the bath acquires the property of scattering small drops of the molten metal all through it, and these drops, coming in contact with the other electrode, are there burned, thereby causing a great loss in current efficiency. If the caustic soda bath is heated 40° above the melting point, absolutely no yield of sodium is obtained, no matter how much current is passed through the cell. With aluminum the temperature limits are considerably wider; but it is desirable not to go more than 60° or 70° above the melting point of the bath.

In the preparation of metallic phosphorus and metallic zinc we have a very different problem in regard to drops. These two substances are distilled from the furnace and are condensed from the vapor form outside the furnace. If either of them becomes oxidized, there is formed a surface film around the drops, and we do not get a compact material. In the case of zinc, the product that is obtained, in case things go wrong, is called blue powder, and contains only 85 per cent zinc.

An emulsion consists of drops of liquid suspended in a second liquid. If we use the generic term oil to signify any liquid which is not mixable with water, we may say that we have two types of emulsions, the one being drops of oil suspended in water, and the other being drops of water suspended in oil. Milk is an emulsion of butter fat in water; butter is an emulsion of water in butter fat. Mayonnaise is an emulsion of oil in water, and so is cod liver oil. Lanolin is an emulsion of water in purified wool fat, and may contain as high as 80 per cent of water. One man has recently taken out a patent for making cheaper printing inks by diluting them with lanolin and water. This is merely producing an emulsion of water in the lanolin and oil which acts as a vehicle for the pigment of the printing inks.

It is, of course, important to know under what conditions one gets an emulsion of oil in water or of water in oil. The general belief is that this is determined by the relative amounts of oil and water, one getting an emulsion of oil in water when using relaitvely little oil, and of water in oil when using a large excess of oil. Recent investigations have shown that this is not so, and that the ordinary emulsions consist of oil, water, and a third substance which forms a film around the drops. The nature of this substance determines the type of the emulsion absolutely, and the relative amounts of oil and water have nothing to do with it. Under certain circumstances we can predict without any difficulty which type of emulsion will be formed. If we have a substance which forms what is called a colloidal solution in water and which is absorbed by oil, this substance will form a film around the oil and give us an emulsion of oil in water. If the third substance forms a colloidal solution in oil and is adsorbed by water, it will emulsify the water in the oil. Typical cases are to be found with the sodium and calcium soaps. The sodium soaps form colloidal solutions in water and do not dissolve in oil. Consequently they emulsify oil in water. The gums act in a similar manner. On the other hand, the calcium soaps form colloidal solutions in oils and not in water. Consequently they may be used to emulsify water in oil. Rosin acts in a similar manner, and in the old days ready-mixed paints used to be adulterated very largely with water, even up to 80 per cent in some cases, the water being emulsified in the linseed oil by the rosin which is always present.

A dilute emulsion is distinctly fluid; but a concentrated emulsion may behave exactly like a solid. Pickering, in England, emulsified 99 per cent of kerosene by volume in one volume of water containing soap. This gave him a stiff jelly which could be cut with a knife and the cubes would stand alone. He noticed the curious thing, that when these solid cubes were left standing in dry air, they liquefied. The reason for this was that the water in the soap films evaporated and the emulsion consequently cracked, setting free the kerosene. The mass did not become liquid because it had taken up water, but because it had lost water. The solid alcohol, which is so popular nowadays, is not an emulsion, although it does contain water. It is, more properly speaking, a jelly.

The books on lubrication tell of an experiment which bothers the authors very much. If one starts with a heavy mineral oil containing a considerable percentage of a calcium soap, and adds water to it, it was expected that the mixture would be more fluid than the original oil, because water is much more mobile than the mineral oil. Instead of that happening, however, the whole mass became solid, giving a grease instead of an oil. The reason for this is very clear to anybody who knows about emulsions. Owing to the presence of the calcium soap, the water was emulsified in the oil, and when enough water had been added a semi-solid grease was formed, just as Pickering had found with intermediate concentrations of kerosene in water.

The pharmacists make a great use of emulsions, and the books on pharmacy are filled with elaborate descriptions as to the methods of making them. The usual way is to dissolve the gum which is used as an emulsifying medium in the water, place this in a mortar, and then add the oil a little at a time with continuous stirring. The chemist is trained to use vessels which seem to stand in some proportion to the amount of substance that he is using. On the other hand, the pharmacists lay down the rule that one must use a very large mortar, the more nearly the size of a bath tub the better. They are also very particular about the way that the mixture shall be stirred. If one starts stirring to the right, one must continue stirring to the right, or no emulsion will be formed. Some books go so far as to say that a left-handed man cannot make an emulsion, which seems a bit absurd. Many of the precautions given by the pharmacists seem foolish; but, on the whole, empirical rules, which have stood the test of years, usually prove to have some foundation, although the reasons given for them may be entirely wrong. This is the case with emulsion-making.

When the chemists started to make emulsions, they said that it ought to be much simpler to add all the oil at once and to shake by machine instead of stirring by hand. This did work well for the dilute emulsions, but it was found that no amount of shaking would give a very concentrated emulsion. At first the chemist thought that this was due to inefficient shaking, and he devised a much better shaking machine, which, however, gave practically the same results. It was then found that if one put the mixture in a bottle, shook it by hand for a few times, allowed it to settle, and then shook again, this intermittent shaking gave results which could not be obtained by doing a thousand times as much work with a shaking machine. It was then clear that one reason why the pharmacist had added the oil a little at a time was because this was equivalent to intermittent stirring, for he stopped between times. Since it is necessary to break the oil up into drops or thin films in order to get a good emulsion, the pharmacist had used a mortar which appeared much too large, because he then spread the mixture over the whole surface of the water, thereby giving him a thin film and consequently a rapid emulsification. We now know the reasons for the pharmacist acting as he did, and we can also get the same results with much less effort.

This experience threw some light on the preparation of mayonnaise. As everybody knows, the making of mayonnaise is a thing which the average housewife approaches with fear and trembling. Everything has to be just so or else the mayonnaise will not come out successfully. Since mayonnaise is essentially an emulsion of oil in water with white of egg as the emulsifying agent, it ought to behave like any other emulsion. The experts in the Departments of Home Economics have no difficulties with mayonnaise. They can add the ingredients in any order; they can add them all at once or in separate portions; they can add them hot or cold; and I know one expert who could actually make a mayonnaise using the yolk of a hard-boiled egg instead of the white of egg. It was not a very pretty mayonnaise, because it was distinctly granular and looked like the end of a needle when seen under the microscope; but there was no question about its being mayonnaise. On the other hand, these same experts are not able to tell their pupils how to make mayonnaise successfully every time. This means that there is something or other which they do unconsciously and which consequently they cannot tell to their pupils. The experiments with the intermittent shaking seem to give a clue to this difficulty. The expert is so sure of the result that she probably works leisurely and without being hurried or flurried. On the other hand, the person who is not an expert and who is uncertain about the outcome, probably goes at the thing so vigorously as to defeat her own object in many cases. This has not been tested as yet; but I have been told by one expert that she had found that if the materials were beaten well together and then allowed to stand for a moment or two, a couple of swishes would make the mayonnaise. Instead of the conclusion of the pharmacists that a left-handed man cannot make an emulsion, it would probably be more correct to say that a nervous woman cannot make mayonnaise.

