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by

Meissner

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Television in Theory and Practice

INTRODUCTION

This discussion of television will include a brief explanation of how the synchronizing and blanking signals of the composite television signal are generated at the transmitter. It is belived that a practical understanding of just how the characteristic wave-shapes of a standard R.M.A. signal are generated will lend reality to the readers notion of a television signal. Then, when the same wave-shapes are encountered in the consideration of the receiver a familiarity will have been achieved which is most helpful in following the signal through the various amplifying, separating and synchronizing circuits.

Before a detailed explanation of the synchronizing signal is undertaken, however, it may be well to give a very brief description of the entire system from the transmitter to the receiver.

At the transmitter, light reflected from the scene to be telecast, is collected by a lens system and focused on the plate of the television camera tube. This plate is covered by a "mosaic" of photoelectric cells. The camera tube also includes an electron gun similar to that used in a standard cathode ray tube. Scanning at the camera tube is accomplished by electromagnetic deflection of the electron beam using external coils. These coils are energized by currents which cause the "spot" (at which the beam strikes the mosaic) to move horizontally across the mosaic, then snap back and scan another line in much the same manner in which the eyes follow the lines of a printed page. At the end of 1/30 of a second the complete mosaic (and hence the scene) has been entirely scanned by a succession of 441 lines in a desired order. When the electron beam strikes a bright portion of the mosaic a maximum current will flow through the output of circuit of the camera tube, and this current will vary in proportion to the amount of illumination on the portion of the mosaic being scanned. These current pulses, corresponding in time sequence to the light and dark areas of the picture, are called video signals. After being amplified, they are combined with synchronizing and blanking signals separately generated. At the transmitter, the synchronizing and blanking signals are used to "time" the deflection of the electron beam and to extinguish the beam during retrace time.

The method of combining the video signal with the synchronizing and blanking signals is accomplished in such a way that it causes no interference with the portion of the signal conveying information about the picture. These pulses can be separated from the picture and finally used for blanking and synchronizing corresponding to those functions at the transmitter. The composite video signal, of course, is used to modulate a high frequency transmitter.

At the receiver the received signal is amplified and separated into sound, picture and synchronizing signals. The picture signal, with the blanking signal, is applied to the cathode ray picture tube in such a way that the intensity of the electron beam varies in proportion to the light and dark areas of the scene being scanned at the transmitter. The synchronizing signals with the video portion removed take control of the sweep circuits at the receiver and keep the electron beam in the cathode ray tube in step with the electron beam in the camera tube. Thus the receiver places on the screen of the picture tube, the right amount of light at the right place at the right time and thus produces a pattern of light and dark areas which is a reproduction of the transmitted picture.

SCANNING FREQUENCY

This over-all descripton necessarily gives little attention to many very interesting details of the television system. For instance, the scanning method demands additional explanation before we may logically consider the generation of synchronizing signals. The 441 scanning lines into which the picture is horizontally divided are not successively scanned but are "interlaced" to reduce flicker. That is, the top line of the picture, if called No. 1, is followed by line No. 3, No. 5, No. 7, etc., until No. 441 at the bottom is scanned. This scanning (one field) is completed in 1/60 of a second after which the spot goes back and "gets" the even numbered lines, finishing the complete picture in 1/30 of a second. Hence the frame frequency becomes 30 per second. In motion picture projection the frame frequency is 24 per second. In motion pictures, however, the "frame" is the picture element, while in television thousands of picture elements are required for one frame.

Some simple arithmetic involving the foregoing figures on scanning lines and picture frequency will serve to introduce the frequencies with which the synchronizing and blanking generator at the transmitter are most concerned.

PICTURE SIGNAL GENERATOR CONSIDERATIONS

Since 441 lines are scanned in 1/30 of a second it is evident that the time required to scan one line is the product of 1/30 by 1/441 or 1/13,230. This 13,230 cycle frequency (which for purposes of discussion is often referred to as 13 KC) thus becomes the first of the frequencies with which the synchronizing generator will have to deal.

A second frequency inherently important in the picture generator is the 60-cycle frequency since the time required to scan one field is 1/60 of a second. An equalizing pulse at a frequency of 26 KC must be available for injection during a short interval to secure proper interlacing.

The frequencies involved, therefore, in the composite picture signal used to modulate the carrier are as follows:

1. Picture information, 60 cycles to 4 MC.
2. Horizontal synchronizing and blanking, 13 KC.
3. Frame frequency, 60 cycles.
4. Equalizing pulses, 26 KC.

With these three fixed frequencies in mind we may now consider the wave shapes of the pulses at these frequencies and see how they are generated and used.

In a synchronizing and blanking signal generator some method must be used to "tie in" the 60 cycle frame frequency, the 60 cycle supply frequency and the 13 KC frequency. This may be accomplished by starting with a 13 KC oscillator, doubling to 26 KC and then with a series of multivibrators dividing by ratios of 7, 7, 3, and 3 to arrive at a 60 cycle pulse.

This chain of events may be pictured with a block diagram and wave forms showing the starting 13 KC sine wave and the 60 cycle pulse which is shaped to last exactly 7% of 1/60 of a second. See Fig. 1.

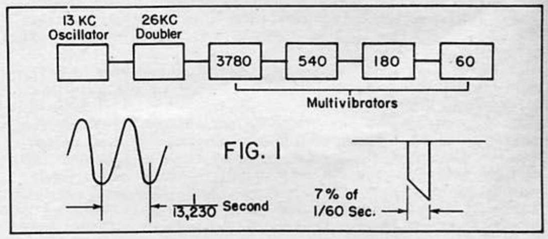


FIG. 1

To tie the 60 cycle pulse to the 60 cycle supply and the 13 KC oscillator it is necessary to combine some low voltage 60 cycle supply frequency with the 7% pulse in a 6H6 phase detector. Through a 6K7 control tube the resultant d.c. voltage is used to control the frequency of the 13 KC oscillator, increasing its frequency if the 7% pulse lags the 60 cycle sine wave and decreasing its frequency when it leads. Fig. 2 shows this arrangement, and will be called the timing unit.

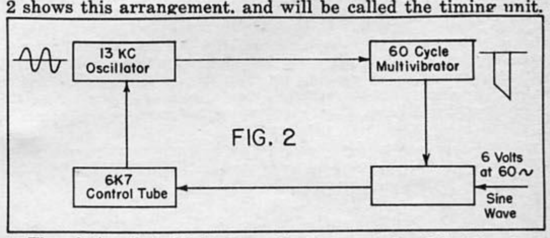


FIG. 2

The chain of multivibrators has been omitted in Fig. 2 to simplify the control arrangement and to call attention to the fact that only two wave shapes are taken from this part of the generator, one a 13 KC sine wave and one a 60 cycle pulse of a duration of 7% of 1/60 of a second. The 26 KC frequency is obtained in circuits following the timer, the 26 KC oscillator in the timer being used only for purposes of correct frequency division.

It has been stated that but three frequencies are used in the synchronizing and blanking generator. However, in the clipping, delayed, and narrowing circuits following the timing units the pulses at these three frequencies are altered as to shape and duration to produce the standard R.M.A. television synchronizing and blanking signals. The duration of the pulses are measured in per cent of horizontal or vertical sweep frequency such as a .07V in the case of the vertical blanking signal or .04 H as in the case of the equalizing pulse.

