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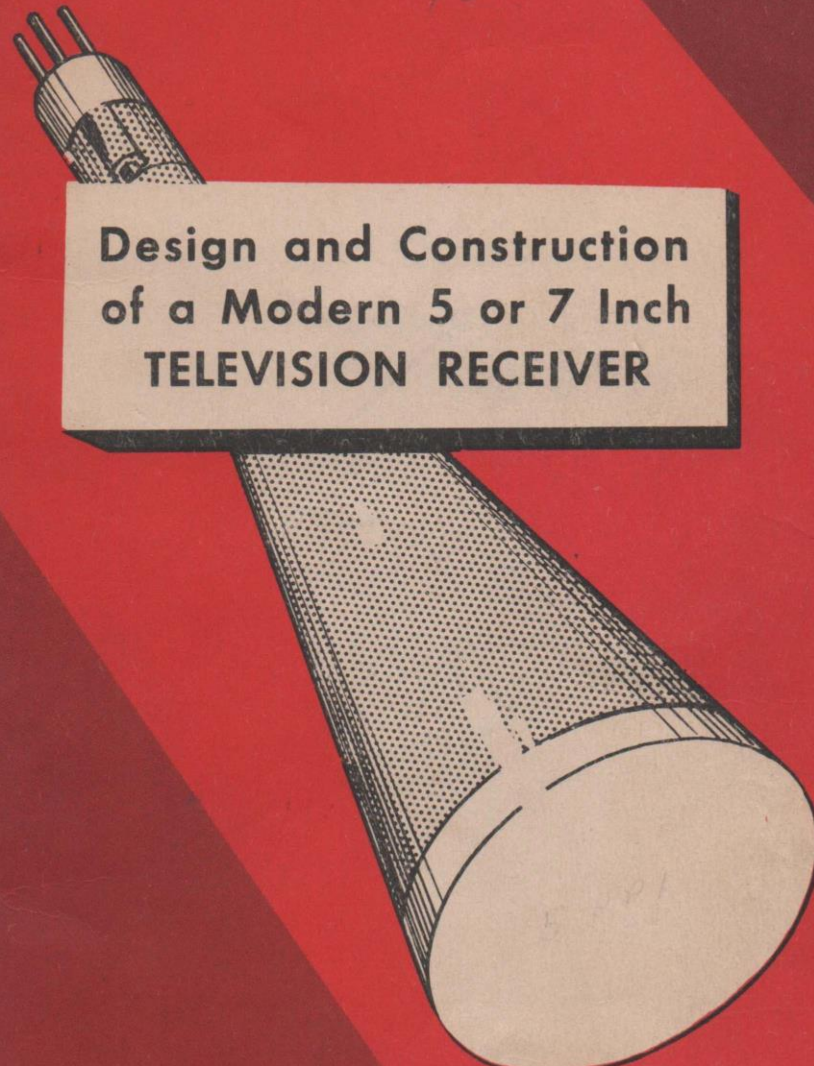
Design and Construction of a Modern 5 or 7 Inch TELEVISION RECEIVER



VISION RESEARCH LABORATORIES

Design and Construction of a Modern 5 or 7 Inch TELEVISION RECEIVER

by
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VISION RESEARCH LABORATORIES
Kew Gardens, New York

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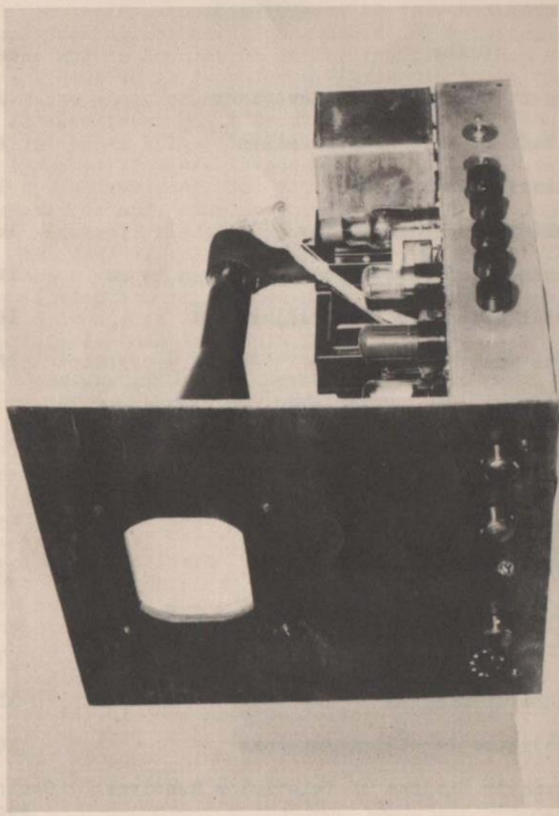


A Practical Television Receiver.

The present day television receiver is similar in many respects to pre-war designs. However, new and improved tubes and simplified design techniques have made construction and adjustment of the modern television set hardly more costly or complicated than that of an ordinary communications receiver. Standard practice of present day receivers is to include a stage of r.f. amplification ahead of the mixer. This not only improves sensitivity but also minimizes the possibility of interfering with neighboring television receivers due to leakage from the local oscillator. Another feature now included in television receivers is that of FM sound reception which results in improved quality over the old AM method. As for circuit details the reader may compare modern circuit design with pre-war design and he will find that many simplifications have been effected. The only portions of the set which may be totally unfamiliar to one not acquainted with television circuits are those relating to scanning and synchronization.

Three main considerations determine the design of the television receiver about to be described: cost, simplicity and foolproof operation. To keep costs down, the design incorporates inexpensive and readily available components. Simplicity and foolproof operation are closely related to each other and toward this end, the number of tubes and necessary adjustments consistent with satisfactory performance is kept at a minimum.