The behavior of sodium and calcium salts in emulsion-making throws light on some problems in physiology which had bothered people a great deal. Jacques Loeb and his pupils had found that certain marine organisms died when put into fresh water. This was not surprising, and the explanation that was offered was that the water passed into the organisms, causing them to swell and burst, which was of course fatal. This osmotic pressure explanation, as it was called, came to grief because it was found that the organisms died quite as rapidly if they were put in a sodium chloride or a calcium chloride solution having the same osmotic pressure as sea water. This could not be accounted for on the basis of osmotic pressure. On the other hand, the organisms which died in pure sodium chloride solutions or in pure calcium chloride solutions lived when they were placed in a solution having a definite ratio of sodium chloride to calcium chloride. The explanation has been given by Clowes. If we consider protoplasm as consisting of lipoid materials, which we will call oil, and water, we shall have an emulsion of oil in water in presence of sodium salts, and an emulsion of water in oil in presence of calcium salts. When the sodium and calcium salts are present in a definite ratio, there will be a balancing between these two types of emulsions, and it may well be that this critical state is the one which is conducive to life and growth. As a matter of fact, Clowes found that the ratio of sodium and calcium salts necessary to produce a balancing between the two types of emulsions when working with oil, water and soap, was practically the same as that found in sea water. This shows a very close connection between the two sets of phenomena. Osterhout, at Harvard, has shown that the specific electric conductivity of certain tissues is increased by addition of sodium salts and decreased by the addition of calcium salts. If the hypothetical emulsion changed to one of oil in water, the conductivity should increase, and it should decrease if the emulsion changed to one of water in oil. Clowes has succeeded in duplicating Osterhout's results by impregnating filter paper with an emulsion of oil, water and soap, to which he afterwards added sodium and calcium salts.

GRAINS.

If we take spherical shot and place them in a box so that they are packed uniformly, mathematics shows that so long as the shot are uniform, we get the same amount of metal in the box regardless of the side of the shot. If we add shot of two different sizes, the fine shot goes into the voids left by the coarse ones and we get more shot in the box. If we work with very fine powders, we get a different result, because the finest particles do not pass into the voids left by the coarser powders, but coat the coarser powders. A well-known case of this is sugar and blue-berries. C. G. Fink, who was then with the Harrison Works of the General Electric Company, and who is now Director of Research for the Chile Exploration Company, took equal mixtures of metallic tungsten, which forms a black powder conducting electricity, and of thoria, which form a white powder which does not conduct electricity. If the thoria powder was relatively fine and the tungsten powder relatively coarse, the thoria coated the tungsten and Fink obtained a white powder which did not conduct electricity. If the tungsten was relatively fine and the thoria powder relatively coarse, he obtained a black powder which conducted electricity.

If one mixes a coarse white powder with a very fine red powder, the red powder will coat the white grains and the mass will look almost as red as though it were made of the red powder alone. If the red powder is relatively coarse and the white powder relatively fine, the white powder will coat the red and will mask its color practically completely. This has been known empirically to the paint-makers for a long time, though they have not known the reason for their practice. They are in the habit of adding ground barytes, which is a white powder, as a filler for red paints. They say that precipitated barium sulphate cannot be used. Since barytes is a natural, and consequently impure, barium sulphate, this statement seems to the chemist at first quite inexplicable. The explanation is a very simple one. The precipitated barium sulphate is very much finer than the ground barytes and consequently not so much can be added without interfering with the red color of the pigment.

A flat surface may be considered as a piece of a grain of infinite size. If we look at the reagent bottles in a chemical laboratory, we shall find that some of those which contain solid powders are dirty on the inside. In all cases those will prove to be the ones containing the finest powders, which are able to stick to the glass surface. The same principle of a fine powder sticking to a coarse powder or to a surface is involved when we write with pencil on paper or with chalk on a black board, the only difference being that the paper surface and the black board surface are fairly rough, so that they help to rub off pieces of the pencil or of the chalk. If the piece of chalk which breaks off is too coarse, it will not stick to the black board but falls to the ground.

The ceramic industry depends on the behavior of grains. If we take the clay and burn it, the grains sinter together and we get a porous plate, a brick, or earthenware, as the case may be. If we put in some fusible material, we get the various grades of china and of porcelain. In fact, porcelain may be considered essentially as a silica glass made translucent by grains of the aluminum silicate known as sillimanite. If the whole mass fuses so that the grains disappear, we have a glass. The opaque enamels are glasses in which are suspended white grains of tin oxide, zirconia, or other suitable material. In the case of cement, the clinker is ground to a powder and it is the resulting grains which are used for building purposes.

Porous charcoal is a granular material which came into prominence during the war, because of its use in gas-masks to stop toxic gases. The use of other porous materials, such as pulverulent platinum and nickel, is very important both in times of peace and war, on account of their power to accelerate reactions. The manufacturer of sulphuric acid, ammonia, nitric acid, and hardened oils illustrates the importance of such granular materials, and the list could be extended indefinitely.

Smoke consists of solid particles, usually carbonaceous, suspended in the air; but we also include under the general heading of smoke the solid particles from the fumes of smelters. The Cottrell electrical process enables us to remove the solid and liquid particles from these fumes, and this has proved very effective in California, where people insisted on making cement in the midst of orange groves. The dust thus recovered at cement plants bids fair to be an important source of potash. While the Cottrell process takes the solid and liquid particles out of the smelter fumes, it does not solve the problem completely so far as the farmers are concerned, because it will not remove the gaseous sulphur dioxide which also damages the crops. At the Washoe smelter of the Anaconda Company, the Cottrell process involves the use of 111 miles of chains merely to make one set of electrodes, the other set being composed of huge plates. This means a possible recovery of 35 tons of arsenic per day.

The flames of burning fires, candles, lamps, and gas jets owe their luminescence to the presence of incandescent particles of carbonaceous material. This can be shown by putting a chilled dish down into the flame, in which case one gets a deposit of soot on the cooled surface. When we put different salts into the gas flame of a bunsen burner, we may get different colors, yellow with sodium, blue or green with copper, and red with lithium. Since the temperatures of these films are, or may be, all the same, the difference in the colors cannot be a question of temperature and must therefore be due to a chemical reaction. It seems probable therefore that with a copper salt, for instance, we have a salt breaking up at the high temperatures into metallic copper, and that the color is due to the alternating formation and decomposition of a copper salt. In order to prove this, one must show that metallic copper is really present in the flame. This can be done easily in a way quite similar to that used for showing the presence of soot in the ordinary flame. If we let cold water run through a porcelain tube and then place this porcelain tube in a flame colored green by a copper salt, we shall get a beautiful deposit of metallic copper upon the porcelain. Similar results can be obtained with salts of the other metals. In some cases, as with tungsten salts, no metal can be obtained when using the bunsen burner, because the temperature is not high enough. By putting these salts in the oxyhydrogen flame, it is possible to obtain a deposit of metallic tungsten on the porcelain tube. Of course, this suggests a wonderful possibility in perpetual motion. All one has to do is to burn coal and air to carbon dioxide, heat the carbon dioxide to a temperature at which it will break down to carbon and oxygen, collect the two and burn them over again. This could actually be done, but of course not economically.