The following table (Fig. 3) shows the separate characteristic synchronizing and blanking pulses:

NAME	FREQENCY	WAVE SHAPE	DURATION
Vertical Blanking	60 cycles		.07 V
Horizotal Blanking (Pedestal)	13,230 cycles		.15 H
Vertical Sync. Pulse	26,460 cycles	→| |←X, |←Y→|	X = .43H Y = 3H
Horizontal Sync. Pulse	13,230 cycles		.08 H
Equalizing Pulse	26,460 cycles		.04 H

All of these pulses are formed from the 60 P.P.S. signal and the 13,230 cycle sine wave taken from the timing unit. Because of the great difference in duration of the five pulses shown in the table the wave shapes are not drawn to scale, and slight slopes are disregarded.

An inspection of the complete R.M.A. television signal shown in Fig. 4 will now indicate how these five pulses (all originating from the 13,230 cycle oscillator in the timing unit) are combined. Referring to the pulses in the order in which they appear in the table it will be seen, that:

First, the vertical blanking signal occupies the largest part of the portion of the signal shown, that is, from a minimum of .07V to a maximum allowed of .10V. This signal has an amplitude extending only up to "black level" and serves to bias the grid cathode ray tube in the receiver to cut-off during the retrace time. This retrace time in the receiver must be complete at the end of .07H.

Second, the horizontal blanking signals may be seen extending to the same (black) level as the vertical blanking signal but lasting only 15% of 1/13,230 sec.

Third, the vertical synchronizing signal may be seen riding above the blanking signal and consisting of a series of 6 pulses each lasting more than twice as long as a horizontal synchronizing pulse.

Fourth, the horizontal synchronizing pulse may be seen riding above the blanking signal. The duration of this pulse is slightly more than half the duration of the blanking pulse.

Fifth, the equalizing pulses replace the horizontal synchronizing pulses for an interval which begins before the start of the vertical synchronizing pulse interval and lasts until after this pulse is completed. The substitution of one kind of pulse for another is accomplished by keying circuits which apply or remove screen voltage from keying tubes upon the grids of which are continuously applied the pulses involved.

So far we have not considered the varying picture signal which lies between the horizontal blanking pulses. The only reference to this portion which need be made is to point out that bright portions of the picture are indicated by zero modulation amplitude while black parts of the picture are indicated by 80% modulation amplitude, which is approximately the amplitude of the blanking signals. The proper amplitude of the various parts of the composite video signal are adjusted in a mixing amplifier where the amplitude of pedestals, synchronizing pulses and picture signal may be independently controlled. When this has been done, the composite video signal may be used to modulate a high frequency carrier.

MODULATION AND CARRIER FREQUENCY RELATIONS

With the foregoing discussion of synchronizing and blanking signal generation to refer to, we may now point out a few comparisions between the television system and sound broadcasting and make a few general observations about the necessity for widely different modulation and carrier frequencies.

In sound broadcasting a band width of 10 k.c. is required. In television a band width of about 4 MC is required for the picture modulation. The reasons for this great range of frequencies becomes apparent if we consider more closely the scanning method already described.

Vertical detail is determined by the number of lines in the picture. To obtain as good horizontal detail as we have vertical, we must be able to handle picture elements along a line that are as closely spaced horizontally as are the lines spaced vertically. If the picture size transmitted were square the number would then be 441 but since the picture is longer in the ratio of 4 to 3 there must be 588 elements in each line.

Since a pair of such adjacent elements would be required to represent a signal voltage cycle, it must be possible while only a single line is being scanned to transmit $\frac{588}{2}$ or 294 cycles. Since 441 lines are traced during 1/30 of a second, it is obvious that the output from the camera tube will cover a great range of frequencies. A formula for this calculation might be set up as follows:

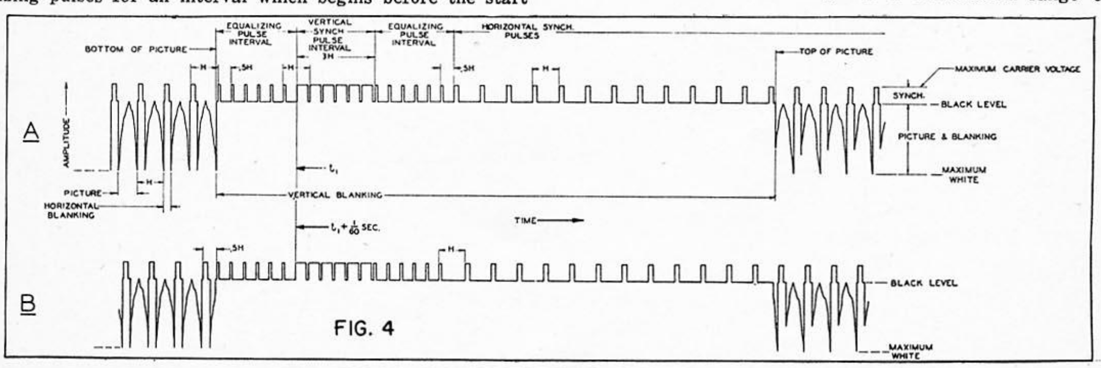
Band width equals $\frac{\text{Horizontal picture elements}}{2}$ x Number of lines x Number of pictures per second

or

Band width equals 294 x 441 x 30 equals 3,889,620

Thus a band width of approximately 4 MC is required if we are to have high definiton television pictures.

Having seen the necessity for a tremendous range of



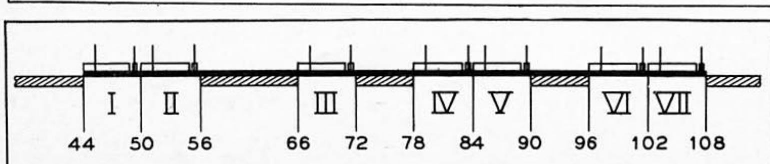


FIG. 5 TELEVISION BROADCAST CHANNEL ALLOCATIONS

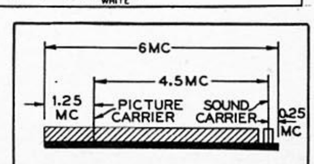
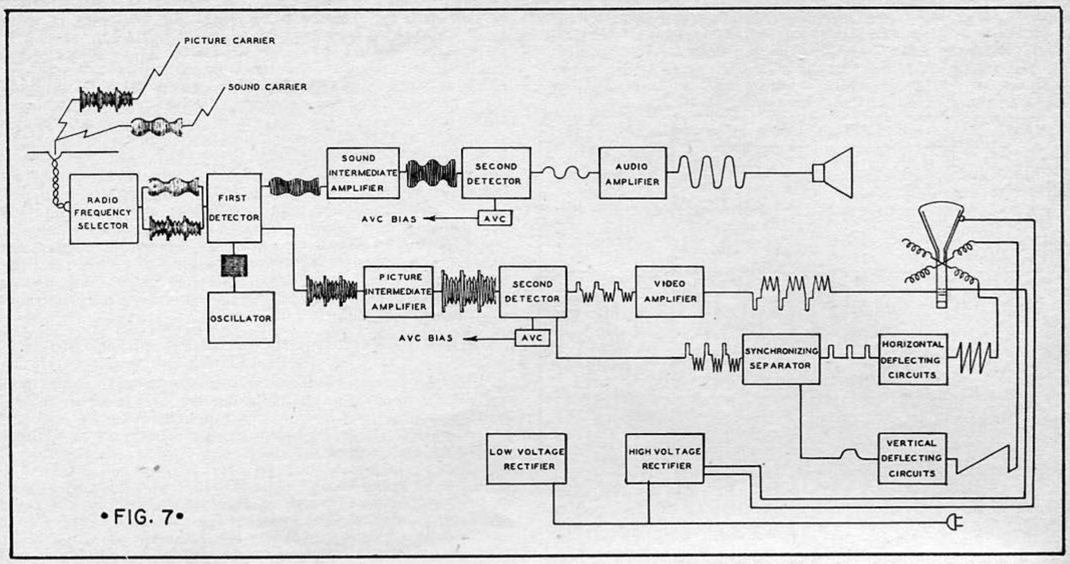