Figure 1 shows a block diagram of the basic circuit and the function of each tube in the set. There are eighteen tubes required to perform all functions necessary to provide simultaneous picture and sound reception. Front panel controls (Refer to parts layout and photograph) are: tuning, volume control, brightness, and contrast. Other controls, not on the front panel only require occasional adjustment and therefore do not complicate operation of the receiver.

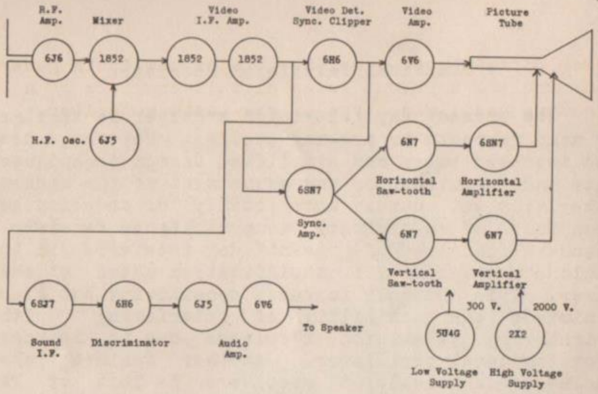


Fig. 1

Two power supplies are included one the low voltage (300 volts), the other, the high voltage supply (2,000 volts). The "front end" consists of an r.f. amplifier (grounded grid type), mixer and local oscillator. The picture or video I.F. channel consists of two stages of I.F. amplification which differ from any conventional I.F. amplifier only in the degree of coupling used in the transformers. Figure 2 shows a response curve of the picture I.F. amplifier and from this curve can be seen the correct position of the sound and picture carriers. At the output of the sound I.F. amplifier a discriminator and an audio amplifier produce sound reception. A double diode is used at the output of the video I.F. amplifier to perform a dual function, namely as a detector for the picture (video) components of the signal and to separate the synchronization pulse from this signal (clipping). The output of the video detector is amplified and then applied to the picture tube control grid where the rapid fluctuations in voltage are translated to variation of light intensity on the face of the cathode ray tube. The synchronization pulses which are literally sheared off the composite television signal by the clipper detector are applied to the sweep circuits. The horizontal sweep circuit uses a multi-vibrator saw-tooth generator and the vertical sweep circuit consists of a blocking oscillator type of saw-tooth generator.

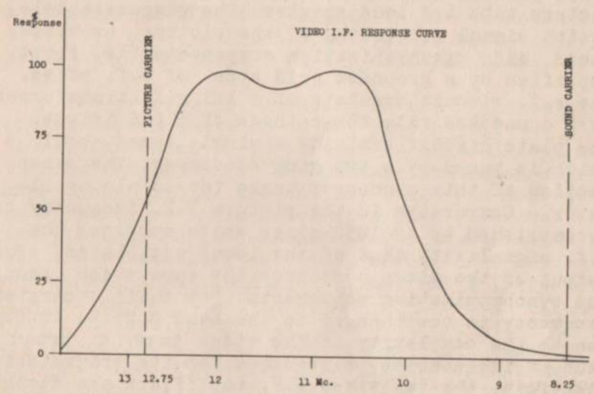


Fig. 2

Circuit Details and Operation.

The circuit and its functions may best be described by tracing the signal as it is received at the antenna input terminals step by step to the picture tube and loud speaker. The composite television signal consisting of the picture or video, sound and synchronization components is first amplified by a grounded grid type of r.f. stage. The r.f. circuit consists of a 1:1 r.f. transformer (T1) connected into the cathode of a 6J6 triode. The plate circuit contains a single tuned coil, which is tuned by a two gang condenser. The other section of this condenser tunes the local oscillator. Conversion to the picture I.F. frequency is accomplished by an 1852 mixer which combines the r.f. signal with that of the local oscillator. The output of the mixer containes the same video sound and synchronization components, but their carrier frequency is now changed to the band 8.25 to 12.75mc.. Due to the complexity of the video wave a broad band of frequencies is required for its transmission. Therefore, the two video I.F. amplifiers are designed to cover a broad band of frequencies extending from about 10 to 12.75 mc.. There is also a small amount of amplification to the sound signal (8.25mc.) but this response is not sufficient to cause noticeable interference to the picture signal. It will be noted, referring to the schematic in the center of the book, that a three turn link is coupled to plate circuit of the output of the video I.F. transformer for the purpose of feeding the 8.25 mc. sound signal to the sound I.F. amplifier. The output of the video I.F. amplifier is fed to the 6H6 detector-clipper circuit where the video signal and synchronizing pulses are separated from the carrier or "detected". The video signal, containing all the necessary intelligence to reproduce a television picture is amplified and then applied to the cathode ray picture tube. In the video detector and video amplifier note coils L3 and L4. These coils are called "peaking coils" and their purpose

is to improve the high frequency response of the amplifier and provide ample gain. This high frequency response is necessary in order to preserve the definition or fine details of the reproduced picture. It now remains to be shown how the picture components as they appear on the cathode ray tube face are synchronized or put in their correct positions with respect to the original scene.

