Get in on Television

HERE is your chance to become an expert in the miracle field of sending pictures through the air. At present, George Waltz, author of this article, is not a television expert, but he will be before he gets through. Go with him and learn all that he means to learn about this absorbing subject.

By
GEORGE H. WALTZ, JR.

I SAW something a few days ago that gave me a real kick. I saw, from behind the scenes, the opening night's program broadcast from station W2XCR, the new $65,000 television broadcasting studio in New York City. Besides getting a real thrill out of it, I was inoculated with the television bug.

What if television still is a long way from perfection? What if the picture you see is small and fuzzy and none too bright? With all its present faults, and it has plenty, it still seems almost like a miracle to me.

Chasing distant stations all over the dial of a broadcast receiver used to be a lot of fun. Now with the modern set, distance is so easy it's not exciting and from now on my spare change is going into building me a television receiver. When I finally get one of those flickering pink "visions" on my own apparatus, I expect a bigger thrill than Admiral Byrd got out of discovering Little America!

Above, Primo Carnera, giant boxer, at W2XCR on its opening night. At left, prominent television engineers get the program in a home.

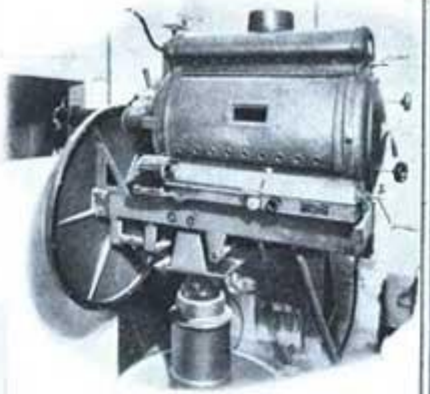
My interest in television began a few weeks ago when I heard over the air a sound like a buzz saw with a couple of teeth missing. I was visiting a friend who experiments in short wave reception. He accidentally tuned in the funny buzz saw noise. He told me the ear splitting wail was pictures coming over the air and he pointed to the television program in the daily paper.

I'd read about television experiments, but actually hearing the signals over the air was what brought the thing to life for me. I determined to investigate and as the first step, I succeeded in getting an invitation to visit W2XCR, where I found out how television programs are put on the air.

At first, as I walked into the television studio, I thought I was in the wrong place. I had expected to find a room filled with weird and complicated looking machinery. Instead it was tastefully draped and for the exception of two small standards supporting the photo-electric cells, it looked quite like any radio studio, several of which I had previously visited. All of the mechanical equipment for picking up pictures was in an adjoining, smaller room that resembled a motion picture booth.

MOST of the space not occupied by studio equipment was filled with people who, like myself, had been invited to the opening night. In the reception room several of them were grouped around a piece of apparatus upon the front of which I noticed a pinkly glowing spot. As I moved closer, it became a picture of a man's head.

Front view of television's scanning mechanism as seen from outside booth.



The scanning mechanism which is in a boothlike room. It can be tilted or turned to follow artist's movements.

Television's control board. Here the operator is looking into the monitor which reproduces image.

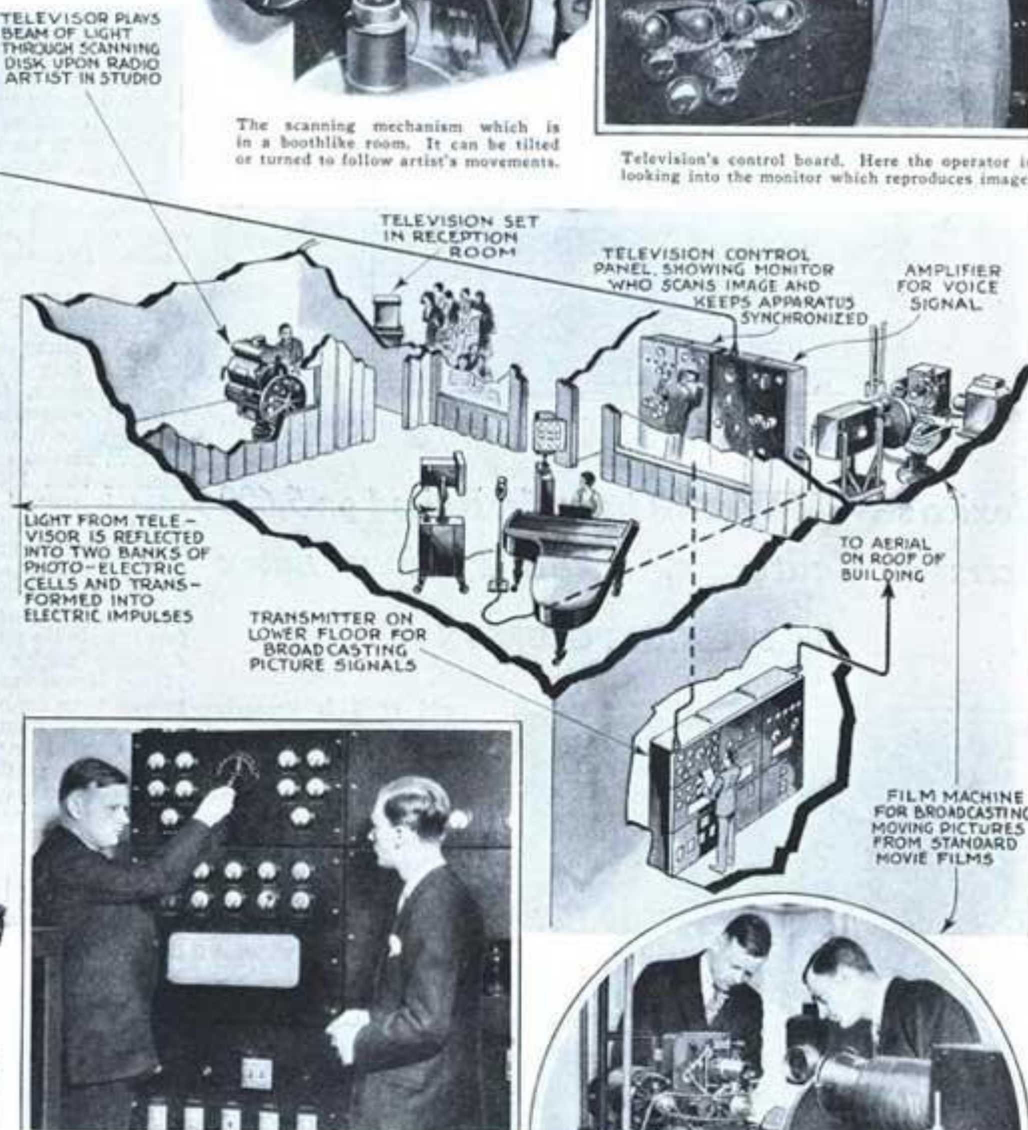


Diagram making clear the operation of a television broadcasting station. Above, photo-electric cell bank. Right, a television transmitter.

Harold Higginbottom, left, engineer in charge of station W2XCR, explains to the author the operation of the film pick-up device that is used to broadcast ordinary motion picture film with sound accompaniment. The photo-electric cell is in the large black box at right.

I could see him smile and turn his head from side to side. Then I looked through the glass windows that separated the reception room from the studio proper and there in front of some apparatus was the man himself. I had seen my first television picture, for the small outfit we were looking at was the studio's monitor set. It was tuned to reproduce whatever was being televised in front of the big machine.

After all the celebrities present had appeared before the machine and their smiles had been sent out on the air, there followed a brief talk on the equipment used. It did not, however, go into the details I wanted so after the crowd had left I buttonholed Harold Higginbottom, the engineer in charge of the station. He was kind enough to answer the questions that were buzzing around in my head.

"Mr. Higginbottom," I began, "you said the subject's face was scanned by means of a disk. Could you show me the disk and tell me just how it works?"

"Do you know how ordinary broadcasting is done with a microphone?" he asked as he snapped on a light over the scanning mechanism *(Continued on page 136)*

Get In On Television

(Continued from page 17)

and swung open a door that covered a large thin metal disk painted dull black on both sides.

"I do after a fashion," I replied. "The microphone takes the voice or music vibrations and turns them into electrical vibrations and these are pumped up to pretty high intensity and then applied somehow to the carrier wave of the station. I'm afraid I couldn't explain just how that is done."

"YOU don't have to," he said. "You've got the main facts. Television, after all, is only piecemeal broadcasting. We really don't send pictures at all; only tiny little pieces of pictures one after the other. All the scanning disk does is to break up the picture into these tiny pieces so we can broadcast them. Do you see this row of holes in the disk?"