FIG. 6 CHANNEL MAKE-UP



•FIG. 7•

modulation frequencies, we now recognize the first reason for using a high **carrier** frequency. Modulation considerations require that the transmitter frequency be appreciably higher than the highest modulation frequency it must handle. Of course other practical considerations such as lack of available space in other portions of the radio spectrum also made it necessary to go to the ultra high frequency region. At any rate, the Federal Communications Commission has assigned seven television bands between 44 MC and 108 MC. These are shown in Fig. 5. In Fig. 6 is shown in greater detail the relation between the sound and picture carrier of any one channel.

The necessary choice of ultra high frequency carrier introduce another series of problems for these frequencies exhibt "line of sight" transmission, and to obtain respectable coverage, the transmitting antennae must be placed at a great height. The NBC transmitter, for instance, has its antennae on top of the Empire State Building. A service area in this instance, with a radius averaging 40 miles is thus obtained. Other difficulties encountered are reflections of the signals from buildings, hills and other objects, which produce multiple images at the receiver. Still another problem is interference from automobile ignition and diathermy machinery.

As more experience and knowledge is gained, we may expect that most of the problems accompanying the use of ultra high frequencies will be solved to a satisfactory degree. Reflections can be minimized by directive antennae systems and interference can be prevented by installation of suitable filters and suppressors.

In order to have a complete television signal, the sounds accompanying the scene must be broadcast. These are picked up by a regular studio technique, amplified, and used to modulate **another** ultra-high frequency transmitter operating 4.5 MC above the picture carrier frequency.

DISCUSSION OF BLOCK DIAGRAM OF RECEIVER

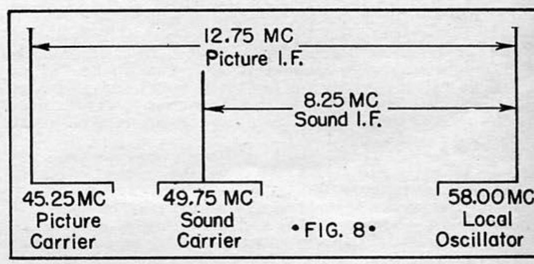
Having discussed the generation and transmisson of the standard televison signal in more detail we may now turn to a more thorough consideration of the receiver and follow the conversion of this rather complicated sequency of signals into a pattern of light and shade which reproduces the scene at the transmitter.

To facilitate consideration of the television receiver, a block diagram will first be employed to show, principally, where the characteristic parts of the signal are separated, amplified and used to perform their particular function.

In Fig. 7 is shown such a diagram.

The r.f. circuits are broad enough to pass both carriers and their side bands. At the first detector they are **both** hetrodyned with a local oscillator placed 12.75 MC above the picture carrier. Because of the 4.5 MC spacing between sound and picture carriers, the oscillator frequency thus becomes 8.25 MC above the **sound** carrier. Thus two I.F. "beats" are produced.

Using the 44 to 50 MC channel as an example, these frequency relations are shown in Fig. 8.



•FIG. 8•

The sound I.F. signals are amplified by an I.F. system tuned to 8.25 MC, impressed on the sound second detector, detected and amplified in the conventional manner and reproduced as sound at the speaker.

The picture I. F. signals are amplified by an I.F. system tuned to 12.75 MC and which passes a band up to 4MC wide, depending on the detail desired at the picture tube. (A 12" tube can reproduce the detail permitted by 4 MC modulation while in the case of a 5" tube a band width of 2½ MC will allow all the detail observable with this tube).

At the picture second detector the amplified picture I.F. signal is demodulated to recover the television signal represented in Fig. 4, already discussed. Without alteration except for further amplification in the video amplifier, this signal is applied to the grid of the cathode ray picture tube, to control the instaneous intensity of the electron beam and thus the relative illumination of the elemental picture areas. The blanking pulses which are present in this signal serve to extinguish the beam during retrace time since their amplitude brings them to the "black level." The synchronizing pulses need not be removed from the signal applied to the grid of the picture tube since the pedestals (of longer duration) have already biased the grid to "black level." Finally, the viedo signal must in some manner adjust the background illumination of the received picture. This action is usually called automatic brightness control and will be explained in the section under circuit descriptions.

Returning now to the second picture detector, the synchronizing chain may be considered. It has been stated that synchronizing pulses need **not** be removed from the video signal controlling the electron beam intensity. It is necessary, however, to remove the **picture** signal from the synchronizing signals if the latter are to take proper control of the **deflection** of the electron beam. Unless this is done the synchronizing control circuit would have a tendency to respond to signals representing black picture areas and loss of synchronism would result.

Fortunately, this separation can be readily secured because of the increased amplitude of these pulses over that of the picture signal. By means of amplitude separation the vertical and horizontal synchronizing signals may be "clipped" from the video or picture information part of the composite video signal. After amplication the vertical and horizontal synchronizing signals must be separated from each other to control the separate deflection circuits. This final separation is accomplished with filters responsive to wave shape since the horizontal synchronizing pulses (refer now to Fig. 3) are of much shorter duration than are the vertical synchronizing pulses.

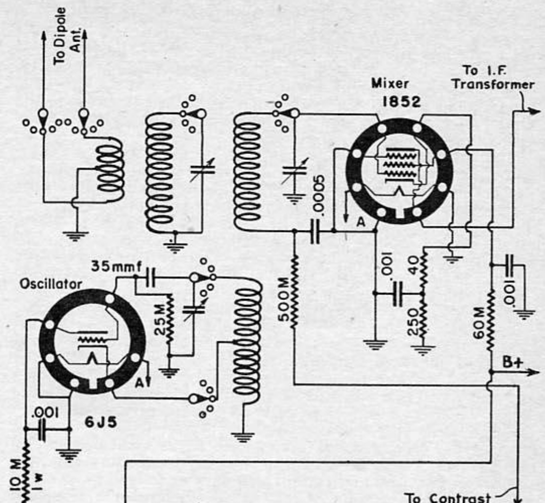
The polarity of the separated vertical and horizontal synchronizing pulses must be chosen for the type of deflection to be employed. Blocking oscillators require a positive pulse while multivibrators require the opposite polarity, for proper control of the picture tube deflection system. The horizontal and vertical synchronizing pulses, then, which were originally shaped from the 13 k.c. oscillator at the transmitter, are enabled to keep the electron beam "in step" with the scanning beam at the transmitter, since the deflection system of the camera tube is controlled by pulses from the same timing unit previously referred to. (in Fig. 2). The picture information part of the signal meanwhile, controlls the brightness of each elementary area of the picture and thus the original scene is reproduced as long as this precise synchronism is maintained.