In the photographic plate we have grains of silver bromide dispersed in a gelatine film. It is the gelatine adsorbed by the grains of silver bromide which determines the speed of the plate; it is the silver adsorbed by the grains of silver bromide which gives rise to the latent image; and it is the reducing agent or developer adsorbed by the latent image which makes the picture.

Reference has been made to the fact that a film may be considered as made up of coalesced grains or drops. These may also be very important in many cases. Aluminum should be oxidized very readily and should, theoretically, be of no value for everyday use. As a matter of fact, there is formed on the surface a film which protects the aluminum from further chemical action. The same thing occurs with nickel. If iron rust formed a coherent film which protected the metal, rust would not be a serious phenomenon with iron any more than it is with aluminum or nickel.

One of the important things in chemistry is to make use of the waste products. As has been stated, blue powder consists of 85 per cent zinc. By heating this in presence of iron, some of the zinc sublimes over and condenses on the iron, giving a galvanized surface. The process is known as sherardizing, from the man who invented it. It has become so important that the supply of blue powder is not sufficient for the needs, and it is necessary to make a zinc powder from good zinc in order to keep pace with the demand.

When we put oil on a road, the oil forms films around the grains of the road material and binds them together. We do the same thing in making foundry cores, except that there we use an oil-water emulsion instead of oil alone. If the liquid film is of a suitable thickness, the mass becomes plastic. In making fondant, the two important things are to heat the mixture so as to change just enough of the sugar over into a non-crystallizable form, and to stir so rapidly that the sugar which does crystallize comes down in very fine grains, coated with a syrupy film due to the invert sugar. That gives us a plastic mass having the desired properties. When pigments are mixed with linseed oil, we get a plastic mass, in which the linseed oil finally dries to a solid material, which holds the pigment to the material painted and which forms a protecting film over the surface of the material. In the case of glue and other adhesives, we have a liquid film which gradually solidifies and which is used to hold the two surfaces together. In the case of varnishes and lacquers, we have a liquid film applied to a surface and which dries finally to a solid film, which is both protective and decorative.

These illustrations are probably sufficient to show the importance of bubbles, drops and grains, which are the subjects of study of colloid chemistry. It is not too much to say that colloid chemistry is the chemistry of everyday life.

GOVERNMENT MAPS.

By Edward B. Matthews,
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The bringing together of men from all parts of the country at Plattsburg, and later in the various cantonments and officer training camps, awakened in them a new interest in geography and in the study of maps, which had lain dormant or become atrophied since boyhood days. More than one officer-in-embryo, lost in the woods with a small detachment, found that he could work his way out by the map which he had in his equipment. At first he regarded the curved brown lines as a nuisance detracting from the clearness of the map, but soon he learned to prize them as a picture of the hills and valleys, and a prophet of the roughness of his coming "hike." To many this was the first introduction to the topographic map of the United States. Some few had learned of these maps in automobiling, but practically none of the boys, except a few collegians knew anything of how the maps are made or of the work which the Government is doing to produce and supply accurate topographic maps of its vast domain.

The topographic branch of the U. S. Geological Survey was organized about thirty years ago through the consolidation of previous organizations for surveying the territory west of the 100th meridian—the Rocky Mountains, and the regions westward to the Pacific Coast. The initial aim was the preparation of a geological map of the public lands to assist in the development of the natural resources of this vast and sparsely settled region. But the need of good maps for all the country immediately led to an extension of the service to include the whole nation. The present aim of the geological survey is to cover the United States with a general utility map, supplementing this with special purpose surveys on larger scales when such are necessary. In spite of thirty years of activity only 43 per cent of the area of the United States has yet been covered by standard topographic maps and a fifth of these now need revision. It is estimated that it will require nearly fifty million dollars and fifteen to twenty years to complete the map, though the work can be done in twelve years if Congress makes the necessary appropriations.

Besides the Geological Survey, there are thirteen other Federal map-making organizations with more or less complete technical staffs and separate appropriations, as follows:

1. *The U. S. Coast and Geodetic Survey* prepares coast charts and larger-scale harbor charts which give the depths of the water, and the shorelines and topography as far inland as can be seen from the water. It also supplies the geometrical network and basic vertical control on which the local maps of the Geological Survey are constructed.

2. *The Hydrographic Office of the Navy Department* makes original surveys and publishes maps, but its work is entirely

outside the continental limits of the United States. When it needs shore topography as an aid to navigation, the maps are based on pre-existing work or on original surveys.

3. *The Corps of Engineers, U. S. A.* prepares detailed topographic maps with military information in the vicinity of strategic points where military operations are probable. It also prepares the special maps necessary for practically all Federal improvement projects such as river control, canals, etc. Many of these maps contain confidential military information.

4. *The Mississippi River Commission* prepares maps of special types dealing with the hydrography of the river and the topography along the shores. This Commission publishes its own maps and issues pamphlets giving information as to its benchmarks, changes in the bed of the river, and other features of value to river pilots.

5. *The U. S. Lake Survey* publishes navigation charts of the Great Lakes, the New York State Canals and the Lake of the Woods.

6. *International Boundary Commission.* This Commission is charged with the survey and marking of the International boundary between Canada and the United States from the Arctic Ocean to Cape Muzon and from the Atlantic to the Pacific, excepting through the Great Lakes, the St. Lawrence and connecting waters. According to the treaties the lines must be described in reliable maps, and it has therefore been necessary to make a topographic survey of a strip a mile or so in width all along these lengthy lines. The published maps will conform as far as possible with those made by the Geological Survey.

7. *The Forest Service* uses the standard topographic map when possible, but it makes surveys and maps for its own purpose as occasion requires. These conform in general to the standard topographic map when based on original surveys, but often maps are compiled from such meagre information as may be available. The scale of its maps are just a trifle different from the standard topographic map.

8. *The Bureau of Soils* uses existing maps whenever possible, but to meet the demands of farmers' organizations and Congressional requests in all the states of the Union it is often forced to use any map available, such as Land Office maps or local county atlas sheets. Very frequently it makes traverse maps of its own. The scales of the maps and their accuracy, therefore, vary widely at times from the standard topographic maps. The unit of publication is usually some minor political subdivision, so that the sheets vary in size or scale.

9. *The Reclamation Service* makes a wide variety of maps to cover its needs in the construction of irrigation and drainage works and in the classification of the lands for irrigation purposes. These maps vary from preliminary reconnaissance surveys to refined surveys for reservoir sites, and therefore differ widely in scale and accuracy.

10. *The General Land Office* is primarily interested in subdivisions showing public and civil land boundaries, especially in the Public Lands and Indian Reservations. The character and scales of the maps vary widely. Some are based on actual surveys while others are merely compilations from county or commercial maps.