"You mean those small holes arranged in a spiral?" I asked.

"That's it," he replied. "Now what would those holes look like if you turned the disk very rapidly?"

"They wouldn't look like anything to me," I decided. "How could I see those tiny spots if the disk were spinning? They'd fly by so fast I couldn't follow them."

"Correct," he said. "Now watch closely." He turned a switch and the disk started to whirl. The spots representing the holes disappeared in the ordinary light of the studio. Then he held a drop light behind the disk.

"Now I see what you mean," I exclaimed. "The disk looks as if it were made with a band of gray glass where that spiral of holes is and I can see the electric bulb right through the disk."

"You only think you can," he laughed. "You could see only a tiny part of that bulb through any one hole in the disk or even through all the holes if they were in line instead of being spaced out around the disk in spiral form. Your eye fools you. Seeing through that disk is an optical illusion just as motion pictures are an optical illusion, and a television vision is an optical illusion.

"When light flashes into your eye," he explained, "the eye goes on thinking it sees light for over a thirtieth part of a second even if the flash only lasts for a thousandth of a second. The scientific sharps call that persistence of vision.

"Now, I'm going to turn on this big arc light back of the disk and put out all the lights in the room. Watch the wall there."

THE arc sizzled and then glowed brilliantly. Then the lights in the room went out and as he again started the disk, a row of tiny, brilliant light spots chased each other faster and faster across the blank wall. As the disk picked up speed, the light spots traveled so fast they became streaks. Because of their spiral arrangement, each one a bit closer to the center than the preceding one, these streaks overlapped and as far as my eyes could perceive, the rectangular section of the wall was uniformly lighted all over.

"I suppose you noticed," Mr. Higginbottom said, "that when the disk started up the rectangle was just wide enough to allow one spot of light to disappear at the edge of the rectangle at the instant the succeeding spot appeared at the opposite side. That means that there is actually only one spot of light in that entire rectangle at any one time.

"Now the amount of light reflected to your eye from the blank wall is steady because the draperies on the wall are all one color, but if you were sitting in front of it, the spot would reflect a lot of light when it struck your white collar and a lot less light as it passed over the neckband of your suit. Those photo-electric cells, which you see placed on either side of the piano in the studio, are affected by the amount of light reflected and are hooked into the broadcast transmitter in place of the microphone used in ordinary sound broadcasting. The result is that the radio wave carries a string of electrical pulsations equivalent to the variations in the one-after-the-other streaks of light."

"It's beginning to filter through my thick cranium," I interrupted. "By means of the traveling spots of light you get a piecemeal electrical picture that you can put on the air. Then all I have to do to receive that picture is make up some apparatus to reverse the process so I can turn the electrical impulses back into light that can be seen. Is that it?"

"YOU'VE got the right idea," Mr. Higginbottom replied. "In theory all you need is another disk like this one, a radio receiver, good audio amplifier, and a light that will flicker according to the electrical impulses. The neon light is the only one available to the amateur that will do the job."

"I'll buy one tomorrow and start making the disk," I said enthusiastically. "Then I'll hook it to my radio set and watch your next program."

"Go to it," he grinned. "Only remember that your radio set will do fine to bring in the sound accompaniment which goes out on a broadcast wave but it isn't a bit of use on the television signals. To begin with, it won't tune down to where the television signals are and besides, the audio amplifier in it isn't good enough.

"Television signals cover a much wider band of frequencies than broadcasting and you have to have a special, distortionless, wide-band audio amplifier. The television image isn't so good that you can afford to make it worse by using an unsuitable amplifier."

"Besides the special amplifier and short wave receiver, what other equipment will I need?" I asked.

"Of course," Mr. Higginbottom replied, "you will need a motor to drive the scanning disk and a neon lamp."

"How much do you think all of the equipment should cost me. That is," I added, "if I make and assemble some of the parts myself?"

"Let's see," he said. "If you buy all of the parts, it probably will amount to about $120, but if you hunt for bargains, assemble your own amplifier and short wave receiver, and make your own scanning disk you ought to be able to cut a third off that or maybe more."

"THAT'S a lot of money. What I am wondering," I asked hopefully, "is what kind of programs I am going to receive after I get the set built?"

"I think you'll like them. Our programs consist of musical numbers, vaudeville skits, speeches, and then, of course, interesting moving pictures with sound accompaniment."

"Moving pictures?" I asked. "I suppose you broadcast those by allowing the film to run through an ordinary moving picture projector and pick it up with a disk and photo-cell?"

"Partly right," he said, "but we don't stop the film a certain number of times a second as in the regular moving picture machine. It runs through continuously and the scanning disk has radial slots instead of holes. You see," he added, "the film runs by vertically and the slots in the scanning disk run by horizontally so that the combination of the two gives us the same effect we would get if we stopped the film twenty times a second and used a disk with holes accurately arranged in a spiral."

"What sort of pictures are you going to broadcast?" I asked.

"Just the same kind you see in a theater. Of course, they won't be brand-new feature pictures but I think you'll like them."

"How many television stations are now broadcasting in this country?"

"Well," he said, "on the last listing I saw there were twenty in all. Eight of these are located in New York, four in New Jersey, four in Illinois, and one each in Maryland, Indiana, Pennsylvania, and Massachusetts. Of these stations, eleven are operating on regular broadcast schedules."

"HOW about outdoor broadcasts?" I asked. "Have you been able to put outdoor scenes on the air yet?"

"In an experimental way, yes. Here," he said, pointing to a cameralike piece of apparatus, "is a television camera. Unlike the scanning mechanism used here in the studio this depends on the brilliant illumination of the subject for its operation."

"It has a disk just like the other, hasn't it?" I asked.

"Yes, it has a disk. The reflected light coming from the brightly illuminated object passes through the holes in the disk and scans a photo-electric cell housed at the rear of the camera," he explained.

"Oh, I see. The fact that the only light which reaches the cell is the spot of light reflected by the object allows you to use it out of doors," I said as the explanation struck home.

"That's right. Now, on the side of the housing is a control board," he continued. "The operator plugs in a pair of ear phones and by manipulating the various switches, controls the out-going signals as well as the sight."

"I guess next fall I'll be able to sit in my living room and enjoy a football game," I said enthusiastically.

"I doubt that," said the engineer. "This camera at the present time is just an experiment, and there are lots of difficulties that must be ironed out before we can use it with a fair degree of success."

"Football or no football," I said, "I am going down to the bank tomorrow and draw out some money and then shop around and see what I can pick up in the way of bargains in television equipment."

NEXT month you can go with George Waltz on his shopping tour for television receiver parts and learn with him just what is available in separate parts and knock-down kits, what can be made and what must be bought, and how much it costs. If you follow along with him you can build a television receiver and share with him his thrill when he completes his set and tunes in his first television image.

OAK TREES TURN INTO LIVING GAS TORCHES

OAK trees that become living gas torches are a curiosity recently reported by two members of the Asheville, N. C., Forest Experiment Station. When they bored into the trunks of chestnut oak and white oak trees they were found to emit an inflammable gas. When a match was applied, a blue flame sometimes as long as two and a half feet shot from the hole. It burned at full force for about thirty seconds. The source of the gas was found to be decaying wood.

Buying the PARTS for Your Television Receiver

By GEORGE H. WALTZ, Jr.

The clerk showed me an undrilled scanning disk and explained, "**Most of the amateurs want to drill their own.**"

LAST month George Waltz related how he first became interested in television when he heard the peculiar buzz-saw signals of vision transmission on a short wave receiver. Later he visited one of New York City's sight broadcasting stations and was so fascinated by what he saw that he decided to build a television receiver. In this article he takes you with him on a shopping tour, telling you all you will want to know about what is available in television equipment—kits, parts, and complete receivers—what they cost and how they are used.

"I WANT to see some parts for television receivers," I told the clerk in the radio store.

"O. K.," he replied, "but why build a set when you can buy one already assembled and ready for use? Here's one that costs only $150 complete. You couldn't do much better than that if you assembled the parts yourself. If you can wait about ten minutes we'll show you the set in operation."

"What station is on the air then?" I asked as I inspected the assembled set.

"Oh," the clerk said, "we don't receive any station. You see this isn't a good location for short wave reception so we have a film-pick-up device in the store and we wire it direct to the receiver."

While the clerk threaded the film in the transmitter—an apparatus that resembled a motion picture projector—a crowd gathered around the receiver, eager to see the television demonstration.