CIRCUIT CONSIDERATIONS

Having considered briefly the functions of a television receiver with the aid of a block diagram, we may now study an actual circuit, emphasizing the operational details more readily portrayed by a typical example. To facilitate this study, various sections of the schematic circuit of a television receiver of the superhetrodyne type will be separately considered; only those parts of the circuit necessary for an understanding of its operation will be shown and a general knowledge of radio circuits will be assumed.

The first section considered is the radio frequency circuit of Fig. 9.

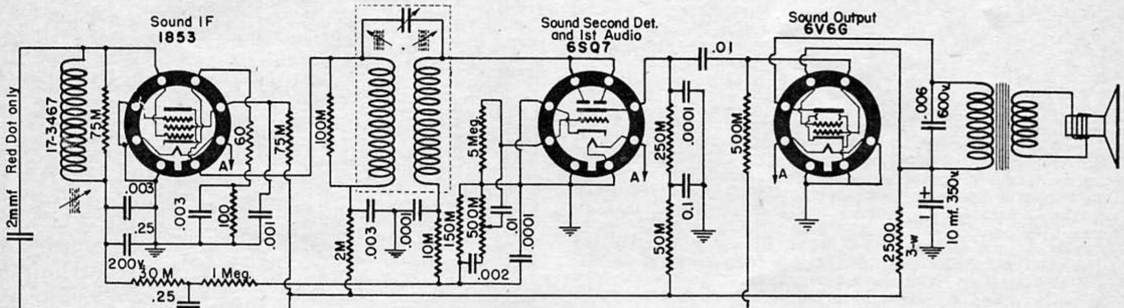
In this r.f. system each band (of which but one is shown) consists of an antennae primary, a preselector, r.f. input and oscillator coil. The oscillator voltage is magnetically coupled to the mixer tube and the oscillator is provided with a small condenser for receiver tuning. The coupling, in the case of the 44 to 50 MC channel is adjusted to give approximately



• FIG. 9 •

flat transmission characteristic from 45.5 to 47.5 MC dropping to about 40% response at 49.75 MC. The coupling between the oscillator and secondary is adjusted to give 5 volts peak of induced oscillator voltage. With an 1852 as the mixer tube with an unbypassed cathode resistor of 40 ohms, 5 volt bias and 5 volt oscillator voltage gives maximum conversion conductance.

At the plate of the 1852 mixer, the sound I.F. is taken off thru a capacity of about 2 mmfd. to the grid of the 1853 sound I.F. amplifier, the grid circuit of which is tuned to 8.25 MC by an adjustabe iron-core coil. A portion of the cathode resistor is left unbypassed so that changes in A.V.C. voltages will not seriously affect the input capacity with bias change. The 1853 is followed by an iron-core tuned 8.25 MC trans-



• FIG. 10 •

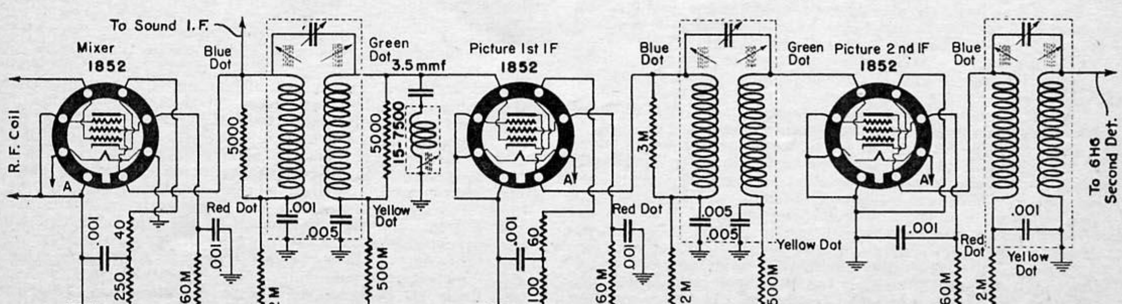


FIG. 11

former, a 6SQ7 and a 6V6G. The selectivity is 200 KC at 70% response. This portion of the receiver is shown in Fig. 10.

In Fig. 11 is shown the picture I.F. system. The three picure I.F. coils are similar, differing only in loading capacity, coupling and presence of small coupling condensers. There is included also a 14.25 MC trap which is needed to prevent the sound I.F. carrier of the next lower adjacent channel from getting into the picture I.F. signal.

Since practically all of the gain and selectivity of a superheterodyne type television receiver lies in the I.F. stages, it seems desirable to study each stage in detail and to note how the overall frequency characteristic is obtained.

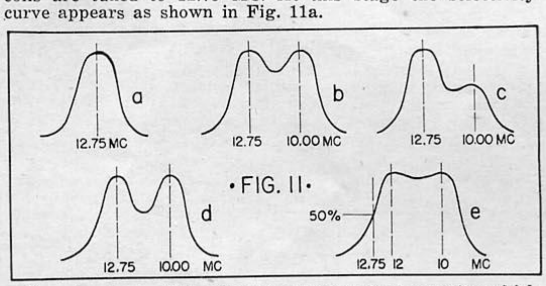
Two general methods may be used to get the desired frequency characteristic. Either each stage may be made substantially flat over the desired pass band, or two stages may be overcoupled, with the third stage "fillng in" the valley between the two response peaks.

The I.F. system in question was designed to make it possible for the experimenter to align the three coils in an acceptable manner without the use of an expensive frequency modulated generator and cathode ray oscilliscope. While the use of this equipment is unquestionably the most satisfactory and most rapid means of picture I.F. alignment, nevertheless excellent pictures have been consistently received after alignment with more modest facilities.

To further clarify the effect of each adjustment on the picture I.F. coil, it may be useful to show by means of selectivity curves for one, two and three coils, just exactly how the picture I.F. may be aligned with a signal generator and output meter.

Starting with the output I.F. coils, the signal generator is connected through a coupling condenser to the grid of the preceeding 1852. An output meter having a 0-1.5 volt range makes a suitable indicator and may be connected through a blocking condenser to the plate of the 1852 video amplifier.

The small condenser across the grid and plate leads of the coil is first set at minimum capacity while both iron core coils are tuned to 12.75 MC. At this stage the selectivity curve appears as shown in Fig. 11a.



• FIG. 11 •

Now, by slowly increasing the overcoupling capacity which had been set at minimum, a second peak will "move out" and can be made to appear at some lower frequency say at 10 MC, without appreciably disturbing the resonant frequency of the original 12.75 peak. The signal generator, in fact, may be set to 10 MC, and the overcoupling capacity slowly increased until resonance is reached. By slowly shifting the generator frequency through the two frequencies of 10 MC and 12.75 MC the relative response at these two points may be checked and equalized by a slight change in one or the other of the coil tuning adjustments. The selectivity curve for the output now appears as shown in Fig. 11b.