The process of scanning in the television pickup camera and also in the picture tube of the television receiver is similar to that of a person reading a newspaper. The picture is broken up into many lines, 525 by present day standards and each group of these lines makes up a page or frame of the picture. A fine cathode ray beam scans those 525 lines from left to right, each line separately, and moving down the page or frame until it reaches the bottom and then starts out on the next frame etc. The eye interprets the resultant pattern as a rectangular area of light called the scanning raster. Thus two sweep circuits are operating simultaneously, one to sweep 525 lines* and the other sweep circuit to turn the pages or change the frame. This latter sweep circuit operates at a rate of 60 c.p.s. and produces a stanning raster that consists of 525 linesrecurring 30 times each second. While the cathode ray tube spot is scanning the face of the cathode ray tube its intensity is being modulated by the video signal and if the scanning generators are in exact synchronism with the scanning generators associated with the pickup camera at the transmitter, then a picture will be reproduced that is very much like the original scene. The horizontal scanning generator generates

*This explanation is purposely simplified to illustrate the method of scanning and, therefore, does explain the present day system of interlaced scanning. For further explanation the reader is referred to a bibliography at the end of this booklet.

a saw-tooth wave-form operating at a frequency of 15750 c.p.s. and the vertical scanning generator a frequency of 60 c.p.s. The synchronization of the scanning generators is accomplished by applying the synchronization pulses after they have been amplified at the synchronization amplifier (see figure 1) to control a local oscillator which in turn initiates the saw-tooth sweep. The output of the synchronization amplifier consists of positive pulses which are applied to the vertical blocking oscillator and negative pulses which are applied to the horizontal multivibrator. Filters consisting of components R31, R32, C38, C39 and C50, C51, R49 (see schematic) are for the purpose of filtering the synchronizing pulses so that only 60 c.p.s. pulses appear at the vertical blocking oscillator and 15750 c.p.s. pulses appear at the horizontal multivibrator. The multivibrator and the blocking oscillator produce strong synchronized pulses which are converted into a saw-tooth wave which is then amplified and applied to the cathode ray tube deflection plates.

The low voltage power supply is conventional and total power requirements are 300V at about 150ma.. The high voltage power supply consist of a high voltage low current (2,000V 2ma.) transformer with r.c. filtering. Taps for the second anode and first anode (focusing) voltage are taken off the bleeder and picture brightness is varied by control R33 in the cathode of the cathode ray tube which adjusts the cathode-grid potential.

Reference to the parts layout on page 26 will give an idea of the controls used in the receiver.

Constructional Details.

Before construction is started it is well to study carefully the parts layout. This diagram is not drawn to scale but major dimensions are given and the indicated position of components is in proportion to the correct position on the chassis. The dimensions given will be helpful in chassis drilling and the mounting of the main parts. The chassis size recommended is 17" x 13" x 3". If desired a chassis of larger dimensions may be used although this is not necessary. When mounting tube sockets note the correct position for the tube pins to point. This is indicated by small arrows in the parts layout diagram. The arrow is placed between pins 1 and 8 (1 and 7 on the 6J6) on each socket. By following this procedure shortest leads and most convenient arrangement of parts will result. Figure 3 and reference to the parts list on page 24 will provide all the necessary details for r.f., I.F. and peaking coil design. All these coils are simple solenoid windings and except for the I.F. and discriminator transformers, they are mounted simply by threading a small hole at one end of the coil form and screwing directly to the chassis. The I.F. coils are mounted horizontally with two screws and spacers one at each end. This is shown in figure 3A.

VIDEO I.F. TRANSFORMER

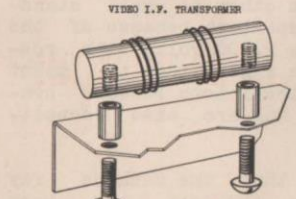


Fig. 3A

DISCRIMINATOR TRANSFORMER

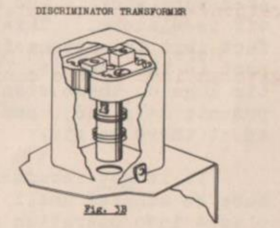


Fig. 3B

In order to reduce costs and eliminate complicated mechanical design, the video I.F. coils are tuned with trimmers instead of iron cores. The trimmers are mounted simply by soldering one end to a tie lug and the other to its associated tube socket pin. This arrangement provides adequate mechanical and electrical stability. The trimmer adjusting screw should face the chassis and a 3/8" hole drilled above each trimmer to provide easy adjustment from above the chassis. This will be found most convenient when aligning the receiver.

In wiring, the usual hook-up wire will suffice for low voltage circuits. However, care must be taken on all wires that are at high potential (2,000 volts). Here, wire with heavier insulation must be used, preferably a 5,000 volt rated covering. It will be noted in the parts layout diagram that a bakelite strip supports three of the potentiometers, namely the focus, vertical centering, and horizontal centering adjustments. This eliminates the need for specially insulated controls. The dimensions of the strip are 1" x 4" of ¼" bakelite or polystyrene and it is mounted over three one inch socket holes punched in the chassis to provide insulation between these three controls and chassis. Other high voltage points to be noted are the mounting of C47, C48 and C56, C57. Reference to parts layout diagram will show that these condensers are connected on one end to their associated tube sockets and on the other to small standoff insulators. This is important because of the fact that this connection is 2,000 volts with respect to the chassis. It is a good idea to mount tie lugs on these standoff insulators because components R47, R48, and R60, R61 are also connected at these points.

It is <u>not</u> recommended that the cathode ray tube be mounted until after the set has been placed into operation and the initial tests and adjustments to be described later are made. During the adjustments that follow completion of the set,

it is well to keep the cathode ray tube in its original container just opening front and back of the container so that connection to the set may be made and the tube face observed. When mounting the cathode ray tube it is advisable to keep it as far as possible from transformers, filter chokes, etc. In a compact arrangement it may be necessary to shield the tube from stray magnetic fields which may cause picture distortion, or difficulty in centering. Such a shield is available commercially and is designed to fit the particular cathode ray tube that is used.

Preliminary Measurements.

First be sure that all wiring has been carefully checked against the schematic diagram. Then turn on set to make preliminary measurements. When set is first placed in use do not advance brightness control any further than is necessary for switching set on. This will prevent a bright spot from appearing on the tube first before the sweep circuits have warmed up. A bright concentrated spot such as this may impair the life of the picture tube or burn small areas of the tube face.