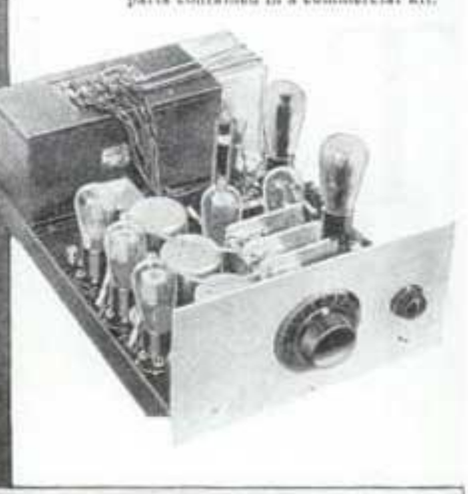
As the final adjustments were made a faint pink glow appeared on the lens of the receiver. Unlike the demonstration I had seen at station W2XCR, which I described last month, this faint glow continued, and, as far as I could make out, never did grow into an image. Instead, black spots streaked back and forth across the lens like the specks seen by a man whose liver is out of order. If this was a sample of the "vision" you got with this particular factory built receiver working under apparently ideal conditions I decided that I wanted to buy another make or build my own.

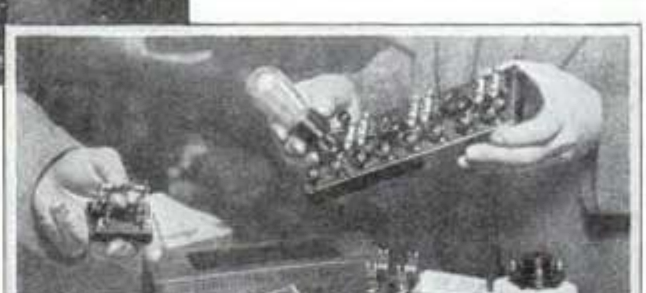
"Not so hot, eh?" commented a man standing beside me. "I'm building a television set myself. I bought a complete kit for $120. You get all the parts that you need and you assemble them by following simple diagrams. It's a cinch. I've seen a set made from a kit like mine, and it really gives a 'vision.' Interested?"

At left, parts with prices **attached that are needed** in building a sight receiver, **except scanning disk** costing $1.35, which is shown at top of this page.

Summer fashions being broadcast from a station in New York. On each side of the performers are photo-electric cell banks.

Below, a short wave television receiver and amplifier built from parts contained in a commercial kit.





At right above is an assembled resistance coupled amplifier costing $2.95. On the counter are parts needed to build it, costing $4.20.

"Well," I said, glad of the opportunity to talk to a kindred soul, "I haven't built a set yet; in fact, I haven't even bought the parts. I'm shopping around in the radio stores trying to get an idea of the parts I'll need and picking up hints on how to get started."

"The company that puts out the kit I bought," my chance acquaintance continued, "sells a larger kit for $214.50 and four types of factory built sets ranging from $169 to $335. The $214.50 kit contains a self-synchronizing device."

"What is a self-synchronizing device?" I asked, somewhat puzzled.

"It's an apparatus that keeps the variable speed motor that drives your scanning disk in synchronism with the disk on the transmitter," he replied. "You know, unless the disk on the receiver is turning at just the same speed as the transmitting disk and is in step with the transmitting disk, you can't receive an image. With one of these self-synchronizers, you just bring your disk up to the speed of the transmitter and the synchronizer does the rest."

"Why can't you use a synchronous motor?" I asked.

"A synchronous motor is fine," was the reply, "if you receive your power from the same power house that supplies the motor on the transmitter. Most of the kits supply a variable speed motor and a self-synchronizer. Of course, you can use a variable speed motor and keep it in step by slowing up the disk with a little judiciously applied thumb pressure."

"Then if I want to receive stations outside of New York City I'll have to provide some sort of synchronizing device. Are they very expensive?"

"No," he said, "and besides you can buy them along with all the other parts you need for your receiver in the five cent, ten cent, and dollar stores now. I happened to find that out when I needed a few connecting lugs the other day. I went to a chain store in my neighborhood and right next to the radio parts was another counter with television parts. You can get everything you need there and I think the entire list of parts for a receiver only comes to about $110, including the tubes. Pretty cheap, don't you think?"

As I walked from the store I consulted my list for the next store I had planned to visit and headed in that direction.

"Sure we sell television parts," the clerk said. "Just what do you want?"

"That," I replied, "is what I would like to know. What do I need?"

The clerk reached behind the counter and brought out a catalogue of parts. As he thumbed through the pages he said, "To start with, you'll need a resistance coupled amplifier. For television a three-stage amplifier ought to hold you. Now let's see. We can supply one for $2.95."

"How much would it cost if I bought all of the parts and assembled it myself?" I asked, anxious to save money in any way that I could.

"For each stage of resistance coupled amplification you'll need two coupling resistances, costing about thirty cents each; a socket, costing twenty cents; and a coupling condenser, costing sixty cents. That's $1.40 for each stage or a total for the three stages of $4.20. It's really cheaper to buy one already assembled."

"How about the parts for the short wave receiver," I asked. "How much do they cost?"

"Most short wave receivers," the clerk explained, "consist of a tuning arrangement and a detector unit. For television I would suggest two variable condensers costing about $3 each and a detector unit that you can build for about sixty cents. The complete receiver, figuring $7 for the coils, shouldn't cost you much over $14."

"Besides the scanning mechanism, that's all I'll need then," I interrupted.

"No," the clerk replied, smiling, "you'll need some sort of power supply for the tubes in your set, just as in a regular radio. Figuring about $6 for the power transformer, $2 for the resistances, twenty cents for a socket, and $6 for filter condensers, the power pack, as it is called, should cost about $14.20 complete."

"Well then," I figured, "the amplifier, short wave receiver, and power pack should cost me approximately $28."

"That's right," the clerk replied. "Of course, if you want to take a chance on replacement parts you may be able to cut that price some."

"Do you sell scanning disks?" I asked, feeling a little more confident of what I was talking about.

"Yes, we have two kinds in stock." He put two metal disks on the counter. "One, made of aluminum, costs $1.35, and the other, of duralumin, costs $1.50. Each is twelve inches in diameter and as you can see is undrilled. We sell the disks undrilled because most amateurs would rather drill their own."

"Then," I said, "I'll have to drill the disk myself?"

"Not necessarily. You can buy disks already drilled if you prefer. But I don't think you'll find it difficult to drill your own. The most important thing is to lay it out accurately. You see, drilled disks are rather expensive, so you can keep the cost of your receiver down by drilling your own."

"How about the motor to drive the disk? I understand that I have two choices," I said, remembering what I had been told about (Continued on page 115)

BUYING THE PARTS FOR A TELEVISION RECEIVER

(Continued from page 46)

self-synchronizing devices. "I can either get a variable speed motor and use a self-synchronizer or adjust it to synchronous speed with my thumb, or use a synchronous motor and just receive those stations that are running on the same power line that supplies the power for my motor."

"Yes, but as far as the price is concerned there is little choice. The motor in either case, not figuring the price of the synchronizer, will be about $15. I'd suggest that you buy a variable speed motor and synchronize it in the beginning by the thumb method you speak of. Then, if you feel that the results make it worth while to spend more, you can build a self-synchronizer."

"TO COMPLETE the scanning mechanism I'll need a rheostat and a neon lamp," I said. "How much do they cost?"

"The rheostat shouldn't cost over $4 and neon lamps are from about $2.50 up, depending on the size of the plate."

"What has the size of the plate on the neon lamp got to do with the reception of images?" I asked.

"A whole lot," laughed the clerk. "The size of the plate in the tube determines the theoretical size of the image you receive. If you have a one inch square plate the largest image that you will be able to receive without the use of lenses will be one inch square. The size of the plate likewise limits the pitch of the spiral along which the holes are located on your disk."

I was learning things every minute. "What size lamp would you suggest?"

"Most of the sets on the market," he told me, "are using a one and one half inch plate neon lamp. You can buy a good grade of lamp that size for about $4."

"Then, as I figure it," I said, "the scanning mechanism, without a synchronizer, will cost unassembled about $25."

"OF COURSE," the clerk reminded me, "if you want to enlarge that image, as they do on most of the commercial sets, it will cost you from $3 to $5 for an enlarging lens, giving you a total of $30."

"In other words," I said, "the entire set—amplifier, receiver, and scanning mechanism—ought to cost not more than $50."