The preceeding stage is aligned in the same fashion, but since there is now considerable gain at 12.75 MC the first step will give the selectivity curve shown in Fg. 11c.

The increase of the coupling condenser on this stage, however, will bring up the 10 MC peak and the curve for two stages then appears as shown in Fg. 11d.

The adjustment of the input stage is more critical since this stage must "fill in" the valley shown in Fig. 11d.

The presence of the peaks on each side of this valley make it more difficult to align the input coil. However, by heavily loading the coils already aligned, their response peaks can be temporarily erased without disturbing the correctness of the adjustment of these stages. Specifically if the coils not already loaded, are temporarily loaded with a 1000 ohm resistor, the selectivity curve of this portion will not interfere with the input stage adjustment. With minimum over-coupling capacity, and no loading (on the input stage) both primary and secondary are tuned to 11.9 MC. The over-coupling capacity is then slightly increased to obtain a second peak at 10.9 MC. Finally the proper loading resistors are returned to the input coil, the temporary loads removed from the other coils, and slight adjustments of the input coil made to obtain as flat a frequency response as possible. In Fig. 11e is shown the overall curve which can be obtained by this system. It is seen now that the 12.75 MC frequency is now at the 50% response point on the overall selectivity curve.

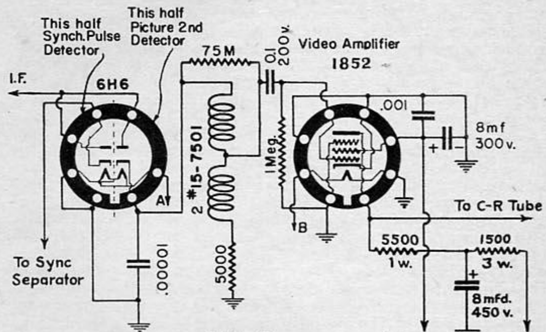
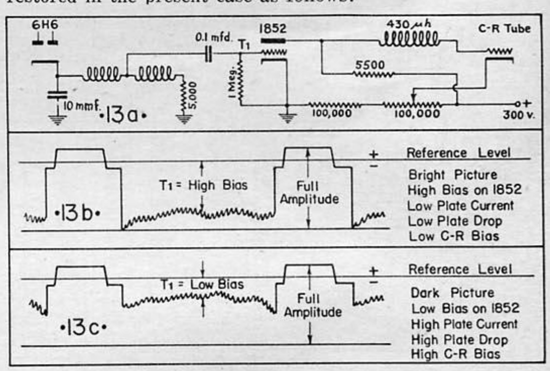


FIG. 12

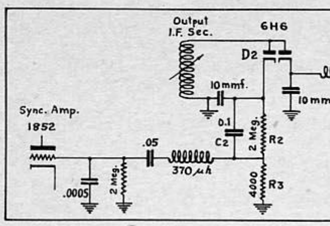
Following the third picture I.F. transformer is the 6H6 picture second detector shown in Fig. 12. Only one diode of this tube is used for **picture detection. This diode is followed by a low pass filter designed to pass frequencies up to 3 MC and to cut off below the picture I.F. frequencies. If harmonics of the picture I.F. are not attenuated, some of them couple back into the input and produce beats which show up as interference patterns just as harmonics of the I.F. produce a whistle interference in sound receiver if allowed to couple back into the input.**

Following the second detector load is the video amplifier operating at zero fixed bias to obtain automatic background control. Some method (often another diode called the D.C. restorer is used) must be employed to enable the received picture to follow the slow variations in background illumination of the scene being transmitted. The D.C. component is restored in the present case as follows:



In Fig. 13a is shown the 1852 video amplifier T_1 in which the plate is connected to the grid of the cathode ray tube and the grid to the output of the picture second detector. Fig. 13b and 13c show how changes in the averages amplitude of the picture changes the bias on T_1 and hence on the cathode ray grid. In the absence of signal, the T_1 bias is low, T_1 plate current high and cathode ray bias is high. With application of a picture signal a reference level is established which is adjusted to be slightly above the pedestal height. In Fig. 13b, the representation of a bright picture, T_1 bias is high, plate current is low and cathode ray bias is low giving bright background illumination. When the transmitted picture has a dark background, the video signal appears as in Fig. 13c, where T_1 bias is low and the cathode ray tube bias is high.

As a video amplifier, T_1 must of course, have excellent frequency response up to 4 MC for high definition pictures. The inductance in the plate circuit s commonly called a "peaking coil", and with the tube and wiring capacity it forms a band pass network designed to obtain the necessary response. With the video amplifier connected to the grid of the picture tube, variations of the video voltage control the intensity of the electron beam thus determining the relative illumination of the many elements of the scene.



•FIG. 14•

•FIG. 15•

It has been stated that synchronizing signals are obtained from the composite video signal by amplitude separation. Fig. 14 shows the portion of the circuit which "clips" these pulses and applies them to the grid of an 1852 sync amplifier. Fig. 15 shows the amplitude relation between the horizontal blanking signal and the portion removed for amplification and synchronization. This pulse will be recognized as the .08H pulse of Fig. 3. Since vertical sync pulses have the same **amplitude** they will be similarly treated. Following the output I.F. of Fig. 14. We see that,

The diode D_2, with its load R_2C_2 and R_3 separates the sync from the picture signals. The R_2C_2, that is, the 2 Meg., .1 mfd. combination have a time constant that is long in comparsion with the video modulation frequencies. If **that** was the entire diode load, the diode voltage would be the peak value of the modulation envelope, that is, E_3.

Now, the part of diode voltage due to R_2C_2 when R_3 is added is E_1, and is uniform through the time of one frame, consequently providing bias for the diode which is adjusted to be slightly above the pedestal voltage. The voltage across R_3 thus consists of the sync signals with the picture portion eliminated. The 370 M inductance and the 500 mmfd. filter serve to keep I.F. components out of the 1852 sync amplifier. Increasing the 4000 ohm will take **more** of the sync pulse; decreasing it will take less.

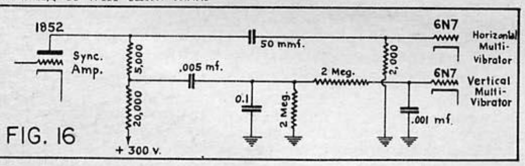


FIG. 16

The 1852 sync amplifier inverts and amplifies both vertical and horizontal pulses. They must then be separated from each other and applied to the deflection system to control its frequency and maintain synchronism. In Fig. 16 it is seen that the horizontal sync pulse can be taken directly from the sync amplifier plate through a 50 mmfd. condenser. The vertical sync pulse is taken through a filter network in which a charge is allowed to accumulate on the condensers proportional to the time the voltage is applied. As the horizontal pulses also present are of shorter duration their effect is minimized.

The equalizing pulses (the .04H pulses of Fig. 3) are of still shorter duration but their presence serves to make the vertical pulses an odd and even field sufficiently alike so that interlacing will result.