11. *The Bureau of Indian Affairs* uses whatever suitable maps are available, and where these do not exist makes maps based on its own surveys. These differ widely in scale and character.

12. *The Bureau of Public Roads* is a map-using rather than a map-making agency, but in carrying out the program of the Federal Aid for roads project it will coöperate with other agencies in the preparation of State road maps. Moreover, during the surveys of roads constructed under its supervision much information in the way of traverses and levels will be gathered which will be of great value to engineers interested in public works.

13. *The Topographic Branch of the Postoffice Department.* Although this organization does not maintain surveying parties, it sends numerous inspectors over the country and compiles and publishes Post Route maps, Rural Delivery County maps, and maps of local centers.

Such a multiplicity of government agencies doing much the same sort of work in surveying and publishing maps leads inevitably to excessive costs and confusion both to the Federal and non-Federal users of maps. Every industry, art or science, governmental or otherwise, which requires a knowledge of the lay of the land is dependent on suitable maps, and detailed work requires specific information regarding facts determined during the making of such maps. An immense wealth of such information has been collected by the several map-making agencies, but experiences during the war have emphasized the fact that few officials and fewer civilians know where to turn to get the specific information desired at the moment. To overcome the lost efficiency, due to overlapping among the Federal agencies, and to reduce the confusion as to where information already secured might be obtained, the President, by Executive Order of August 27, 1919, convened an Interdepartmental Conference of all the Federal Map-making Organizations. This conference, after several sessions, filed a report including the following recommendations:

1. That a permanent Board of Surveys and Maps, composed of one member from each of the Government organizations represented in the conference, be appointed to act as an advisory body on all questions relating to surveys and maps.

2. That a central information office be established in one of the Government map-making agencies, preferably in the U. S. Geological Survey, for the purpose of collecting, classifying and furnishing information concerning all maps and survey data available in the several Government organizations and from other sources.

It was further proposed that the new Board should confer with those interested in the making and using of maps and thereby establish closer coöperation between the work of these outside agencies and that of the Government. In order to make such coöperation effective, representatives of the Engineering Council, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Association of State Geologists, American Association of State Highway Officials, The National Research Council, the Association of American Geographers, The American Geographical Society, and the Geological Society of America met at the rooms of the National Research Council and organized under the chairmanship of Professor Edward B. Mathews, Chairman of the Division of Geology and Geography of the National Research Council.

After several subsequent conferences and correspondence with map publishers, educational institutions and map-users, this committee has prepared a report with recommendations which will be presented to the permanent Board of Surveys and Maps which was established by Executive Order on December 30, 1919, "to coördinate the activities of the various map-making agencies of the Executive Departments of the Government, to standardize results, and to avoid unnecessary duplication of work."

In pursuance of this Executive Order the Board has met, organized, and established its methods of procedure. It purposes to establish at an early date a map information office in the Interior Department Building, Washington, D. C., which will collect and catalogue, as rapidly as possible, information concerning maps, surveys and survey data, not only of the Federal Government, but of other Governmental and private agencies. The members of the new Board desire that this information office shall be of service not only to the Federal Departments and Bureaus, but to the general public. The Board would welcome suggestions concerning the means whereby this office can be of most public value and hopes that the fullest use will be made of its facilities. Such suggestions may be sent direct or transmitted through the committee representing outside agencies mentioned above.

Science and National Progress

Edited by a Committee of the National Research Council

Dr. Vernon Kellogg, Chairman, Dr. R. M. Yerkes, H. E. Howe

BLUE EYES AND BLUE FEATHERS.

By Wilder D. Bancroft.

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The National Research Council is a coöperative organization of the scientific men of America. It is established under the auspices of the National Academy of Sciences and its membership is largely composed of appointed representatives of the major scientific and technical societies of the country. Its purposes are the promotion of scientific research and of the application and dissemination of scientific knowledge for the benefit of the national strength and well-being.

The color of red paint or of yellow paint is due to red or yellow pigments, which owe their color to their chemical nature. These are called pigment colors. There are other colors which are due to the physical structure, and which are therefore called structural colors. The rainbow, for instance, is not a painted band in the sky. In fact, no two people see the same rainbow. Structural colors may be due to a number of causes and to understand them it is necessary to start almost at the beginning. An absolutely smooth, reflecting surface is invisible. We realize this very often when we come unexpectedly face to face with an exceptionally good mirror. It was suggested by a German that the Zeppelins should be coated with a polished metallic surface which would make them perfectly invisible. While it would be impossible to see such a surface, there is some doubt whether this would be a great success from a military point of view, because almost anybody would realize that something queer was going on if he were to see a reflected section of the earth's surface apparently moving along up in the sky.

If we put powdered glass in a liquid having the same index of refraction as the glass, no light is refracted when passing through the mixture and consequently the glass is invisible. If a glass rod be dipped into such a liquid, the rod seems to melt and disappear when it touches the surface of the liquid. Since different colors may have different indices of refraction, it happens sometimes that the glass will be invisible for certain rays, which are transmitted without change, while other rays are scattered by the glass. Under these circumstances the mixture of glass and liquid may transmit only yellow light and will appear yellow. At some other temperature it may transmit only red or only blue. This is known as the Christiansen effect, from the man who first studied it.

If we have a thin film with light reflected from the front and the back surfaces, it may happen that the crest of certain waves reflected from one surface will coincide with the hollow of waves reflected from the other surface, in which case this particular color will disappear and the place where this disappearance occurs will appear to have the complementary color. The colors of thin films are often known as Newton's Rings. We are quite familiar with them in the case of soap bubbles and with oil films on the ground. In the streets of Washington the colors due to oil films are exceptionally brilliant; but this is not due to any particular brand of oil which is spilled there. It is because the streets are asphalted and consequently there is practically no reflection of light from the asphalt surface to interfere with the colors of thin films. This is a very good illustration of the importance of a dark background in the case of structural colors.

We may get colors by reflection and refraction. The rainbow is an illustration of this. The old-fashioned cut-glass chandelier gives a good example of the colors that may be produced by light passing through a prism. If we have a number of lines ruled parallel and very close together on a smooth surface, this gives us what is known as a diffraction grating, which may spread a ray of light out in a way very similar to a prism. Agates are composed of thin films about 0.001 of a millimeter in thickness, and when the agate is properly cut it may behave like a diffraction grating. In the case of mother-of-pearl, we have alternate layers of calcium carbonate and an organic material. These layers overlap very slightly in a regular fashion and consequently act to some extent like a diffraction grating, giving rise to the peculiar effect known as pearly lustre.