"Yes, if you have the tubes you need for the amplifier, rectifier, and detector. If you haven't, it will cost you about $7 more for those. Of course, I have only figured the prices roughly. It may be that when you actually go to buy the parts, you'll find that the total may be less. Remember, too, that these prices are for new parts."

So that night as I walked home I was loaded down with bundles of every size and shape. The bundles contained the following: one resistance coupled amplifier, one blank scanning disk, tubes for the amplifier and detector, parts for one short wave receiver with detector unit, one neon lamp, one motor, and a few accessories such as connecting lugs, wire, and solder. While I wasn't sure that I had all the parts I needed for my set I knew that I did have all the essentials and there was nothing to stop me from going downtown again to the radio stores to buy any small parts that I lacked.

Now I'm all set to build my first television receiver, and I'll let you know how I get along.

IN THE Home Workshop Department next month, George Waltz will tell you how he went about drilling the holes in the scanning disk. If you want to get in on this new and interesting field follow along with him and progress as he does.

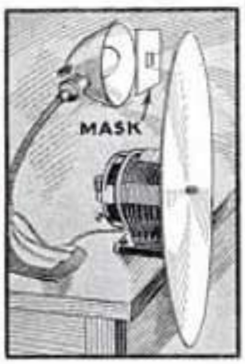
An Easy Way to Make an Accurate *Scanning Disk*

. . . THE HEART OF YOUR TELEVISION RECEIVER

IN THIS article, George Waltz, who has already told you about his visit to a television studio and his shopping tour for television parts, takes you into his home workshop and tells you just how he went about making the scanning disk for his "vision" receiver. Even if you are not building a television set, you can keep abreast of the latest developments by following along as he proceeds.

. . .

By George H. Waltz, Jr.



Don, my neighbor, showed me how it was possible to test the accuracy of a scanning disk by using a drop light and a mask of tissue paper.

"WHAT'VE you been doing—buying out the five-and-ten?" my neighbor Don Marshall called out as I staggered up the front steps with the load of television parts I had bought on the shopping tour I described last month.

I dumped the bundles on the top step and fished for my door key. "All this, let me tell you, is a television receiver—or at least it will be when I put the parts together. See what you got me into when you handed me that invitation to station W2XCR!"

My neighbor grinned. "How much did all that set you back?" he chuckled as he helped me carry the stuff down to the cellar where I have my workshop.

"Oh, about fifty dollars—more or less," I told him. "I guess I'll tackle the scanning disk first; that's going to be the hardest job." I carefully unwrapped the 12-in. blank disk and laid it down on one end of my workbench. Then I hunted up some large sheets of drawing paper that would be just the thing for the layout.

"Let's see," I said, half to myself, "since I'm going to follow the standard sixty-line scanning arrangement, I'll have to have sixty holes arranged evenly along a spiral. The spiral must have a pitch equal to the height of the image I plan to receive. Now, there are three hundred and sixty degrees in a circle and since there are to be sixty holes, they will have to be spaced six degrees apart. Is that right?"

"Seems O. K.," replied Don, who is a radio expert and television experimenter.

First, I set my large compass and drew an 11-in. circle, figuring that this size would give me the extremity of my spiral, making it less than the full 12-in. diameter of the disk. Then I stepped the circle off into 60 parts with my dividers and drew in the radial lines to the center.

"Don't forget that only one hole must pass in front of the plate of your neon tube at one time," Don cautioned as he looked over my shoulder. "In other words, the width of the image you can receive is equal to the distance between two radial lines where they intersect the circle."

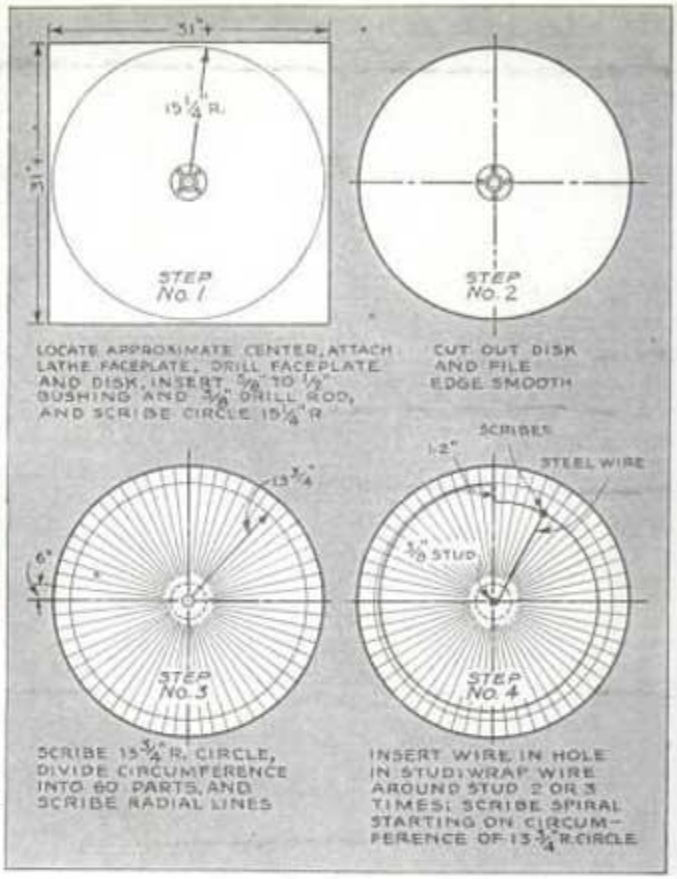
"But that will give me an image only about one half inch square, and I want one at least one and one half inches square. That's why I bought a neon tube with a one-and-one-half-inch plate. Don't tell me I've made a mistake already!"

"Well, you see," said Don, "you forgot when you bought that twelve-inch disk that only one hole should be in front of the neon plate at any one time. In order to take full advantage of that one-and-one-half-inch plate, you'll have to have a larger disk. Of course, you can use that small disk with the one-and-one-half-inch neon tube, but you can get only a small image."

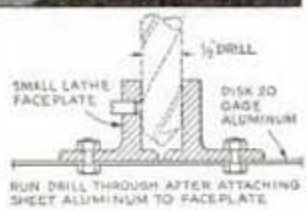
"How can I tell how large the disk has to be?" I asked.

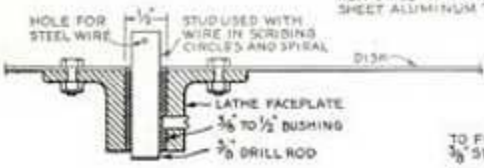
"Just continue those radial lines you have drawn until the distance between two lines approximates one and one half inches. Don't forget that in sixty-line scanning, the height of the image is to the width as sixty is to seventy-two."

I drew the lines and after juggling a few figures in a 60 to 72 ratio, I found that in order to keep within the boundaries of the neon plate the height would be 1.2 in., the width 1.44 in., and the

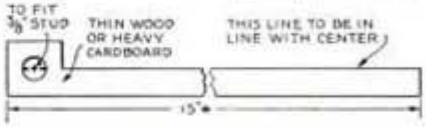


Above: Scribing the spiral by wrapping the wire around a ⅜-in. stud. *At right:* A ½-in. lathe faceplate, drilled through, is used as a hub for the disk. *Below:* A ⅜ to ½ in. bushing is inserted in the faceplate to take the ⅜-in. stud.





The four fundamental steps in the laying out and drilling of an accurate scanning disk. The ⅜-in. stud is used in scribing the circle and spiral.



How the straightedge used in scribing the radial lines is cut from wood or cardboard.

radius of the extreme circle would be 13¾ in. Also, I figured that since 1.2 divided by 60 gave me .02 in. for the diameter of the holes, I would have to use a No. 76 drill.

"That's what comes of buying a lot of stuff without making sure first just what you need," I grumbled as I checked my figures. "Why the dickens didn't you tell me I was wrong when you saw that I had a one-and-one-half-inch neon tube and only a twelve-inch disk. Figuring this way, I'll need a disk at least thirty-one inches in diameter. Where can I get one that large?"

"YOU can make one, can't you?" Don said. "Go down to one of the large hardware stores and buy a piece of sheet aluminum the right size, and cut out the disk. Of course, you can buy a large disk all cut if you want to, but it will cost you more."

Next day I purchased two big squares of sheet aluminum, 20 gage. I bought two pieces because after looking at the small hairlike drills I'd have to use, I wasn't any too sure that I could make a good job of it at the first attempt.