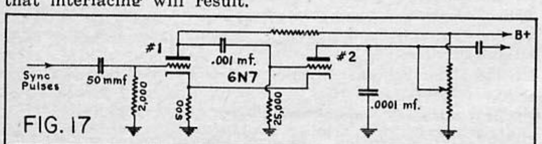


FIG. 17

Since horizontal and vertical deflection circuits are quite simlar, only one (the horizontal) will be described here. Fig. 17 shows a sweep oscillator using a 6N7 in a multivibrator circuit. The output of the 6N7 in a multivibrator circuit. The output of the 6N7 is applied to a 6F86 push-pull amplifier.

To explain the action of this multivibrator it may be worthwhile to list in order the series of actions which takes place in each triode. Accordingly, the triodes are numbered 1 and 2 and one cycle may be analyzed as follows:

1. Assume a disturbance which makes grid No. 1 negative.
2. Plate current in No. 1 triode decreases.
3. Plate voltage in No. 1 triode rises and a positve pulse arrives at grid No. 2.
4. Plate current in No. 2 triode increases and plate voltage drops.
5. Cathode current increases, driving grids to cut-off.
6. The .001 condenser discharges during retrace time.
7. The .001 condenser charges during line time and oscillations are maintained by common cathode coupling.

When the amplifier sawtooth voltage is applied to the deflection plates of the cathode ray tube and the multivibrators are controlled by a discreet negative synchronizing pulse, the electron beam scans the picture area at the proper frequency thus establishing synchronization with the deflection system at the transmitter.

Electromagnetic deflection is usually used with the large cathode ray tubes and in that case a sawtooth current must be passed through the deflection coils. This requires special wave-forms best generated by blocking oscillators and discharge tube circuits. In the blocking oscillator, the grid is transformer coupled to the plate and is adjusted to have a free running speed slightly slower than the frequency of the synchronizing pulses. These being positive will trigger the blocking oscillator associated with the deflector circuits. One advantage of this synchronizing system is that pulses caused by noise, and arriving **ahead** of the synchronizing pulse must have sufficient amplitude to overcome the negative self-bias on the blocking oscillator before it can upset the synchronizing control.

POWER SUPPLY

In order to supply the high voltage at low current needed for the cathode ray tube and the lower voltage at high current for the amplifying tubes, two rectifiers are used in the typical television receiver. Since the current consumption to the cathode ray tube is very small, a resistor capacity filter is sufficient. The voltage to the first anode must be adjustable so that the electron beam may be properly focused. Figure (18) shows the circuit of the high voltage power supply.

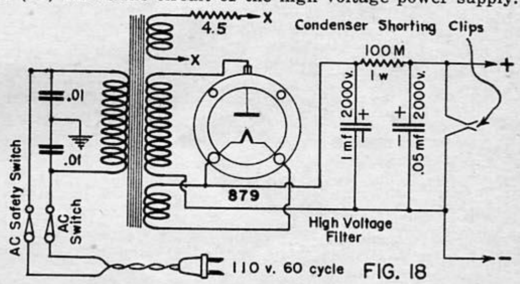


FIG. 18

The low voltage power supply is conventional. However, unusually good filtering is of prime importance.

SAFETY POINTERS

Of still greater importance, where power supplies are concerned, is the necessity on the part of the experimentor to develope a safety technique in the use of high voltages and large cathode ray tubes. All cathode ray tubes should be protected from scratches such as might be caused by sliding tubes across a hard surface. Extreme and sudden changes in temperature should be avoided. Especially in handling large tubes, goggles should be worn to guard against the possibility of collapse of the tube and the attendent danger of flying glass.

When working on a portion of the receiver not requiring high voltage, the high voltage transformer should be disconnected and taped up. When making high voltage measurements or any measurements where high voltages are present anywhere in the receiver, the supply line plug should be removed from the outlet (rather than trusting memory or an AC switch) while the test leads are attached. Power may then be supplied by replacing the line plug and measurements made without touching any part of the reciver. The line plug should then be removed and the high voltage filter condensers shorted with an insulated screwdriver before the test leads are removed. Above all, a good ground must always be connected to any chassis or apparatus normally grounded since breakdown of the primary or secondary of a high voltage transformer can expose high voltage under the most dangerous conditions, namely; at a time when the user feels perfectly safe.

Television Definitions

Aspect Ratio: The Aspect Ratio of a frame is the numerical ratio of the frame width to frame height.

Audio (Latin, "I hear"): Pertaining to the transmission of sound.

Automatic Brightness Control: Automatic Brightness Control is a device for automatically controlling the average illumination of the reproduced image.

Automatic Volume Control: A self-acting device which maintains the output constant within relatively narrow limits while the input voltage varies over a wide range.

Band-Pass Filter: A filter designed to pass currents of frequencies within a continuous band limited by an upper and a lower critical or cut-off frequency and substantially reduce the amplitude of currents of all frequencies outside of that band.

Blanking Pulse: Pulses produced during the return time of the cathode-ray beam to "blank out" the undesirable signals produced by the return lines in both the Iconoscope and Kinescope. Sometimes referred to as the "pedestal."

Brightness Control: Brightness Control is the receiver control which varies the average illumination of the reproduced image.

Carrier: A term broadly used to designate carrier wave, carrier current, or carrier voltage.

Carrier Frequency: The frequency of a carrier wave.

Coaxial Cable: Special telephone cable suitable for conveying television signals.

Contrast Control: A knob on the receiver for adjusting the range of brightness between highlights and shadows in a picture.

Cycle: One complete set of the recurrent values of a periodic phenomenon.

D.C. Transmission: D.C. Transmission means the transmission of a television signal with the direct current component represented in the picture signal.

Distortion: A change in wave form occurring in a transducer or transmission medium when the output wave form is not a faithful reproduction of the input wave form.

Electron Emission: The liberation of electrons from an electrode into the surrounding space. In a vacuum tube it is the rate at which the electrons are emitted from a cathode. This is ordinarily measured as the current carried by the electrons under the influence of a voltage sufficient to draw away all the electrons.

Fidelity: The degree to which a system, or a portion of a system, accurately reproduces at its output the signal which is impressed upon it.

Field Frequency: Field Frequency is the number of times per second the frame area is fractionally scanned in interlaced scanning.

Focus: Adjustment of spot definition.

Frame: One complete picture. Thirty of these are shown in one second on a television screen.

Framing Control: A knob or knobs on the receiver for centering and adjusting the height and width of pictures.

Frame Frequency: Frame Frequency is the number of times per second the picture area is completely scanned.

Fundamental Frequency: The lowest component frequency of a periodic wave or quantity.

Ghost: An unwanted image appearing in a television picture as a result of signal reflection.

Harmonic: A component of a periodic quantity having a frequency which is an integral multiple of the fundamental frequency. For example, a component the frequency of which is twice the fundamental frequency is called the second harmonic.

Horizontal Centering: Adjustment of the picture position in the horizontal direction.

Horizontal Hold: Adjustment of the free-running period of the horizontal oscillator.

Height: Adjustment of the picture size in the vertical direction.

Iconoscope: A type of electronic cathode-ray pickup tube which has been developed by RCA.

It serves the dual purpose of analyzing the visible picture projected on its mosaic into elements and produces electrical impulses for each of these picture elements.

Interference: Disturbance of reception due to strays, undesired signals, or other causes; also, that which produces the disturbance.