After the set is allowed to warm up for a few minutes, it is important to measure voltages at various points in the circuit as a double check on wiring and also on component parts ratings. Table 1 below, shows <u>approximate voltages</u> to be expected at the indicated points in the circuit. Measurements may be made with a 20,000 ohm/volt meter except where indicated otherwise.

TABLE 1

CIRCUIT	DC VOLTS APPROX.
6V6 Video Amp. Plate (at tube socket)	200
" " " Screen "	100
6AC7 I.F. Amp. Cathode "	1.8
" Mixer Plate "	280
" " Control Grid "	*2-4 (neg.)
6J6 RF Amp. Cathode "	.5
6SJ7 Sound I.F. " "	2
6J5 " Amp. " "	5
6V6 " " " "	15
6SN7 Sync. Amp. Plate 1	250
" " " " 2	250
6N7 Horiz. Saw-tooth Plate 1	*150
" " " " " 2	* 80
6N7 Vert. " " " 1	* 50
" " " " " 2	300
6SN7 Horiz. Amp. Plate	*125
6N7 Vert. Amp. Cathode	* 6
Picture Tube 1st anode	2000
" " 2nd " (Focus)	300 - 500
" " Cathode-grid **	0 - 50

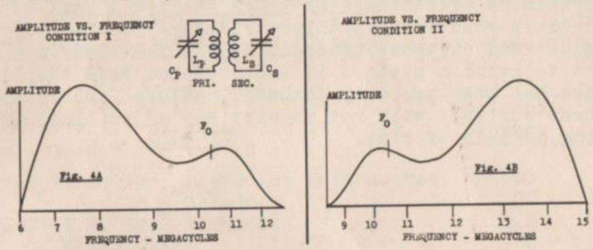
It is recommended that these measurements be made with a 20,000 ohm per volt meter or better still a Vacuum Tube Volt Meter. After the voltage measurements have been made, advance the brightness control until the picture tube face becomes lighted (moderate intensity). Then adjust focus control until the scanning lines are discernable. It should now be possible to set the size of the scanning raster with the horizontal and vertical size controls. The correct size setting is approximately 5 1/4" wide x 4" high when a 5" picture tube is used or 7" wide x 5" high for the 7" tube. This setting will result in cutting off the corners of the picture, however, not much of the average scene is lost, but an increase in picture size is thus obtained. If it is found that the raster is not centered on the tube, adjustment of the horizontal and vertical centering controls will rectify this. Further "touching up" adjustment on these controls may be necessary when the television picture is received but once the picture has been properly focused, centered and "sized" these controls will not require any adjustment over long periods of time.

* Measured with Vacuum Tube Voltmeter.

** Picture tube grid should never be positive with respect to control grid.

Alignment of Television Receiver.

The process of alignment of a television receiver is different than that prescribed in adjusting narrow band receivers such as broadcast superhetrodynes. It is very important that the alignment of the television set be done correctly if best results are to be obtained. Improper alignment may cause poor definition or blurring of the picture, poor synchronization which is evidenced by the tendency for the picture to tear horizontally or drift vertically or in pictures that either lack contrast or are too contrasty. This is particularly true in aligning the I.F. amplifier since the overall response curve is determined mainly in this portion of the receiver.



NOTE: Fig. 4 illustrates the effect of improper tuning of an overcoupled tuned transformer, such as that used in the video I.F. amplifier (T2, T3, T4). Assume the secondary tuned circuit (Ls, Cs in the above figure) to be tuned to a fixed frequency, (Fo). When the primary circuit is tuned to the same frequency as the secondary than a symmetrical selectivity curve will result, as in Fig. 2. If the primary is resonated to a lower frequency than the secondary then a curve similar to Fig. 4A will result. Tuning the primary too high in frequency causes a similar effect except that the greater peak is on the high frequency side of Fo.

To align a television I.F. amplifier, it is necessary to know the selectivity requirements and also to understand the behavior of the I.F. circuits that are used. The explanation that follows will enable the experimenter to realize the optimum performance of this receiver with a minimum of time and equipment. The equipment required will be an ordinary serviceman's signal generator and a D.C. Voltmeter of the 20,000 ohm per volt variety. Figure 2 shows how the response or gain of the I.F. amplifier varies within the required band of frequencies. This curve is obtained when alignment has been correctly made. The important points to note are that the response curve is tuned to 50% of maximum amplification at 12.75 and at 10 mc.. There may be irregularities between those two points but they will not be troublesome if they are never less than 70% of the highest peak which in this case is at 12 mc.. This is the condition to strive for and if coil specifications have been closely adhered to, there should be no difficulty experienced in this design. The test set-up for I.F. alignment is illustrated in Figure 5. The first step is to carry out tuning ad-

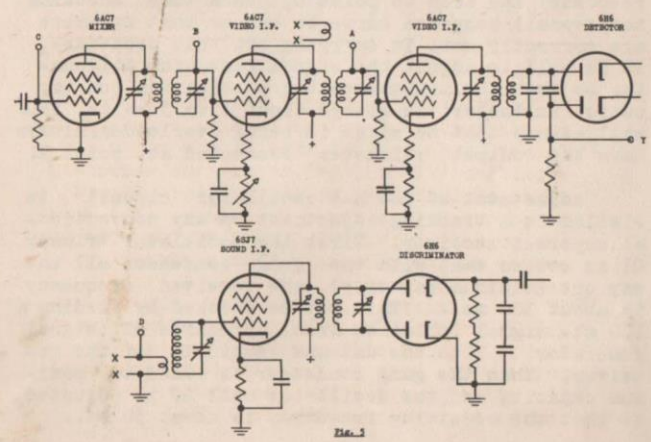


Fig. 5

justments with the generator connected to point A (Figure 5). The generator is set for maximum output on 11.3 mc.. Trimmer C28 (see schematic diagram) is tuned to highest capacity and trimmer C29 is tuned for maximum response as indicated on voltmeter. Then the capacity of trimmer C28 is reduced to about the same setting as trimmer C29 and the response characteristics of the last I.F. stage may then be checked by tuning generator from 7 mc. to 15 mc.. If trimmer C28 is incorrectly set then either of two conditions may exist. These conditions are illustrated in Figure 4A and 4B. Comparison of Figure 4A and 4B with results obtained will indicate whether C28 should be increased or decreased in capacity. (Once the tuning of T4 is completed C28 and C29 should not be touched.)