Several nights later I was again in my shop preparing to lay out the spiral and drill the holes. Using the 13¾-in. radius I had obtained by my calculations a few nights before, I drew in the extreme circle on a large sheet of drawing paper and proceeded carefully to step off the 60 equal parts around the circumference. After drawing the radial lines and the spiral having a pitch of 1.2 in., I located the 60 holes. Before going further I scribed a 30½-in. diameter circle for the disk, mounted the square of aluminum on a wood turning lathe faceplate as shown in one of the sketches, and then cut the disk to the circle.

Next, I placed the paper layout over the disk and with a sharp prickpunch located the centers for the holes on the metal. With my flexible shaft drill and some of the fine No. 76 drills I proceeded to drill the holes. I broke five drills before I finished—those tiny drills are such pesky things to work with!

As I lifted my drill from the last hole, I heard footsteps on the basement stairs and I guessed that the light from my cellar window had told Don I was at work.

"Well, Don," I said, holding up the shiny disk, "here she is, all finished!"

"How does it work?" he asked.

"What do you mean, how does it work? Of course it'll work all right, but I'll have to wait until I finish the whole receiver before I can try it out."

"No you won't," Don interrupted. "We can test that disk right now if you want to." As he said this he walked over to the motor, which I had hooked up earlier in the evening, placed the disk on the shaft, and tightened the set screw in the lathe faceplate I was using as a hub.

"Now," he continued, "all we have to do is place a strong light behind that disk with a piece of tissue paper over it framed to the size of the image, and then go around in front and see how it looks."

Working together, we fixed up a drop-light and tissue paper and turned the switch that started the motor. As the large disk gained speed, a small rectangle of light became visible. I was disgusted to find, however, that the illumination was not uniform. The light was streaked with irregular bright and dark bands. Before I could speak, Don said, "Not so hot! Those funny looking bands come from not having the holes accurately located and drilled. Half the fight in making one of these disks is to get the spacing of the holes uniform and arranged on an accurately drawn spiral. The bright streaks are formed by the holes' covering overlapping portions of the ground glass. I'm afraid you won't be able to use that disk in your receiver."

"It's beyond me," I said, keenly disappointed. "Just how would you go about drilling it? I laid the spiral out accurately on a sheet of paper and located the holes carefully. I don't know of any better method than that."

"You made your mistake by laying the holes out on the paper. Why didn't you do all your work right on the metal in the first place?"

"IT'S lucky that I had a hunch I might make a false start and bought two sheets of the aluminum. If you have the time, Don, I wish you'd stay and help me get started right."

Don acquiesced with a nod. "First,"

he said, "we'll locate the approximate center of this square of aluminum by drawing the two diagonals. Then we'll mount the lathe faceplate right over the center. The most important thing in making a television disk," he continued, "is to get the spiral accurate. That's the heart of the whole job. The best way I know of to do that, short of making a complicated special fixture, is to fit a stud having a circumference equal to the pitch of the spiral you desire into the center of the disk. Then, by winding a wire around the stud for one revolution and holding a sharp scriber in a loop at the other end, it is a simple matter to obtain a good spiral. You see, as the wire winds around the stud, it shortens the radius and pulls the scriber in towards the center. One complete revolution will give you the spiral you need. Now let's see—in your case the pitch of the spiral is one and two-tenths inches." He picked up a pencil and began figuring. "From the formula for the circumference of a circle, that will mean that you will need a three-eighths-inch diameter stud. A piece of drill rod will serve very nicely."

"But, Don," I interrupted, "I haven't any steel wire around here."

"YOU play the mandolin, don't you? We can use the metal E string from that. It will be strong and not large enough to introduce any appreciable error. It has a loop on one end, too, that will be just the thing for the scriber point. Another thing," Don continued, "we have a one-half-inch hole in that faceplate, so we'll have to bush it to take the three-eighths-inch stud."

Don slipped the 3/8 to 1/2 in. bushing into place and then inserted the 3/8-in. stud. "Now," he said, as he straightened the E string I had taken from my mandolin, "we are ready to go ahead. First we'll use it to scribe in a fifteen-and-one-quarter-inch radius circle for the outside of the disk."

It didn't take long to scribe in the circle, and when I finished Don picked up the tin shears and cut away the excess metal. After the cutting had been done, he mounted the disk on the motor and trimmed it smooth with a file held against the edge as the disk revolved.

"The next thing to do," Don said, "is to scribe in the thirteen-and-three-quarter-inch extreme circle, divide it into sixty parts, and scribe in the radial lines."

"How can we draw in the radial lines," I asked, "when we have lost our center on the disk and now have a stud in its place?"

Don started making a sketch on a scrap of paper. "While I'm scribing in this circle, you cut out a piece of plywood to the shape I'm sketching. [Center of page 72.] The hole should fit over the stud, and the upper edge should be in line with the center of the hole. You see, we can slip that over the stud and use the upper edge as a straightedge."

When the radial lines were drawn, Don scribed in the spiral, using the steel wire in the method he had described. "The important thing in this operation," he said as he adjusted the length of the wire so that the scriber rested on the intersection of the extreme circle and one of the radial lines before he started to scribe the spiral, "is to be sure that you keep the wire taut. The wire, as it wraps around the stud, will give an accurate spiral automatically."

Working with a magnifying glass, I carefully located the center of each hole with a punch and then, with my flexible shaft, I proceeded to drill the 60 small holes. This time I broke only three drills.

After all the holes had been drilled, we mounted the disk on the motor shaft and rigged up the light to test the accuracy of the holes. "I think," Don said after the disk had reached its full speed, "that while that light coming through is even enough for a television image, we will get better illumination if we run a No. 73 drill through the holes to enlarge them slightly, and countersink each with the point of a larger drill. You see," he explained, "the light is uniform enough, but it is not very brilliant. That's caused by the fact that the portion of the image covered by one hole just butts up against the portion covered by the preceding one. The larger holes will give you a trifle more overlap and consequently better illumination."

"Well then," I said, "I guess that finishes up the scanning disk. The next on the schedule is the short wave receiver and amplifier, isn't it, Don?"

"That's right, and when you build the set don't forget that you have to get an extra loud signal on the speaker if you expect a decent image on the disk. Let me know when you get started."

"I'll let you know," I said as Don climbed the basement stairs. "I'll need your help with that too."

A magnifying glass was used in locating the intersections of the radial lines and the spiral. Accuracy at this point is important.

In drilling the scanning disk, hairlike No. 76 drills were used. Care was taken to keep the drill vertical.

George Waltz is now at work building the short wave receiver and amplifier for his television receiver, and next month he will tell you just what luck he had. Meanwhile, if you have any questions to ask about television, address the Technical Editor, POPULAR SCIENCE MONTHLY, *and inclose a self-addressed, stamped envelope for reply. Be sure to state your questions clearly.*