The reflection of light by powdered material may produce a number of interesting color phenomena. When white light is scattered from a surface instead of being reflected as in a mirror, it gives rise to the sensation of white. A block of ice is not white, because it does not scatter the light. If the ice is powdered, or still better if we have snow, the light is scattered and we call the snow white. Instead of having solid particles of ice in air we may have air bubbles embedded in liquid, in which case we get a white froth or foam. If the blue crystals of copper sulphate are ground to a fine powder, the light passes through such fine layers of the material that it does not become colored blue to any appreciable extent. On the other hand, the light is scattered from the powdered surfaces, and the powdered copper sulphate looks white instead of blue. When silver is precipitated by an electric current, it does not come down with a mirror-like surface, but rather in a mass of tiny crystals which scatter the light in every direction. Consequently electrolytic silver is white and only has the characteristic appearance of silver after it has been burnished. There is no white pigment in any white flower or in white hair, and probably not in white bark. The white color of the lily is due to the presence of innumerable air bubbles and the same is true of white hair. In order that hair may turn white in a single night, it is not necessary for the original pigment to disappear and for white pigment to develop. It is only necessary for a mass of minute air bubbles to be formed in the hair as a result of worry. While this accounts for the physical change, we are as much at a loss as ever to know why intense grief should develop air bubbles in the hair.

The scattering of light by a powder or by the fibers of a sheet of paper is due to the difference in the index of defraction between the solid particles and the air. If we replace the air by some liquid having very nearly the same index of refraction as the solid particles, these latter will cease to be white and will become more transparent. It is well known that oiled paper is distinctly translucent. If powdered copper sulphate were immersed in a liquid having about the same index of refraction as the crystals, these would probably become blue. This experiment has not been tried; but there is a more interesting one which has puzzled people for a good while. In the zoölogical gardens some flamingoes are much redder than others. At one time it was thought that the redness was connected with a fish diet; but flamingoes have been raised which had bright red feathers even though the birds had never eaten fish, so this explanation had to be given up. It is now believed that the brilliancy of the color is due to the presence of oil in the feathers, this making them more translucent and bringing out the red color. Water colors always become paler as the water dries out, because the pigment is then surrounded by air and not by water. Some people have gone so far as to say that white pigments do not occur in nature in living beings; but this is an over-statement. Some butterflies have a whitish pigment in their wings and the white bellies of many fishes are due to the presence of a substance called guanin, and not to air bubbles.

Complete absorption of light gives the sensation known as black. Pulverulent silver is black because the crystals are so arranged that all the light is absorbed by reflection forward and back. This can be shown in another way. If we take a bunch of steel needles and place them with their points side by side facing the observer, the mass will appear black, although we know that no single needle is black in itself. The rich color of velvet is due to its trapping the light, and the peculiar effect known as damask is due to the fibers being arranged in two different ways, so that one set absorbs more light than the other. Trees and grass may act as light traps when seen from above and they are said to look black to aviators. If we have a material which absorbs light so completely that the powder is black, we shall get all gradations between the original color and black if we grind up such a substance, just as we got all variations between blue and white by grinding crystals of copper sulphate. If we start with yellow gold and make it more porous, it will become brown before becoming black. This happens unintentionally in the assaying of gold, a brown powder being obtained which people have thought was an allotropic form of the metal. It is merely a porous gold and when it is heated until the crystals sinter together and become less porous, the yellow color of gold reappears.

When powders are grouped, there may also be a change of tint owing to the fact that the pigment or absorption color varies with the thickness of the film. This will show up just as well with thin layers as with powders. Both cobalt glass and cyanine are blue in thin layers and red in thick ones. Large crystals of potassium ferricyanide are red and the color changes to yellow when the crystals are ground to powder. It has been made probable by the Geophysical Laboratory that rouge would be yellow if we could grind it fine enough. So far this has not yet been done; but it is merely a question of time when somebody will make yellow rouge, in spite of the contradiction in terms which is implied. In all these cases adding a liquid having approximately the same index of refraction as the powders would change the color towards that of the larger crystals.

If we have very fine particles suspended in a transparent solid, liquid, or gas, these particles scatter blue light much more than they do red light, and consequently such a mass appears red by transmitted light and blue by reflected light. Skimmed milk is an instance of this sort, being distinctly bluish by reflected light and reddish by transmitted light. Tobacco smoke is also blue by reflected light and red by transmitted light. The blue color of the sky is due to light which is scattered by drops of liquid or by particles of dust in the air. The intensity of the color is undoubtedly increased by the fact that we see this against the black background of infinite space, so that the color is not changed by light reflected from the boundaries of the atmosphere.

There is no blue pigment in blue eyes and it was pointed out by Tyndall years ago that the blue of the eye is really the blue of turbid media, and is thus analogous to the blue of the sky or the blue of skimmed milk. At the back of the iris there is a dark pigment known as the *uvea*, which prevents the reflection of light and keeps the color of the blood behind it from being seen. When this dark pigment is absent, we have an albino and a pink eye. The various stages between the blue and the gray eye are due to differences in the coarseness of the particles giving rise to the blue color, the blue color being the more intense the finer the particles. This is probably the reason why babies' eyes are so very blue, because the suspended particles tend to grow coarser with increasing age. All other people have a yellowish-brown pigment in the front of the iris, and the combination of the structural blue with the yellowish-brown pigment gives rise to the green, hazel, brown and black eyes. Except with people who have very black eyes, the pigment in the front of the iris does not develop at birth, just as the teeth do not come till later. Consequently most babies have blue eyes, the color changing to hazel, brown or black as they grow older, while the reverse change never occurs. Once in a while we see a man whose eyes are colored differently. This means that pigment has developed in one eye and not in the other, or that the pigment has developed unequally in the two eyes. The green eye is due to the combination of structural blue with the pigment yellow. While this is not a common type in human beings, we get it very markedly in the case of the green tree-frog, which has no green pigment and whose green color is due to structural blue with a yellow pigment overlaying it. If we scrape the pigment layer off the back of an unfortunate frog, he turns blue. The Latin name of the Australian tree-frog means "the sky-blue frog," because he is blue when he comes to us preserved in alcohol, the alcohol having dissolved the yellow pigment.

If we leave out of account feathers with a blue metallic lustre, which may constitute a special case, we may say that there is no blue pigment in the feathers of any bird. This means that the blue of the kingfisher, the indigo bunting, the blue-jay, and the blue-bird, is not due to blue pigment, but is a structural color. The only pigment in the blue feathers of these birds is a dark brown one which apparently serves merely as a background, just as in the case of the blue eyes. The best explanation of the blue feather is that the horny matter is filled with an enormous number of minute air bubbles, which scatter blue light and transmit red, which is absorbed by the dark background. The blue feather is therefore the same in principle as, and the opposite in detail from, the blue sky. The color of the sky is due to the scattering of light by particles of liquid or solid suspended in a gas, the air. The blue of the feathers is due to the scattering of light by bubbles of gas, air, suspended in a solid medium. While this explanation is undoubtedly the right one, nothing analogous to a blue feather has yet been made in the laboratory. This is one of the things that people must do in the future.

In this country the tufted titmouse is a gray bird with no brilliant colors; but the German titmice show great differences in color. One variety is green on the back, due to structural blue overlaid by a pigment yellow, and yellow on the belly. In another variety the brown pigment which is essential to the structural blue has not developed and the bird is consequently yellow all over. There is a third form in which the yellow pigment has not developed and the bird is therefore blue on the back and white underneath. One would like to think that the differences in color between the male and the female redstart were of this type and were due to the presence in the male of a single color which is lacking in the female; but this seems not to be the case.