Before proceeding any further with alignment, study Figures 4A and 4B carefully as it will provide a clue to incorrect adjustments that may occur later. Repeat the same process,moving generator to point B, (tuning C22 to maximum capacity and C23 for maximum output, then retuning C22 for the proper response) and then to point C, each time checking the overall response curve to assure that trimmers are correctly set. In carrying out this procedure, it is well to adjust the signal generator attenuator so that the maximum voltage indication (on the output voltmeter) is always about 1 to 3 volts. This will assure that no stage is being overloaded. Always have the output voltmeter connected at point Y.

Adjustment of the R-F oscillator circuit is similar to a tracking adjustment on any conventional superhet receiver. First the oscillator trimmer C1 is set so that with the gang condenser all the way out (minimum capacity) the received frequency is about 100 mc.. This may be checked by feeding a 100 mc. signal (obtained from harmonics of signal generator) to the antenna terminals of the receiver. Then the gang condenser is tuned to maximum capacity and the oscillator coil L2 is adjusted so that the receiving frequency is about 50 mc..

Trimmer C2 (RF Amp.) should be tuned for maximum output at the highest frequency (100 mc. approx.) and L1 adjusted for maximum output at the lowest frequency (50 mc.).

Alignment of the sound I.F. channel is the same as for any FM receiver. The signal generator tuned to 8.25 mc. is connected at point D (in figure 5)and is tuned to a null point (minimum response).Trimmers C58 and C63 are then tuned for maximum speaker output (with signal generator slightly detuned from 8.25 mc.). Then tune C65 to a minimum or null at 8.25 mc..The loudspeaker is used as output indicator.

After these initial adjustments have been made the receiver is ready for operation. Some further "touching up" will be required after the television signal is tuned in, but this should not be attempted until a satisfactory antenna installation has been made. Before the received picture is discernable, it will be necessary to adjust both horizontal and vertical speed controls until the picture is correctly synchronized. Proper synchronization will be evidenced by a "locking in" of the picture so that it is stationary on the screen and does not drift vertically or tear horizontally.

The Installation and Final Adjustment.

One of the most important parts of your television receiver is its antenna. The requirements as in alignment and circuit design are much more exacting and subject to difficulties than in the ordinary broadcast receiver. The eye is more sensitive in discrepancies in what it sees than the ear is about what it hears. Therefore, care must be taken in the antenna installation to minimize reception of unwanted interference such as reflection from buildings, man made noise and poor sensitivity. Reflection of the television signal from surrounding buildings will manifest itself as a double or blurred image on the television screen. Excessive noise and poor sensitivity will result in loss of picture detail as well as tearing or drifting of the picture. The type of antenna required depends a lot upon the location of the receiver. In the average location not too far distant from the television transmitter, an antenna of the type illustrated in Figure 6 will serve admirably. This antenna is called the Folded Dipole and is used with the 300 ohm ribbon type transmission line. In order to balance the feeder system so that it doesn't pick up man made noises, the feed line may be twisted or transposed at random points as it is fed into the house. The antenna illustrated in Fig. 6B may be used where higher sensitivity is required as in locations near the end of the service range of the local television broadcast station.

"FOLDED DIPOLE"

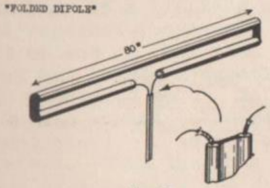


Fig. 6A

"FOUR HALF WAVES IN PHASE"

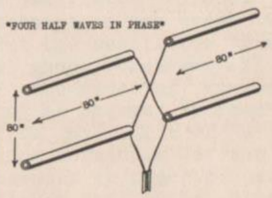


Fig. 6B

After the installation has been completed a local television station should be tuned in and "touch up" adjustments then made. First be sure a local station is operating at the time you tune in (this can be ascertained by consulting your newspaper or the local station). Turn on receiver, remembering not to advance the Brightness - AC switch control too far. As the tuning control is turned starting from the high frequency end of the band, reception of the television signal will be evidenced by a loud buzz in the speaker. When this "buzz" is received the dial should be turned carefully until the sound is heard clearly. The tuning control should be set where the sound is strongest and the buzz disappears. Increase Brightness until light is visible on the cathode ray tube screen. The un-synchronized picture will then appear as a pattern of light streaks on the screen. Tune the horizontal speed control until the picture becomes discernable. If the picture is drifting rapidly upward or downward, adjust the vertical speed control until stationary. The picture may then require re-focusing and also adjustment of contrast. Adjustment of the contrast control should be carried out in conjunction with the brightness control. For increasing picture contrast the contrast control should be increased and brightness reduced. The reverse is true when a less contrasty picture is desired.