Interlacing: A technique of dividing each picture into two sets of lines to eliminate flicker.

Kinescope: A type of electronic cathode-ray receiver tube which has been developed by RCA.

It converts electrical impulses into picture elements which are visible to the eye.

Line: A single line across a picture, containing highlights, shadow, and half-tones; 441 lines make a complete picture.

Linearity Control: Adjustment of scanning wave shapes. May be qualified by the adjectives "Top," "Bottom," "Right," "Left."

Megacycle: When used as a unit of frequency, is a million cycles per second.

Modulation: Modulation is the process in which the amplitude, frequency, or phase of a wave is varied in accordance with a signal, or the result of the process.

Mosaic: Photo-sensitive plate mounted in the Iconoscope. The picture is imaged upon it and scanned by electron gun.

Negative Transmission (Modulation): Negative Transmission (Modulation) occurs when a decrease in initial light intensity causes an increase in the radiated power.

Panning: A horizontal sweep of the camera. (From "panorama.")

Polarization: The particular property of an antenna system which determines its radiation characteristics.
i.e.—Vertical or horizontal polarization.

Positive Transmission (Modulation): Positive Transmission (Modulation) occurs when an increase in initial light intensity causes an increase in the radiated power.

Progressive Scanning: Progressive Scanning is that in which the scanning lines trace one dimension substantially parallel to a side of the frame in which successively traced lines are adjacent.

Radio Channel: A band of frequencies or wave lengths of a width sufficient to permit of its use for radio communication. The width of a channel depends upon the type of transmission.

Return Line: Trace of the cathode-ray beam in returning from bottom to top of the picture. (Return trace from right to left between lines usually not visible.)

Sawtooth: A wave of electric current or voltage employed in scanning.

Scanning: Scanning is the process of analyzing successively, according to a predetermined method, the light values of picture elements constituting the total picture area.

Scanning Line: A Scanning Line is a single continuous narrow strip which is determined by the process of scanning.

Side-Bands: The bands of frequencies, one on either side of the carrier frequency produced by the process of modulation.

Signal: The intelligence, message or effect conveyed in communication.

Spot: The visible spot of light formed by the impact of the electron beam on the screen as it scans the picture.

Spottiness: Spottiness is the effect of a television picture resulting from the variation of the instantaneous light value of the reproduced image due to electrical disturbances between the scanning and reproducing devices.

Television: Television is the electrical transmission and reception of transient visual images.

Tilting: A vertical sweep of the camera.

Vertical Centering: Adjustment of the picture position in the vertical direction.

Vertical Hold: Adjustment of the free-running period of the vertical oscillator.

Vestigial-Side-Band Transmitter: A Vestigial-Side-Band Transmitter is one in which one side band and a portion of the other are intentionally transmitted.

Video Frequency: The Video (Latin, "I see") Frequency is the frequency of the voltage resulting from television scanning.

Width: Adjustment of the picture size in the horizontal direction.

Yoke: Produces magnetic deflection of an Iconoscope or Kinescope when supplied with sawtooth currents of proper voltage and phase.

COMPLETE INSTRUCTIONS
FOR CONSTRUCTION AND OPERATION OF THE

Meissner

Television Receiver

Model 10-1153

The Meissner No. 10-1153 receiver kit was designed to answer the requirements for an easily built, safe receiver for television sight and sound. It covers only the two lowest frequency American television channels 44–50 MC and 50–56 MC, but provisions have been made for two additional channels when the need for them arises.

The sound channel operates simultaneously with the picture—one control serves to tune both channels. The sound channel has a wide acceptance band giving a much higher degree of fidelity than can be obtained in the normal broadcast band.

The receiver employs 17 tubes in all, divided as follows:

1	Oscillator	6J5
1	Mixer	1852
2	Picture I. F. Amplifiers	1852
1	Picture Detector	6H6
1	Picture Video Amplifier	1852
1	Picture Tube (Kinescope)	1802-P4
1	Sound I. F. Amplifier	1853
1	Sound Detector	6SQ7
1	Sound AF Amplifier	6V6G
2	Sweep Oscillators	6N7
2	Sweep Amplifiers	6F8G
1	Synchronizing Pulse Amplifier	1852
1	Rectifier, high voltage	879
1	Rectifier, low voltage	5V4G

A single mixer and a single oscillator serve as the input to both sight and sound channels. The video (sight) channel utilizes two I.F. stages, a second detector, a video frequency amplifier and a Cathode Ray tube. The sound channel utilizes one I. F. stage, a conventional combined diode detector, AVC and 1st Audio amplifier, and a power amplifier.

The sweep circuit oscillators are multivibrators of simple design. Sweep voltage amplifiers are provided so that the picture will occupy the desired área on the screen without the use of excessive voltage on the multivibrators. Controls on the input circuits of the sweep amplifiers permit easy adjustment of the picture size.

Synchronization is accomplished through the aid of synchronizing pulses transmitted between successive lines and frames of the picture. These synchronizing signals are selected by a synchronizing pulse separator circuit, amplified by the synchronizing pulse amplifier and applied to the sweep oscillators to control their frequency.

The sound channel is provided with conventional AVC. The picture channel has only manual control because of the complications introduced by the use of satisfactory AVC on the sight channel.

The high voltage supply for the Kinescope has been carefully housed in a completely closed compartment so that accidental contact with dangerously high voltage is impossible unless the safety devices provided are purposely made inoperative. Two safety switches are provided which cut off the high voltage whenever the cover is removed from the compartment housing this high voltage. One is in series with the primary of the high voltage power supply so that the high voltage transformer is inoperative whenever the cover is removed from the safety compartment, and the other switch short circuits the high voltage filter condensers so that there can be no residual charge to produce an unpleasant or dangerous shock. The voltages that are of the same magnitude as in ordinary radio sets are given no special protection.

The high frequency tuning unit is furnished prealigned and tested. The I. F. transformers are easily adjusted to the desired band width or sensitivity by following the simple instructions given, using as an aid, the common service oscillator possessed by every radio shop.

The receiver is furnished with a black crackled metal front panel which serves to carry the main control knobs and furnishes adequate support for the viewing end of the Kinescope. The receiver may be used without cabinet, may be mounted in a cabinet that the constructor may have on hand, or may be enclosed in the handsome wood cabinet of modern design built especially for this receiver and available through the same dealers handling this kit.

The kit is sold complete with speaker and all necessary tubes. No extra parts need to be purchased in order to make the set operative. The wood cabinet is not included in the price of the kit.

MAKE HASTE SLOWLY

This television receiver has a great many parts but each part is simple. The proper performance of the receiver depends upon the complete cooperation of all of the circuit elements. "Make haste slowly" by being perfectly sure that each part is installed in the proper place, that is, has the correct value, that it is installed in the correct direction and that it is connected to the proper lugs. See that each coil has the proper **part number** since there are several coils that look alike but are electrically different. See that each resistor has the proper resistance by checking the color code carefully. See also that its size is correct for the wattage rating specified. Mica condensers should have their capacity checked by the same color code as resistances. The values read indicate micro-microfarods. Volume controls should be checked for part number.