The gorgeous sunset colors are due to the red light which is transmitted through the cloudy sky and is the reverse of the blue of the sky. Water is apparently blue in itself when one looks through a sufficiently long layer. If, however, there were nothing to reflect the light back, the water would, of course, look black, and certain lakes do show exactly this phenomenon. If there is a small amount of reflecting particles, the water looks blue. With more suspended particles a certain amount of yellow is sent back, and the water becomes green. In the tropics the water is an intense blue, except near the shore, where it becomes an almost equally intense green. The water of the Rhone where it flows out of the Lake of Geneva is blue, while the Rhine at Strassburg is green, and we find that the Rhine contains seventy per cent more suspended calcium carbonate than the Rhone. Sometimes the water in a swimming tank will be as green as crême de menthe. This is due to suspended solids in the water. The same effect can occasionally be obtained in a porcelain-lined bath tub. The clear brown brooks that one finds in many places in New England owe their color to the presence of a brown material of the nature of tannin, so this would really be a pigment color and not a structural one.

If a substance absorbs light very strongly, it may also reflect that light selectively, in which case the substance has what we call a surface color, due to resonance. Instances of this sort are very common among the so-called aniline dyes. For instance, crystals of magenta transmit red but reflect green. Substances having marked surface colors show some very extraordinary properties when present in the form of very finely divided particles. Indigo in mass transmits blue and reflects red. If we make a colloidal solution of indigo with very fine particles, we find that it transmits red and scatters blue light. Without going into the theory of this, we may make the assumption that a substance which has a surface color will transmit, in finely divided form, the light which it ordinarily reflects, and will scatter the light which it ordinarily transmits. This tentative hypothesis works out very well as a means of explaining the colors of colloidal gold and colloidal silver. The apparent surface color of gold is yellow; but if we make the light pass a number of times between two surfaces of gold, we find that the resulting color is red and not yellow. A thin film of gold transmits green. In accordance with the hypothesis, we find that a colloidal solution of gold having very fine particles transmits red light and scatters green light. If the particles are coarse enough so that the peculiar phenomenon of resonance does not take place, the particles scatter yellow or brown light and transmit blue. As we see it ordinarily, silver has no especial color; but after multiple reflection, we find that the surface color or silver is yellow. A thin film of silver transmits blue and a colloidal solution of silver consequently transmits yellow light and scatters blue. With coarser particles, we get the transmission of blue, which is in line with the behavior of silver films, and the silver scatters the complementary color, which is blue. Sodium fogs scatter violet light, for which the vapors are transparent.

Michelson, of Chicago, has shown that the brilliant colors of butterflies are due in many cases to surface colors so that it is probable that the wings of the butterflies are colored by solid pigments, which behave like such aniline colors as magenta.

We are accustomed to say that metals have a metallic lustre and that glass has a vitreous lustre; but this does not seem to get us ahead at all. If one asks a physicist what constitutes metallic lustre, he is very likely to say that metals conduct electricity and that the electrons which are present give rise to the sensation of lustre. This cannot be the whole truth, because an empty glass test-tube placed in water and looked at so as to give total reflection, is more metallic than mercury itself. Also, if we take a black image on a white ground and a white image on a black ground and combine these two in a stereoscope, we do not get a sensation of gray—we get metallic lustre. A similar effect is obtained if we have a yellow image on a blue ground and combine it with a blue image on a yellow ground. This shows that the problem of metallic lustre is a psychological one in some cases and possibly in all. It seems probable that one gets the sensation of metallic lustre whenever we have a nervous flutter or unsteadiness of attention, as when one combines two pictures having different degrees of brightness. The elements of fatigue would enter in very largely here and some people are much more sensitive to binocular lustre, as it is called, than others. Woolen goods striped black and white appear lustrous to a few people, though not to most. This seems to be an exaggerated case of the eyes wandering over the surface in a jerky manner.

With metals there is reflection from the surface and from a plane only just below the surface, this giving rise to the flutter effect. When looking at a thing which is not in itself a metal, the sensation of metallic lustre will be attained more easily if the texture of the surface of the material resembles that of a metal. We also get the sensation of lustre in cases in which there is simultaneously a roughened surface and a high reflection of light. The most familiar instance of this is the silvery streak which marks the reflection of the moon from a water surface rippled by the evening breeze. The wavelets make the surface of the water seem rough and the accompanying high reflection of light makes the water look metallic, even more metallic than the disk of the moon itself.

Even in the best colored moving-picture films, we do not get the sensation of metallic lustre because both eyes are looking at the same image. It seems probable that this could be overcome in case the photographs were taken by means of two or more lenses sufficiently far apart. On the other hand, it would be very easy to overdo this, with the result either of getting a blurred image or of getting one with a metallic shine over everything, which would be worse than the present arrangement.

What is probably the color of colloidal particles is to be noticed with gems. Colorless topaz is made orange by radium and heating makes it colorless again. Ultra-violet light tends to change the orange, due to the radium, to a lilac. Blue sapphires are changed to yellow by radium, and yellow sapphires are changed to blue by ultra-violet light. Sapphires become colorless when heated and white sapphires are turned yellow by radium. In other words, in a good many cases, gems become colorless when heated, and the effects of radium and of ultra-violet are antagonistic. There is no known substance which behaves like this when present in mass. Consequently one is forced to the conclusion either that many of the gems are colored by hitherto unknown elements, or that the color is due to colloidal material which behaves differently from the same substance in mass. The second explanation is the more probable one, because we know that ruby glass, which is colored red by colloidal gold, becomes colorless if heated too hot, and the red color changes to blue if the glass is heated moderately for a long time. So far, however, no one has duplicated in the laboratory the color phenomenon shown by the gems and we consequently do not know what the real coloring matter is in many cases.

MEAT AND MILK IN THE FOOD SUPPLY

(Report of the Committee on Food and Nutrition of the National Research Council, April 3, 1920)

It has long been known, but perhaps never sufficiently emphasized, that the milk cow returns in the human food which she yields, a very much larger share of the protein and energy of the feed she consumes than does the beef animal. Dr. Armsby, probably the leading expert of this country on animal nutrition, has estimated (Science, August 17, 1917) that of the energy of grain used in feeding the animal there is recovered for human consumption about 18 per cent in milk, and only about 3½ per cent in beef.

In an official Report on the Food Supply of the United Kingdom, it is estimated that to produce 100 calories of human food in the form of milk from a good cow, requires animal feed of 2.9 pounds starch equivalent; 100 calories milk from a poor cow is estimated to require the consumption of 4.7 pounds; while to produce 100 calories of beef from a steer 2½ years old it is estimated that 9 pounds of starch equivalent in feed are required.

Stated in terms comparable with those used by Dr. Armsby, this would mean that the good milk cow returns 20 per cent of the energy value of what she consumes, the poor milk cow 12 per cent, and the good beef steer only 6 per cent. Although this estimate is more favorable to the beef steer than is that of Dr. Armsby, yet even in this estimate it will be seen that the poor cow is twice as efficient, and the good milk cow more than three times as efficient as the beef steer in the conservation of energy in the food supply.