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PARTS LIST

CAPACITORS

Legend	Value	Substitution
C1	2-10 uuf trimmer	2-25 uuf
C2	2-10 uuf trimmer	2-25 uuf
C3, C4	dual 5-25 uuf Gang	
C5	50 uuf	
C6	.002 uf	.001-.005 uf
C7	.002 uf	.001-.005 uf
C8	.001 uf	
C9	.002 uf	.001-.005 uf
*C10	1-2 uuf	see note
C11	250 uuf	
C12	.002 uf	.001-.005 uf
C13	.001 uf	
C14	.002 uf	.001-.005 uf
C15	.002 uf	.001-.005 uf
C16	2-10 uuf trimmer	2-25 uuf
C17	2-10 uuf trimmer	2-25 uuf
C18	.002 uf	.001-.005 uf
C19	.002 uf	.001-.005 uf
C20	.001 uf	
C21	.002 uf	.001-.005 uf
C22	2-10 uuf	2-25 uuf
C23	2-10 uuf	2-25 uuf
C24	.002 uf	.001-.005 uf
C25	.002 uf	.001-.005 uf
C26	.002 uf	.001-.005 uf
C27	.001 uf	
C28	2-10 uuf trimmer	2-25 uuf
C29	2-10 uuf trimmer	2-25 uuf
C30	.05 uf paper, 200 W.V.	
C31	100 uuf	
C32	100 uuf	
C33	.1 uf paper, 200 W.V.	
C34	.05 uf paper, 200 W.V.	
C35	8 uf elect., 450 W.V.	
C36	.05 uf paper, 200 W.V.	
C36A	.05 uf paper, 450 W.V.	
C37	8 uf elect., 450 W.V.	
C38	.005 uf paper, 200 W.V.	

CAPACITORS - cont'd.

Legend	Value	Substitution
C39	.005 uf paper, 200 W.V.	
C40	.25 uf paper, 450 W.V.	
C41	.003 uf	
C42	.25 uf paper, 450 W.V.	
C43	.25 uf paper, 450 W.V.	
C44	.25 uf paper, 450 W.V.	
C45	20 uf elect., 50 W.V.	
C46	.05 uf paper, 200 W.V.	
**C47	.05 uf paper, 3000 W.V.	
**C48	.05 uf paper, 3000 W.V.	
C49	.1 uf paper, 450 W.V.	
C50	250 uuf	
C51	.002 uf paper, 200 W.V.	
C52	250 uuf	
C53	.002 uf paper, 450 W.V.	
C54	.005 uf paper, 450 W.V.	
C55	.005 uf paper, 450 W.V.	
C56	.002 uf mica, 3000 W.V.	
C57	.002 uf mica, 3000 W.V.	
C58	2-10 uuf trimmer	
C59	.001 uf	
C60	.005 uf paper, 200 W.V.	
C61	.002 uf	.001-.005 uf
C62	.002 uf	.001-.005 uf
C63	5-50 uuf dual trimmer	
C64	50 uuf	
C65	5-50 uuf dual trimmer	
C66	100 uuf	50-100 uuf
C67	100 uuf	50-100 uuf
C68	25 uuf	10-40uuf
C69	.05 uf paper, 200 W.V.	
C70	20 uf elect., 50 W.V.	
C71	8 uf elect., 450 W.V.	
C72	.05 uf paper, 450 W.V.	
C73	20 uf elect., 50 W.V.	
C74	.005 uf paper, 450 W.V.	
***C75	.05 uf, 3000 W.V.	.02-.1 uf
***C76	.05 uf, 3000 W.V.	.02-.1 uf
C77	.25 uf paper, 450 W.V.	

CAPACITORS - cont'd.

Legend	Value	Substitution
C78	.25 uf paper, 450 W.V.	
C79	.25 uf paper, 450 W.V.	
C80	.25 uf paper, 450 W.V.	
C81	30 uf elect., 450 W.V.	
C82	30 uf elect., 450 W.V.	
C83	8 uf elect., 450 W.V.	
C84	8 uf elect., 450 W.V.	
C85	8 uf elect., 450 W.V.	

RESISTORS

R1	50Ω 1/2 W	30 - 60 Ω
R2	30K 1/2 W	20K - 50K
R3	20K 2W	
R4	30K 2W	
R5	1 meg 1/4 W	500K - 2 meg
R6	60K 1/2 W	50K - 70K
R7	2K 1/2 W	2K - 4K
R8	2K 1/2 W	
R9	3K 1/4 or 1/2 W	
R10	60Ω 1/2 W	
R11	2K ww pot	1K - 5K
R12	60K 1/2 W	50K - 70K
R13	2K 1/2 W	2K - 5K
R14	3K 1/4 W	
R15	100Ω 1/2 W	
R16	50Ω 1/2 W	20 - 75 Ω
R17	60K 1/2 W	50K - 70K
R18	2K 1/2 W	2K - 5K

RESISTORS - cont'd.

Legend	Value	Substitution
R19	1 meg 1/4 W	
R20	6K 1/4 W	
R21	6K 1/4 W	
R22	1K 1/4 W	1K - 2K
R23	4K 1/4 W	
R24	100K 1/4 W	100K - 500K
R25	10K 1/2 W	
R26	2 meg 1/2 W	
R27	100K 1/4 W	100K - 500K
R28	2K 1/2 W	
R29	10K 1/2 W	
R30	10K 1/2 W	
R31	6K 1/4W	
R32	6K 1/4 W	
R33	100K pot.	
R34	150K 1W	
R35	100K 1/2 W	
R36	1 meg pot.	
R37	1 meg 1/4 W	
R38	2 meg 1 W	
R39	100 K 1/2 W	
R40	2 meg pot.	
R41	1 meg 1/2 W	
R42	400K 1W	
R43	400K 1W	
R44	2 meg	
R45	3K 1/2 W	
R46	68K	
R47	4 meg 1 W	3 - 5 meg
R48	4 meg 1 W	3 - 5 meg
R49	500Ω 1/4 W	
R50	800Ω 1/2 W	
R51	100K pot.	75K - 200K
R52	175K 1/2 W	
R53	200K pot.	
R54	500K 1/2 W	
R55	500K 1/2 W	
R56	1 meg 1/2 W	
R57	68K 1/2 W	

RESISTORS - cont'd.