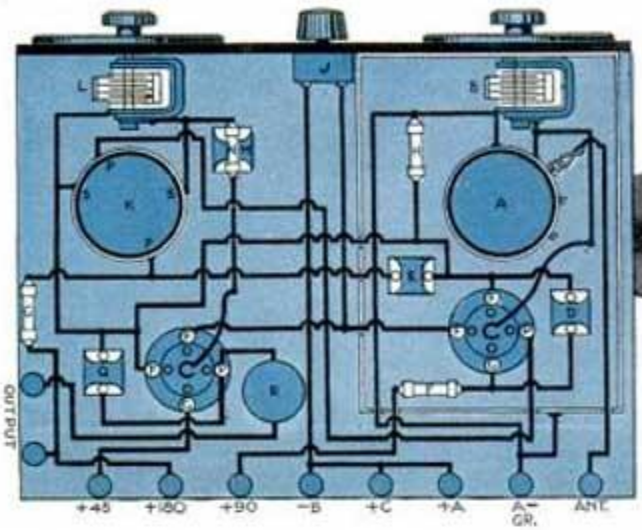
TRASH HEAP PROVIDES PARTS FOR MODELS

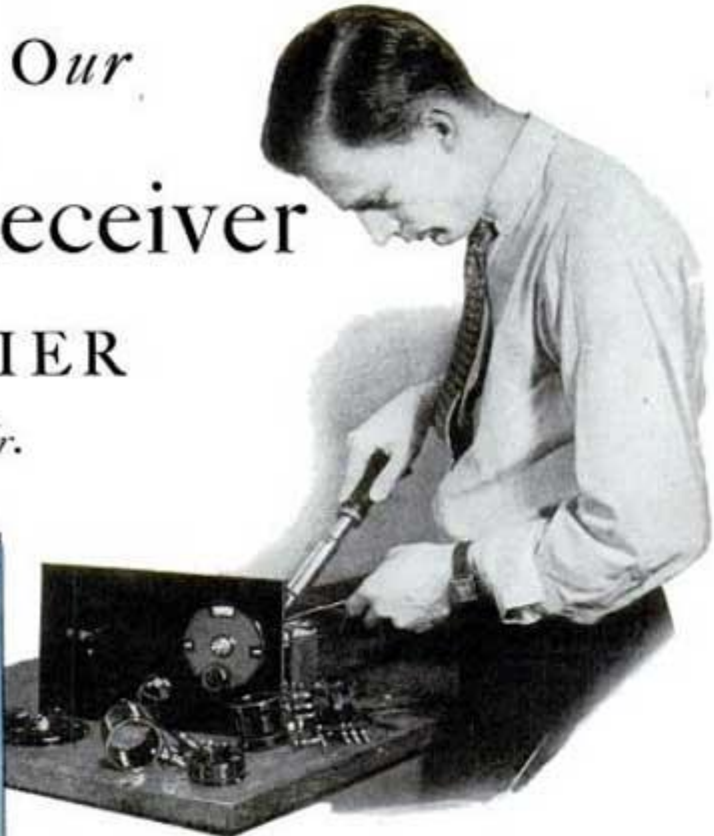
MANY parts of my ship and airplane models were retrieved from the trash heap. It is truly said that the junkman is the ship modeler's best friend. A finished appearance can be given the cabin windows of a galleon or similar ship model by gluing a strip of mesh from an old fly-swatter behind them and painting the wire and the edge of the window openings gold or any desired color. Shoe eyelets, obtained at a shoe repair shop, make inexpensive deadeyes for small, simplified models. It is necessary, however, to borrow or buy the special tool required for pressing the parts together. Pinch them almost closed, with just enough space between the edges to allow the cord to go around. Eyelets also can be used for blocks, and they make neat portholes if glued into tight-fitting holes drilled in the hull.

The fuselage for certain types of scale model airplanes can be turned in a lathe. For planes such as the Lockheed Vega and the Vought Corsair, the fuselage can be turned from nose to tail; then the body is planed to make it oval in cross section. A fuselage like that of the Travel Air "mystery" plane can be turned from nose to rear of cockpit, and the remainder finished by whittling it to shape in the usual way.—W. E. TROUP.

We Assemble Our Television Receiver and AMPLIFIER

By George H. Waltz, Jr.





The author at work soldering a connection on his two-tube television receiver. A tapped antenna coil was used instead of the interchangeable coils shown on the bench directly in front of the set. *At left:* A picture diagram of the short wave receiver unit.

AFTER drilling the scanning disk last month, George Waltz set about assembling his television receiver and amplifier, and in this informative article he tells you how he and his friend Don Marshall did the work. You may not wish to build a "vision" receiver, but if you're at all mechanically minded you'll want to know what makes a television set "tick."

"HERE are the parts I bought for my short wave television receiver and amplifier," I said as I led Don Marshall over to one corner of my basement shop and pointed to the variable condensers, sockets, and other miscellaneous parts piled up on my woodworking bench. "You know when we finished that scanning disk last month you promised to help me with the receiver."

Don, who is a radio expert of long experience and also an experimenter in television, picked up the three-tube resistance coupled amplifier block that had cost $2.95. "Not a bad unit," he remarked. "Have you decided on the hook-up you're going to use?"

"That's where you come in, Don. I've tried to figure out a circuit, but all the diagrams I've seen are Greek to me, so I'm hoping I can take advantage of your short wave experience. The man at the radio store said that with an amplifier unit like that all I'd need would be a simple one-tube short wave receiver."

"Well," Don replied, "most television receivers have one or two stages of tuned radio-frequency amplification. You see the television band is so narrow that you can't get much selectivity without them. It's a real job, though, to assemble two R.-F. stages and shield them properly, so we'll try one stage first. It ought to work on the local stuff anyway, and then later on if you want we can rebuild the set to accommodate the second stage."

"Anything you say goes, Don, but how are we going to test the receiver when we finish it?" I asked. "You know I haven't assembled the scanner yet."

Don grinned. "That's the simplest part of the whole problem. All we have to do is connect the loudspeaker and then tune in on some local television station. If we get an ear-splitting buzz-saw wail that's loud enough to be hard on the ears, we'll know that the set's O. K. as far as intensity of signal is concerned. If we don't, we'll have to look up a better circuit."

"Then as I understand it," I said, "we're going to use a two-tube short wave receiver having one stage of tuned radio-frequency amplification and hook it into that resistance coupled amplifier unit."

Don agreed with a nod as he began sketching out a wiring diagram. While he was busy figuring the values for the various resistances and coils for the two-tube receiver, I cleared the top of my bench, got out my soldering iron, solder, pliers, and screw driver and prepared to go to work.

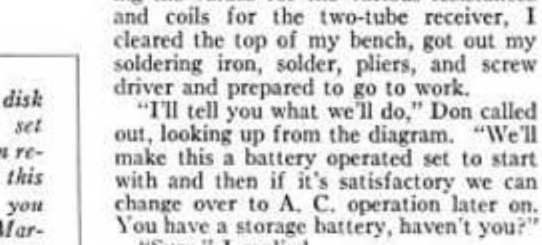
"I'll tell you what we'll do," Don called out, looking up from the diagram. "We'll make this a battery operated set to start with and then if it's satisfactory we can change over to A. C. operation later on. You have a storage battery, haven't you?"

"Sure," I replied.

When Don had finished the wiring diagram, he pulled up another chair and motioned for me to sit down beside him. "In order to make this diagram easy to follow," he explained, "I've placed a letter on each part. This coil, which I have marked *A*, is the antenna coil. It should be wound with number twenty-two double-cotton-covered wire and should have taps taken off at the fifth, tenth, and fifteenth turns."

"What'll we use," I interrupted, "a switch and three taps?"

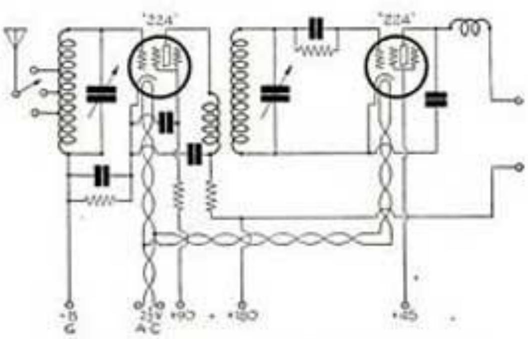
"No," Don replied, "we don't have to go to that much trouble. We can have loops at the fifth, tenth, and fifteenth turns and then by changing an ordinary



Wiring diagram for a three-stage resistance coupled amplifier. Complete units may be purchased, if desired.

Complete Diagrams for "Vision" Sets Run by Either Battery or Alternating Current

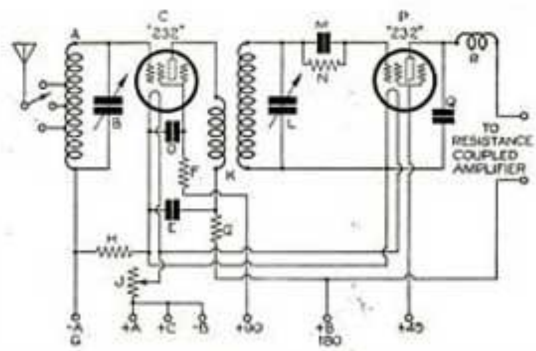
spring clip from one loop to the other we can get the adjustment we desire. Now to go ahead," he continued, tracing the diagram with the point of his pencil, "*B* is a variable condenser having a maximum capacity of .00014 microfarads, and *C* is a type two-thirty-two tube and socket. These resistances, which I have marked *F* and *G*, are a thousand ohms each, and *H* is twenty-five ohms. This twenty-five ohm resistance, which is connected in the negative side of the 'A' battery circuit, causes a voltage drop of about three volts and brings the six volts of the battery down to less than three volts for the tubes. If we were using two dry cells of one and a half volts each instead of the six-volt storage battery, we could omit that resistance because the voltage would be just right. The condensers *D* and *E* are .01 to .1 microfarads. The rheostat *J* should go from zero to fifty ohms and serves to regulate the filament voltage. The part I've designated with the letter *K* is the radio-frequency coil and should be wound with number twenty-two, double-cotton-covered wire. The secondary of this coil should have forty-eight turns, and the primary, which can be wound over the lower part of the secondary, should have twenty turns of the same size or smaller wire."