Considering the whole length of life of the animal, Professor Wood, the leading English agricultural expert, estimates that the cow returns in milk, veal and beef, 1/12 as much food as she has consumed, while the beef steer returns only 1/64. In other words, the cow is five times as efficient as the beef steer as a food producer when the whole life cycle of the animal is considered. Similarly it has been estimated by Cooper and Spillman (Farmers' Bulletin, No. 817, 1917, U. S. Department of Agriculture) that the crops grown on a given area may be expected to yield from four to five times as much protein and energy for human consumption when fed to dairy cows as when used for beef production. As Wood has very strikingly shown, the longer the time that the beef animals are fattened on grain, the less economical the process becomes.

Quite recently Dr. Armsby has pointed out (Yale Review, January, 1920) that "the dairy cow shows the highest efficiency of any domestic animal, both as regards conversion of food and availabality of the product for man."

Not only is the milk cow several times more efficient than the beef steer in the conservation of proteins, fats, and carbohydrate for human consumption, but in the gathering and preparation of mineral elements and vitamines she contrasts even more favorably with the beef animal. It is largely because of its richness in calcium and in fat-soluble vitamine that milk is the most efficient nutritional supplement to bread or other grain products.

Meat is strikingly poor in calcium and does relatively little to balance a diet consisting largely of bread or of other products of seeds. It does, of course, supplement the protein, but American dietaries would nearly always be adequate as regards protein even without the meat that they contain. On the other hand, dietaries containing little or no milk are very apt to be inadequate as regards calcium. Detailed analysis of the results of hundreds of American dietary studies shows that in practice the adequacy of the calcium intake depends more largely on the sufficiency of milk supply than upon any other factor, or, in fact, than upon all other factors combined.

The vitamines furnished by hay and grains, and thus consumed by cattle, are stored in the animals' tissues to only a limited extent, but they are transferred in relative abundance to the milk. Hence the vitamines of the coarse material of grain, not directly available as human food, are brought into form for man's use very efficiently through milk production, and very inefficiently through the production of meat.

Thus the result of recent studies in nutrition, which have made clearer the importance of the mineral elements, and vitamines, is to emphasize strongly the great desirability of a more abundant milk supply, even if this should somewhat reduce the production and consumption of meat. Our present knowledge of nutrition justifies more fully than ever before the statement that "the dietary should be built around bread and milk," bread or other grain products being the foods which furnish the most nutriment for their cost (whether in money or in land and labor) and milk being by far the most efficient nutritional supplement to bread or other grain products. Therefore somewhat more of our grain crops than is the case at present should come directly into human consumption to augment the bread supply, and of the grain fed to cattle more should be used for the production of milk, and less for the production of meat.

In general, 10 pounds of grain may be expected to produce not over one pound of meat or about three quarts of milk. If the three quarts of milk cost the consumer more (because of greater labor cost in production) they are also certainly worth more to him. In so far as things as different in their nutritional properties as meat and milk can be compared, it is fair to say that one quart of milk is at least as great an asset in the family dietary as is one pound of meat. The per capita consumption of meat in the United States is so high that it might be reduced by one-third or even one-half with little or no nutritional loss, while a corresponding increase in milk consumption would certainly constitute a great improvement in the average American dietary. We are confident that a moderate shifting of emphasis from meat to milk will help in the normal evolution of American agriculture and improve the food economy and public health of the American people.

THE PROPER TIME OF DAY TO GATHER FRUIT.

THE Bureau of Plant Industry of the United States Department of Agriculture has recently published some important information with respect to the hour at which fruit should be gathered, which is by no means a matter of indifference as might be thought. On the contrary its shipping quality has been found to depend upon its temperature when plucked, and this naturally depends upon the time of day. Botanists have long ago known that certain portions of plants are capable of attaining a temperature considerably above that of the surrounding air. During the middle of the day direct sunshine frequently causes a very marked and rapid rise of temperature in small fruits. This fact was noted by Messrs. Stevens, Neil and Wilcox with respect to huckleberries in 1916, and inspired fresh researches especially in 1918, with respect to other fruit.

The method of investigation was as follows: Specimens of the fruit mentioned were gathered hourly between the hours of 6 A. M. and 7 P. M. on sunny days and placed in baskets, each containing about one liter. After each collection of fruit a thermometer was placed in the middle of the basket among the mass of fruit and the temperature noted while at the same time the external temperature was registered by a control thermometer. The absolute figures are of but small importance but interesting deductions may be derived from the differences noted at the same hour between the figures recorded by the two thermometers. The extreme difference noted varied in amount and in the time when recorded according to the kind of fruit. But the maximum difference was always registered betwen 10 A. M. and noon.

In the case of strawberries it was 9.5° C. at 12 M.; for a variety of currants it was 9.0° C. at 12 M.; for another variety of currants, 6.5° C. at 10 A. M.; for the gooseberry it was 4.5° C. at 10 A. M.

The minimum difference of temperature, on the contrary, always occurred in the morning and evening, and was almost nil during the night. An effort was also made by inserting the bulb of the thermometer into the pulp of the fruit to discover whether there was an appreciable difference in temperature between the center of the fruit and its outside, but this difference was usually found to be extremely slight. These experiments have as their object the determination of the reason why lots of fruit gathered in the same gardens at the same season, only a few hours apart and in practically the same conditions of weather, sometimes arrive at market in a very different condition, although packed and shipped as soon as gathered in all cases, and after the same number of hours of travel.

Records kept for fifteen years with respect to peaches (a very fragile fruit) have shown that peaches gathered in the middle of the day usually bear shipping badly and we are forced to the conclusion that the keeping qualities of small fruits depend upon their temperature when gathered.

Consequently, horticulturists are advised to avoid the hot hours in the middle of the day for gathering fruit, particularly upon sunny days. In cloudy weather the hour of gathering is of less importance. The early hours of the morning, after the comparative coolness of the night are best of all. Contrary to what one might think it is far better, in case the train upon which the fruit is to be shipped does not reach the nearest station until midday, to gather the fruit early and keep it properly wrapped in baskets in the shade, rather than to leave it upon the trees until 10 or 11 o'clock with the idea of shipping it that much fresher.

- Talbot's Law -

Phil. Mag. Series 3, Vol. 5 (1834) P. 321.

Helmholtz - "Physiological Optics II Anflage, p. 483.

"If any part of the retina is excited with intermittent light, recurring periodically and regularly in the samaway, and if the period is sufficiently short, a continuous impression will result, which is the same as that which would result if the total light received during each period were uniformly distributed throughout the whole period."

Porosity of Liquids.

When a certain amount of powdered sugar is slowly poured into warm water the water will dissolve the sugar and appear to absorb it without increasing its volume. Similarly, when alcohol is poured into water, the resultant will be less than the sum of the two volumes. Apparently one of the liquids has entered into the pores of the other.