Legend	Value	Substitution
R58	4K 1/2 W	
R59	68K 1/2 W	
R60	500K 1/2 W	
R61	500K 1/2 W	
R62	20K 1/4 W	20K - 50K
R63	200Ω 1/2 W	
R64	100K 1/2 W	
R65	2K 1/2 W	2K - 4K
R66	100K 1/4 W	
R67	100K 1/4 W	
R68	100K 1/4 W	50K - 200K
R69	1 meg pot.	500K - 2 meg pot
R70	2400Ω 1/2 W	
R71	100K 1/2 W	
R72	50K 1/2 W	40K - 100K
R73	200K 1/4 W	200K - 500K
R74	250Ω 2 W	
R75	100K 1W	
R76	400K 1W	
R77	100K 1W	
R78	100K 1W	
R79	500K pot.	
R80	500K pot.	
R81	400K 1W	
R82	400K 1W	
R83	400K 1W	
R84	400K pot.	
R85	100K 1W	
R86	1500Ω 25W	Parallels 10W 3K
R87	20K 10W	
R88	10K 5W	
R26A	4K 20W	

COILS & TRANSFORMERS

Legend	Value
T1 Antenna Coupling Transformer	Primary: 10 turns, #26 enamel copper wire Secondary: 10 turns, #26 enamel copper wire (Primary and secondary interwound on 1/2" dia. bakelite form.)
T2, T3 Video IF Transformers	Primary: 28 turns, #36 enamel (close wound) Secondary: 20 turns, #36 enamel (close wound) Spacing between Pri. & Sec.: 3/32" (Wound on 1/2" dia. bakelite form. See text.)
T4 Video IF Output Transformer	Primary: 28 turns, #36 enamel (close wound) Secondary: 18 turns, #36 enamel (close wound) Spacing between Pri. & Sec.: 1/8" (Wound on 1/2" dia. bakelite form.)
T5 Vertical Blocking Oscillator	3:1 Ratio interstage audio coupling transformer. (Low impedance winding connected to plate circuit.)
T6 Discriminator Transformer	Primary: 20 turns, #36 enamel Secondary: 20 turns, #36 enamel Spacing between Pri. & Sec.: 3/8"
T7 Audio Output	Output transformer to match 6V6 Plate to Speaker Voice Coil.
T8 High Voltage Power Trans.	1600V or 2000V Oscilloscope type Power Transformer (1 to 2 ma.) with 2.5V, 2 amp. (H.V. insulation)

T9 Low Voltage Power Transformer	650V C.T., 150 to 200 ma., with 5V., 3 amp., 6.3V 2 amp. and 6.3V 7.5 amp., windings. (Separate filament transformers may be used instead.)
L1	3 turns #14 tinned copper wire 3/4" long approx., 1/2" diameter.
L2	3 turns #14 tinned copper wire 3/4" long approx., 1/2" dia. (Tapped 1 1/2 turns from grounded end.)
L3	100 turns #36 enamel, 3/4" dia. bakelite form.
L4	80 turns #36 enamel, 3/4" dia. bakelite form.
L5	25 turns #36 enamel, 1/2" dia. bakelite form.
L6	5 to 10 henry 150 ma. filter choke
L7	1.5 mh. R.F. choke (Standard 2.5 mh. R.F. choke with two "pi's" removed.)

TUBES

H.F. Osc.	6J5
R.F. Amp.	~~6J6~~
Mixer	1852/6AC7
Video IF (1)	1852/6AC7
Video IF (2)	1852/6AC7
Detector	6H6

TUBES - cont'd.

Video Amp.	~~6V6~~
Picture tube	5BP4 or 7EP4
Sync. Amp.	6SN7
Vert. Sawtooth	6N7
Horiz. Sawtooth	6N7
Vert. Amp.	6N7
Horiz. Amp.	6SN7
Sound IF	~~6SJ7~~
Sound Audio	6J5 or 6SF5
	~~6V6~~
High Voltage Rect.	2X2/879
Low Voltage Rect.	~~5U4G~~

* 1 to 2 inch length of 150-Ω-"twin-lead antenna cable".

** Two .05 uf, 1600 W.V. condensers in series may be used.

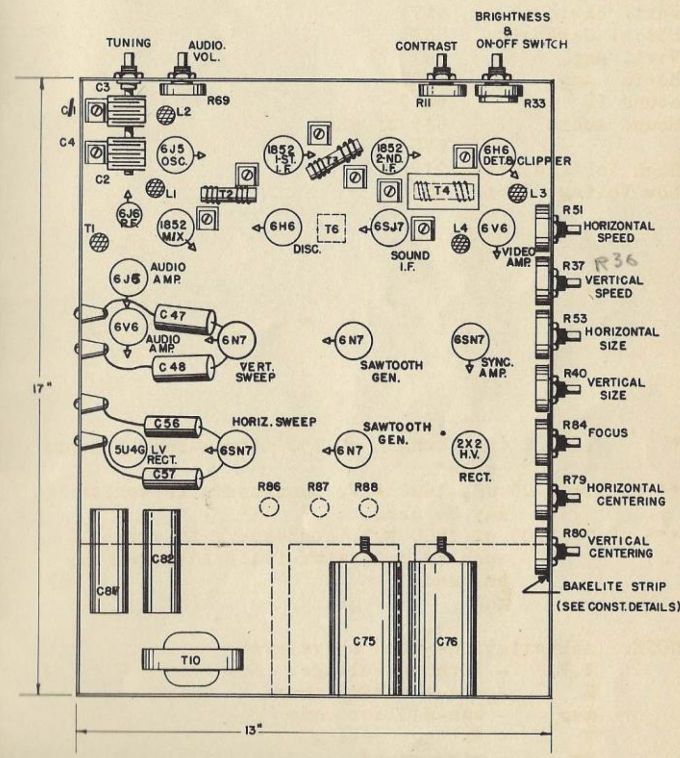
*** Two .05 uf 1600 W.V. condensers in series, such as generator filters (paper) may be used.