The short wave hook-up wired for A. C. operation. In this case, type 224 tubes and sockets are used.

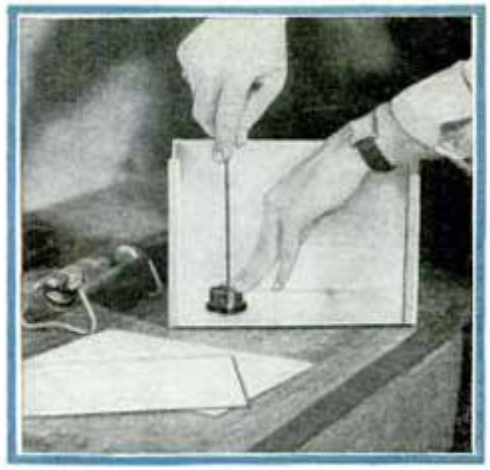
"Can I buy a coil like that?" I asked.

"Oh, I suppose you can," Don replied, "but why bother about that? We can wind one in less time than it would take to buy it. I think I have some number twenty-two wire at home. I'll go over later and see, but first let's finish going over this circuit. The variable condenser *L*," he resumed, "is the same as condenser *B* and is connected across the the secondary coil. Connected in



Battery hook-up for the two-tube short wave television set having one stage of radio-frequency amplification.

parallel into the wire which leads from the secondary of the coil to the control grid of the tube are a .0001-microfarad condenser *M* and a half-megohm resistance *N*. Part *P* is the detector, which is another type two-thirty-two tube. *R* is a radio frequency choke, one end of which forms one of the output terminals to the resistance coupled amplifier; the other side of the output comes from the resistance *G*. That finishes the short wave re-


To cut down regeneration and interference, the radio-frequency stage was placed in an aluminum shield.

ceiver. With that amplifier unit we won't have to worry about the amplifier circuit, but I've drawn one up for you so you can see what it looks like on paper.

"There's just one more thing about this circuit," Don continued when I had finished studying the diagram. "In order to reduce regeneration and interference to a minimum, we'll put the antenna coil *A*, the condenser *B*, socket and tube *C*, condensers *D* and *E*, and resistances *F* and *H* in an aluminum shielding can. If we find, when we start assembling the set, that it is more convenient, we can put the rheostat *J* in the can also, but it's not necessary."

"I'll have to visit the radio store again and pick up one of those shields, but before I go I think I'll check up on the other parts and see if I've all I need."

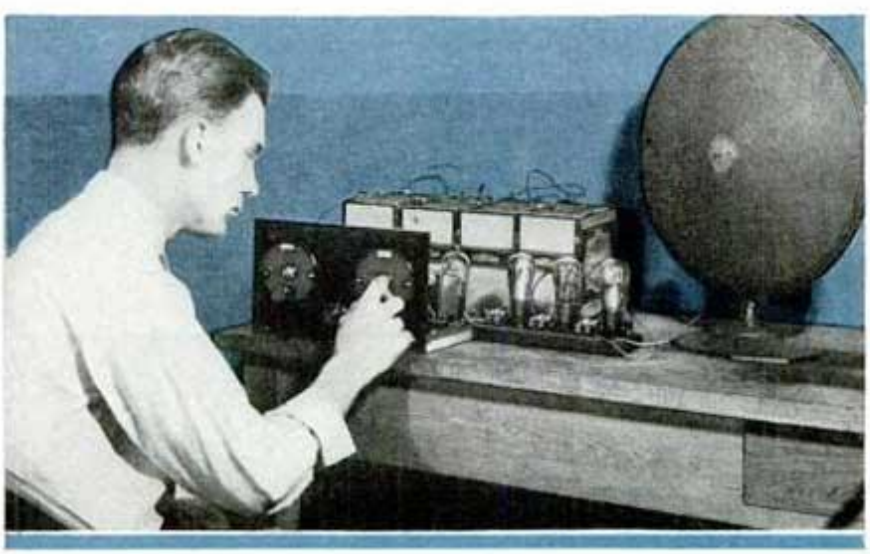
"Come to think of it," Don replied as he put on his coat, "I believe I've got just the size shield we'll need. I'll go home and look around for it."

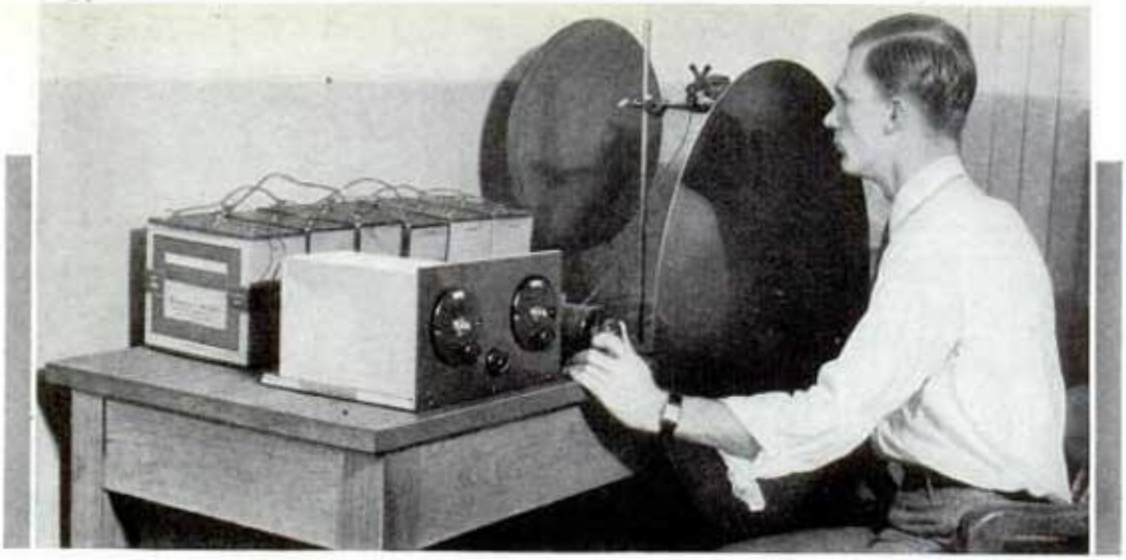
Don returned soon with a spool of number twenty-two wire and a rectangular shielding can. Working together, it didn't take us long to assemble the short wave receiver and connect it to the amplifier.

"Now comes the test," Don said hopefully as he hooked up the loudspeaker into the output of the amplifier.

As Don turned the dials on the receiver, I crossed all my fingers and hoped for the best. Almost immediately he succeeded in picking up the peculiar television signal of some station and after making a few adjustments brought the signal in loud enough to satisfy his critical ear. "This circuit," he said, "isn't the best possible for the job, but it'll work fine for the local stations and when you get better acquainted with the circuit we can rip it apart and rebuild it with two radio-frequency stages. The best thing to do now is assemble your scanner so we can try the two units out together. The proof of this puddin' is in the seeing."

Next month, George Waltz will tell you how he went about assembling the scanner and will report on the quality of the image he obtained.


When we had finished assembling the short wave receiver, Don connected a speaker to the output of the resistance coupled amplifier and we tested the hook-up for intensity of signal.



The author adjusting the disk speed on his five-tube television receiver

How to Complete Your Television Receiver

By GEORGE H. WALTZ, JR.

"DID you happen to see this?" Don Marshall asked as he sat down in one of the wicker chairs on our porch and handed me a long newspaper clipping. "I noticed it in today's paper."

The headline on the clipping read: "S. S. LEVIATHAN AT SEA IN TELEVISION TEST; *Television Receiver on Board Vessel in Mid-Ocean Picks Up Images from Washington and Boston Stations.*"

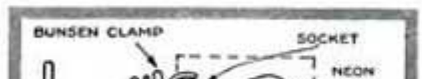
"Interesting, isn't it?" said Don, who is a veteran radio experimenter, as I finished reading. "Television may be a long way from perfection but it certainly has reached the point where it's getting a lot of public notice. Incidentally, how is your television receiver coming along?"

"Not so good Don," I confessed. "It's the same old story. I don't know just how to go ahead. I've painted the disk with flat black and cleaned out the holes by running the drill through, but I'm puzzled about the next step. If you've got some spare time, I wish you'd show me how to mount the neon lamp and connect up the motor."