The experiment as commonly performed in physical laboratories consists in putting measured quantities of the two liquids together, but the effect would be far more striking were it possible for students to see one of the liquids actually soaking into the other. This can be done in this way: Take two glasses, one filled to the brim with water, and the other with alcohol. Color the alcohol with red ink to make it more distinct. The glasses should not be over full. Place a sheet of paper over the glass full of alcohol and, with a hand on the paper to keep it down on the rim of the glass, invert the tumbler over the glass full of water and carefully draw out the paper. This can be done without spilling a drop of the alcohol and yet as soon as the paper is removed, the alcohol will begin to drop. Owing to the fact that it is colored it is possible to see the alcohol actually soaking into the water, while tiny air bubbles that were formerly contained in the pores of the water rise slowly to the top of the tumbler. This will continue until a considerable air space forms in the top of the tumbler.

How to Get High Speeds of Rotation. E. Henriot and E. Huguenard. (*Comptes Rendus,* May 11, 1925.)—In the endeavor to reach high speeds of rotation, friction and the difficulty of getting perfect centring generally intervene to veto success. These investigators have devised a motor operated by compressed gas in which the rotating part is supported upon the escaping gas. This avoids friction and at the same time makes it possible for the rotor to select its axis of rotation for itself. Such a rotor, 11.7 mm. in diameter, was maintained for hours at a speed of 4000 r. per sec. and could be speeded up to 11,000 revolutions per sec. G. F. S.

Franklin Inst 8/1925

subject recently published by the bureau.

A New Amplifier of Sounds. L. Gaumont. (*Comptes Rendus.*)—Many amplifiers of sound distort it without mercy. It is claimed that the following device is free from this defect. The vibrating part is a cone of fine silk fabric around which is wound a spiral of fine aluminum wire in one or more layers. The angle of the cone is 90°. This is introduced into the space between the pole pieces of an electromagnet which have the same angle. The cone fits over one of these. When telephonic currents are sent through the aluminum wire there are forces exerted upon the latter by reason of the interaction between its magnetic field and that of the electromagnet. Since the spiral has no natural period of its own, it does not reproduce the sound with distortion. Great distinctness is claimed as well as great intensity. G. F. S.

MEND Celluloid

men's tailors of the world are in Bond street, London. There is, however, a growing tendency on the part of Americans to give preference to American made clothes.

Q. How can spectacle bows made of celluloid be mended?—R. S.

A. The Bureau of Standards says that glacial acetic acid, not just the ordinary strong acid, dissolves celluloid. It therefore can be used as a celluloid cement. Apply a little of the acid to each of the surfaces to be united, press the parts together and lay the article aside to dry. In this way the bureau has mended a spectacle bow so strongly that when it was broken again the joint held. The acid is not poisonous, for vinegar is a dilute solution of it, but it will blister the skin. It has a very pungent, suffocating odor. It is best to apply it with a thin glass rod such as chemists use, or with a slender stick of wood.

Lit'y Digest 8/15/25

THE LIGHT OF THE FUTURE?

GLOW-WORM light—fire-fly light—has been the goal of many experimenters for decades past, on account of its cheapness and its freedom from waste heat. It has been partially attained in the various systems of lighting by "vacuum" tubes containing rarefied gas, but none of these has possest great intensity except the mercury-vapor tube, which gives a blue-green light that is offensive to some eyes. Now, we are told, a French inventor, by using phosphorescent metallic salts in tubes of this type, has produced a "cold light" that is cheap, effective, of usable strength, and of whatever tint he chooses to make it. This device is described at length by Jacques Boyer in *La Petite Gironde* (Bordeaux, France), from whose article we translate as follows:

Exposed to the proper kind of radiation, certain bodies, and in particular the alkaline-earthy sulfids, become first fluorescent, which means that they shine as long as the excitation persists, and then, after it ceases, they preserve for a time a lesser luminosity, known as phosphorescence. Now by associating these two phenomena, Jacques Risler has devised an original lighting-system. To employ fluorescence, he spreads over the outside surface of a bulb filled with rarefied gas, or he actually incorporates in the glass itself, various substances such as the sulfids of zinc or lime, to which traces of copper, bismuth or other impurities communicate a yellow, green, orange or white luminescence, varying with the substance.

Following the work of Guntz, Claude, Moore, and other inventors of mercury-vapor lamps and tubes filled with nitrogen, carbonic gas or neon, he conceived the idea of utilizing as exciting radiation the vapors emitted by metallic salts at their temperatures of dissociation. He thus obtained luminous sources, brilliant and of great artistic effect. For instance, gallium gives a beautiful violet fluorescence at its association temperature, while sodium furnishes yellow, cæsium blue, and thallium green.

The principal difficulty consisted in getting these substances, in the state of vapor, into the interior of the tube in which an almost absolute vacuum must be maintained in order to give passage to the electric current. In the course of his researches the experimenter eliminated the gas and other traces of impurity by physical or chemical methods, such as molecular pumps, absorbent compounds such as phosphoric anhydrid, liquid air, etc. He examined the fluorescence from time to time, either by a hand spectroscope or a Féry spectrograph—an instrument that gives very useful indications of the state of the vacuum, of the excluded gases and other characteristic peculiarities.

Thus he assures himself of the performance of his tubes before assembling them in various ways to form the varied luminescent patterns that now decorate the façades of several firms in Paris.

The elements derived from radium, such as polonium and uranium, will doubtless furnish, in the near future, the chief media for lighting by fluorescence or phosphorescence. But we can not now predict what gaseous mixture will ultimately be used in the vacuum tubes. We have long known that the color of a source of light depends on its period of vibration, which impresses on our retina sensations of tint that vary with the frequency. We know that zenon, in particular, possesses a conductivity a hundred times greater than the neon used by Claude in his luminescent tubes. Unfortunately we do not yet produce industrially this gas, which may be obtained from liquid air. Perhaps we may take as an illuminant the emanation of radioactive bodies, and then we may have discovered the ideal light, for it will cost almost nothing, since the emissive power of these mysterious substances continues for several hundred years!

Meanwhile, the Risler tubes with convergent cathode, for the bombardment of metallic salts, constitute foci of "cold light," of incomparable beauty, and they use six times less current than a half-watt incandescent lamp. Artistic patterns are made of half-inch tubes covered, within or without, with a phosphorescent substance mixed with divers salts. These supply a range of varied tints. The tubes are excited by high-frequency currents from transformers. Under the influence of the electric emanations, they light up brilliantly, the light rays seeming to concentrate at their immediate periphery. This peculiarity makes them valuable for the decoration of apartments, the ornamentation of store-fronts, cafés or meeting-halls. Hidden amid decorative features they may also cause phosphorescence in certain objects or in the costumes of actors, which are thus made to shine forth in the darkness.

In the electro-medical field, luminescent tubes also find useful application, and in particular they enable specialists to select the ultra-violet rays which are employed to-day in the treatment of certain external disorders. Practitioners may thus choose the rays appropriate to each case. Finally, sulfids of zinc and cadmium spread in thin layers on mercury-vapor lamps or carbon-arc lamps, render these inoffensive to cinema operators, without diminishing their photogenic power. As we proceed to manufacture these fluorescent tubes on a vaster scale, they certainly will not fail of extended use."