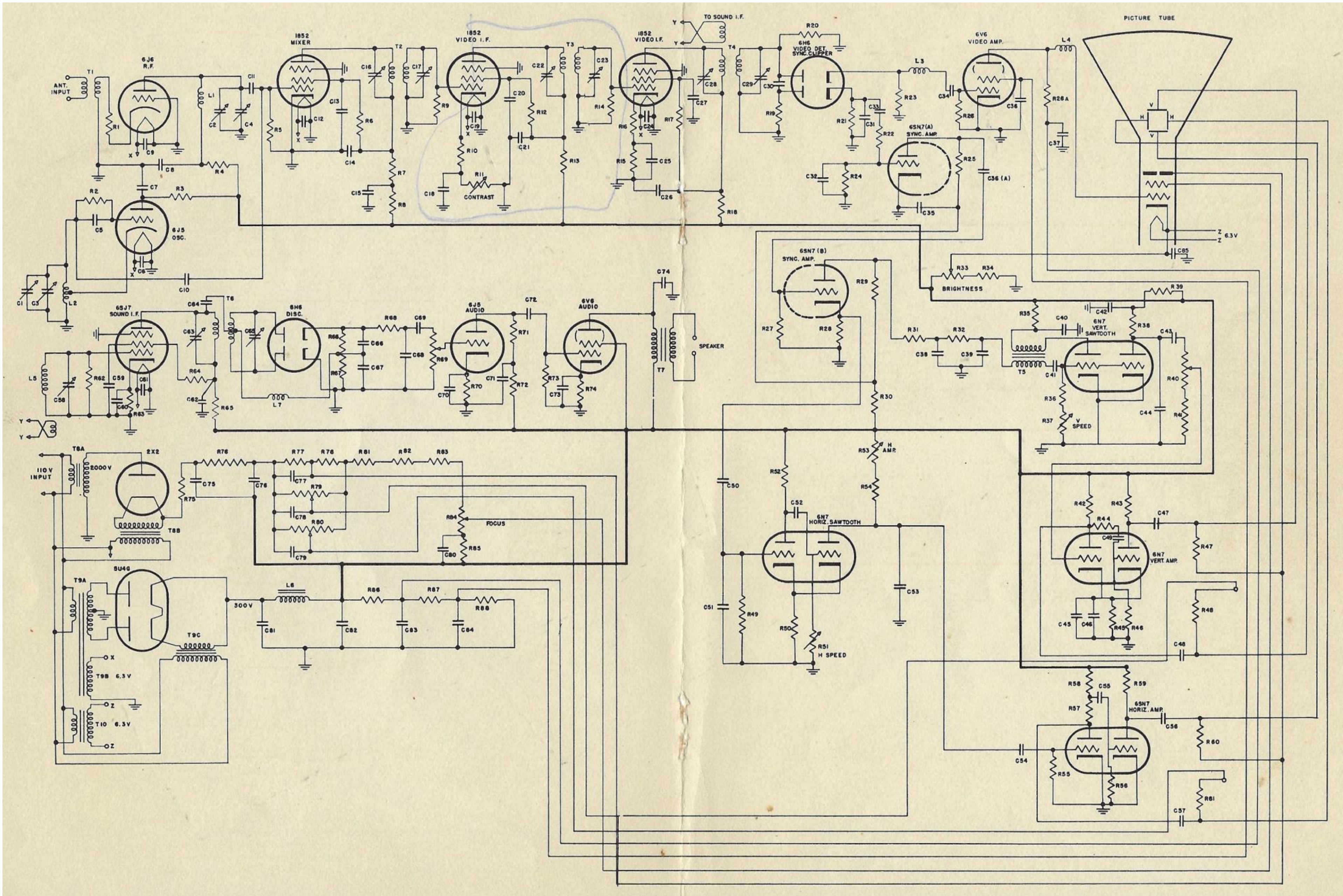
NOTE: Abbreviations used above are:

- W.V. - Working voltage
- K - one-thousand ohms
- meg - one-million ohms
- W - Wattage rating
- ww - wire wound
- elect. - electrolytic (dry) type capacitor
- Paper - paper tubular type capacitor
- mica - molded mica type capacitor

SUB CHASSIS PARTS LAYOUT

(MAJOR COMPONENTS)





ANT. INPUT
6J6 R.F.
1852 MIXER
1852 VIDEO I.F.
CONTRAST
1852 VIDEO I.F.
TO SOUND I.F.
6H6 VIDEO DET. SYNC. CLIPPER
6V6 VIDEO AMP.
PICTURE TUBE
6SN7(A) SYNC. AMP.
6.3V
6J5 OSC.
6SN7 (B) SYNC. AMP.
BRIGHTNESS
6SJ7 SOUND I.F.
6H6 DISC.
6J5 AUDIO
6V6 AUDIO
SPEAKER
6N7 VERT. SAWTOOTH
V SPEED
H AMP.
110 V INPUT
2X2
2000V
FOCUS
6N7 HORIZ. SAWTOOTH
6N7 VERT. AMP.
5U4G
300V
H SPEED
6.3 V
6.3V
6SN7 HORIZ. AMP.

Notes

Notes