He followed me to the basement, and as I switched on the lights I reminded him that the last time he had been in to give me a hand we had finished assembling the receiver (P. S. M., Oct. '31, p. 82).

"Then all that's left is to assemble the scanner and rearrange the last stage on the amplifier so as to obtain a C-bias voltage regulation for the neon lamp," Don said.

"You mean to say we haven't finished messing around with the wiring yet!" was my somewhat disgusted reply. "I thought we finished the receiver last time."



At left: Three ways of mounting a neon lamp. The mask and the lamp should be placed close to the disk

"So we did," Don rejoined grinning, "but now that we're going to hook in the neon lamp we must make some provision for controlling the definition and contrast of the image. It's a simple change."

With this Don hurriedly sketched out a wiring diagram and started explaining what it all meant. "You see," he began, "in order to get the best results we have to supply some means for regulating the quality of the image. This can be done by regulating the C-bias voltage. Up to the resistance which I have marked *Z*, the circuit for the amplifier is just the same as we have it at present (see drawing P. S. M., Oct. '31, p. 82). Now, instead of bringing the lead from the resistance *Y* down to our -C terminal, we connect in a ten-thousand-ohm, wire-wound potentiometer marked *A*, one forty-five-volt B-battery, and a small twenty-two-and-a-half-volt B-battery. Do you follow me?"

"As far as you've gone, yes," I replied, "but what's that condenser marked *B* doing in there?"

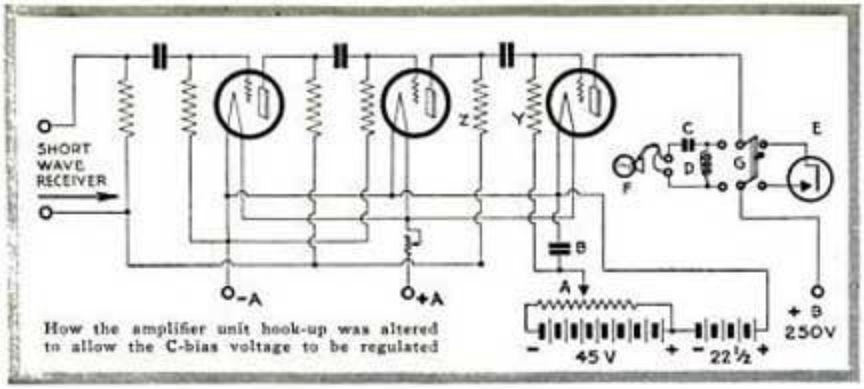
"That two-microfarad condenser," Don explained, "serves as a current reservoir and maintains the flow of current during any possible breaks in the circuit caused by the slider as it moves from one wire to the next."

"In other words," I interrupted, "since it is connected across the C-bias, it stores up current when the slider is in contact and gives off this current when the slider is not in contact."

"That's right," Don agreed. "Now, in order to allow you to change quickly from your loudspeaker *F*, which you will use to tune in the signal, to your neon lamp *E*," he continued, "we must put in the double-pole, double-throw switch *G*. The iron-core choke *D* and the condenser *C* serve as a by-pass for the plate current, which, with two hundred and fifty volts, would be likely to burn out the speaker windings."

"I thought you said that there wouldn't be many changes," I said jokingly.

"Well, I'll tell you what we'll do," Don



How the amplifier unit hook-up was altered to allow the C-bias voltage to be regulated

suggested. "I'll sketch out several ways for you to mount your neon lamp and show you how to connect up your variable speed motor, and then while you're doing that I'll change your amplifier hook-up."

When Don had finished sketching (see drawing on page 86), we both started at our appointed jobs. After studying over Don's suggestions for the neon lamp support, I decided that since I had the Bunsen clamp, clamp fastener, and support on hand in the assortment of apparatus I used on my chemistry bench, I'd use the arrangement shown at *A*. I figured that, besides being the easiest method, it had the advantage of allowing for horizontal and vertical adjustment. Later on, when I wanted to mount the set in a cabinet, I could use the variation at *C*.

Working together, we soon had the parts all ready and assembled. As the last connecting wire on the batteries was placed, Don began explaining the procedure in tuning in a station.

"First," he began, "we throw the double-pole, double-throw switch to the speaker side, turn up our tube rheostats, and then turn the dials on the receiver slowly until we pick up the buzz-saw television signal of some station. Then when we have regulated the condensers and rheostats to get as loud a signal as possible, we throw the switch to connect in the neon lamp."

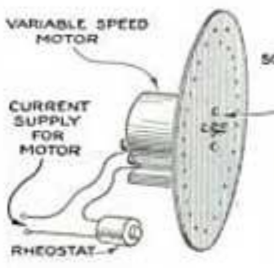
AS HE talked, Don went through the operations. As he threw the switch connecting in the neon lamp, I noticed that the plate of the lamp gave off the familiar pinkish glow I had seen when I visited the television studios of station W2XCR (P. S. M., July '31, p. 16). Don was watching the disk.

"Now that the set is in operation," he said, "the main problem is to get the disk to revolve in synchronism with the disk at the transmitter. We do that by regulating the speed of the motor with the rheostat so that it is just a bit in excess of the speed of the motor at the transmitter, which is, in sixty-line scanning, twelve hundred revolutions a minute, and then by using the thumb of the right hand as a brake, we slow down the disk just enough to obtain the right speed."

"How do we determine the speed?" I asked. "With a tachometer?"

"If you want to," Don replied, "but the simplest way is to watch the image space. When the speed is wrong, all you'll see will be a jumble of spots and streaks. Then all you do is increase the speed until you see a distorted image which will slant off, first to one side and then to the other. Then, by slowing the motor down a trifle with your thumb, you can bring the disk into synchronism. When you've done this, the image will settle down. However, the image you obtain," he continued, "may be out of frame. That is to say, instead of seeing one complete picture you'll see half of one image and half of the image directly following it. If this is the case, increase the thumb pressure so as to slow down the motor appreciably and then proceed to synchronize over again."

When Don had finished explaining, he shut off the motor. "Here, try your hand



Hook-up for the variable speed motor. If a synchronous motor is used the rheostat, of course, must be omitted

at it yourself and see what kind of an image you can bring in," he said.

I seated myself in a position where I could manipulate the motor rheostat and also conveniently adjust the pressure of my thumb against the disk.

"Careful!" Don warned as I turned up the motor rheostat. "You'd better use this old garden glove of yours to protect the thumb you're going to use as a brake."

As I turned up the rheostat, I noticed spots and brilliant streaks speeding back and forth across the image space. As the speed increased, the spots and streaks slowed down, and a distorted image, which first slanted off to the right and then to the left, appeared. I placed my thumb against the edge of the disk. As I did so, the faint, side-slipping image turned again into a dazzle of streaks and spots. This told me that I had slowed the motor too much, so I decreased the pressure. After a dozen or so trys, I succeeded in getting the image to stand still. As I studied it, I saw that it was printing.

"Well," Don asked, "what've you got?"

"I've got some printing," I replied enthusiastically, "but it seems to be upside down. What causes that?"

"Is the image black on white, or white on black?" Don asked.

"It's black on white just like a newspaper," I replied, "but it's printed upside down."

"The sign's all right," Don explained, "but your disk is mounted on the motor backwards and is placing the spots of light in the wrong order. Shut off the motor. We can remedy that in a jiffy.

"You see," Don went on as he removed the disk from the shaft and turned it around so that the face which was turned toward the motor was now facing forward, "the holes in this disk weren't passing by the plate of your neon lamp in the same order as the holes in the disk at the station. In other words, when the first hole at the outside of the spiral on the transmitting disk was passing the upper left-hand corner of the picture area, the last hole at the inside end of the spiral on your disk was passing a point at the lower left-hand corner of the plate in your neon lamp. Your disk was assembling the units of the picture upside down."

"Oh, I see," I said as the explanation finally filtered through. "Then by reversing the disk as you have done, the spiral in my disk will be revolving in the same manner as the one at the transmitter."

"That's right. Believe me, you're lucky you didn't find more wrong than that. And you know," Don continued, "if you want to, you can use a synchronous motor for the local stations operating off the same power line that supplies your house. Then you won't have to synchronize with your thumb. Many times, even if the station is not on the same power line, the current is held so close to sixty cycles that you can use a synchronous motor with fairly good results."

This is the fifth article in Mr. Waltz's television series, which began in the July issue. Another television article is scheduled for next month.


In order to eliminate reflections, a coat of flat black paint was applied to the surface of the scanning disk