The best aid toward accuracy is to use a colored pencil to mark over each component or wire in the Pictorial Diagram as the corresponding part or wire is installed in the receiver. When the receiver is completed, it is wise to have someone who has not worked on the receiver check over all values of components, and all wiring. **Care in doing each small operation perfectly cannot be overemphasized.** Take care of each detail and the aggregate will take care of itself.

ASSEMBLY

There are three principal sheet-metal pieces which carry most of the parts: the chassis, the front panel and the front wall of the safety compartment. The assembly and wiring of the first and second items are clearly shown in the Pictorial Wiring diagram Fig. 1, while the assembly and wiring of the Safety Compartment is shown in figures 2, 3, 4, 5 and 7.

The simplest method of construction is to assemble onto any one of the metal parts as many small items as possible, and to wire up as much as possible before fastening the three major metal parts together.

Starting with the front wall of the safety compartment, first assemble the Cathode Ray tube socket. (This socket is the only one with eleven pins.) A special fastener that appears to have too small an inside diameter is furnished for mounting this socket. The bakelite part is inserted into the mounting hole from the front of the panel, the panel placed on a table (with the front side down) and the mounting ring forced down around the socket. A screwdriver is a convenient tool to use for this purpose, pressing down on the clip in a number of places successively, going around the clip until the mounting ring touches the back of the metal panel. Do not force the ring down too far, however, as it probably will be necessary to turn the socket slightly to line up the vertical and horizontal edges of the picture with the true vertical and horizontal direction. The remainder of the parts on the wall of the safety compartment may be assembled in any convenient sequence. If a ground connection is made to a socket saddle or to a mounting lug on a terminal strip, it is necessary to clean the mounting surface so that a good metal contact is made and so that the mounted part can be soldered to the sheet metal to form a permanent good ground connection. **These soldered ground connections are very important.**

Having completed the assembly outlined above, prepare the large chassis for assembly. Practically every major item has at least one connection to chassis. These connections should all be well soldered. To help the soldering operation a spot on the chassis should be lightly cleaned with sandpaper or a knife. Every socket saddle, every metal electrolytic condenser mounting plate, and every terminal strip supporting lug (to which a wire is connected), should be soldered to chassis. "Make Haste Slowly."

Having bonded all grounding lugs to chassis the filament circuits should be wired complete. Note that there are two independent 6.3 volt circuits for the purpose of preventing the scanning circuits from interfering with either sound or picture reproduction. These circuits must be wired according to the diagram. "Make Haste Slowly."

Many sockets contacts are connected to the chassis. It will probably be found convenient at this point to make all of the necessary ground connections on all of the sockets. "Make Haste Slowly."

The next items most conveniently wired are the electrolytic condensers which should now be assembled. Take great care to see that the condenser with the proper capacity and voltage rating is installed in the proper position. The ratings are stamped on the sides of the cans so that the parts are easily identified. Note that some condensers are grounded to the chassis, in which case metal mounting plates are to be used, while in other cases the condensers must be insulated from the chassis, in which case bakelite mounting plates must be used. In the former case, the metal mounting plates should have one spot on each plate soldered to the chassis.

The condensers are mounted by pushing the mounting lugs through the slots in the mounting plates and then giving each mounting lug a slight twist with a pair of pliers. The amount of twist is only enough to hold the unit tightly, usually one-eighth turn is adequate. At least one mounting lug of each condenser should be soldered to the mounting plate if the plate is metallic. "Make Haste Slowly."

Because of the electrolytic condensers projecting above the chassis, making it impossible to lay the chassis down flat on a table, it will be found quite convenient to mount the front wall of the safety compartment and the front panel of the receiver, which are of essentially the same height, permitting the chassis to stand level on these parts with the bottom side up for convenient work. "Make Haste Slowly."

Next assemble all coils except the high frequency coil assembly on the chassis, paying special attention to the location of terminals on coils that have no color code, and watching carefully to see that the position of the colors on color-coded terminal strips agrees with the position shown in the diagram. Check also to see that the coils of correct part numbers are installed in their designated places. "Make Haste Slowly."

The assembly of the two power transformers and the filter choke may well be delayed until late in the program since these items are heavy and are not actually required until the wiring is almost complete.

Pick out on the Pictorial Wiring Diagram the long leads that connect items located considerable distances apart. These wires should be installed first, followed by the shorter wires. "Make Haste Slowly."

The by-pass condensers may well be installed next, paying particular attention to the capacity and voltage ratings. Wherever one side of a by-pass condenser is connected to the chassis, it is recommended that the end so connected be the "Outside Foil" or the "Ground" end of the condenser. "Make Haste Slowly."

After the by-pass condensers have been installed, the mica condensers and carbon resistors may be installed in any convenient sequence. The resistance or capacitance of these items, as the case may be, should be **very** carefully checked against the color code which is explained in the sheet "General Construction Hints" packed with the kit. It is very easy to misinterpret the color code, therefore utmost caution is urged.

When all of the above work has been completed, the filter choke, low voltage and high voltage transformers should be installed. The high voltage transformer, which is mounted under the chassis, is connected to a rectifier tube mounted inside of the safety compartment. Leads from this transformer are heavily insulated to prevent accidental shock. **Great care should be exercised to see that the sleeving on these leads extends up through the rubber grommets and that the sleeving is adequately anchored above the grommet** by wrapping tape around the sleeving to prevent it from slipping back. **Do not connect the primary leads of the high voltage transformers until the vol-**

tage test is completed on the receiver. As an added precaution against accidental operation of the high voltage transformer, the primary leads should be wrapped together and taped until such time as it is necessary to use the high voltage. The only remaining item, the high Frequency Coil Assembly, should now be installed and connected.

SAFETY SWITCHES

There are two safety switches furnished with the kit of parts. One is of conventional design, and is the primary interlock switch which opens the circuit from the A.C. line to the primary of the power transformers. The second switch short circuits the output of the high voltage power supply. Both of these switches operate whenever the cover is off of the safety compartment.

The line safety switch is mounted on a pair of brackets so that it is recessed below the chassis an appropriate distance. Fig. 3 shows the assembly of this switch and its brackets. In order to insure permanent alignment of the parts it is recommended that the brackets be soldered to the switch as shown. The actuator for the switch is attached to the Safety Cover in accordance with Fig. 4.

The high voltage shorting switch is of special design to arrive at an efficient unit that will satisfactorily withstand the high voltage employed in the Cathode Ray tube. The switch itself consists of two contact arms or springs which are in contact with each other whenever the cover is removed from the safety compartment. These springs mount on the terminals of the output filter condenser in accordance with the details shown in Fig. 5. The actuator for the switch is mounted on the inside of the safety cover and is shown diagramatically in Fig. 4.

SAFETY SWITCH TESTS

Having installed two safety switches in a receiver, the constructor naturally has a feeling of complete protection which may lead to his undoing unless he proves that the safety devices are functioning correctly.

With the line cord disconnected from the line, the cover to the safety compartment should be slid down as far as possible. By the time the cover is in its proper position, the line switch should have snapped on. When the cover is removed very slowly the line switch should snap off by the time the cover has been lifted about one inch. Try the switch with the fingers slowly to see that it always snaps regardless of how slowly the switch arm is moved.

The high voltage shorting switch should be tested for adequate pressure by attempting to push a thin piece of stiff paper or a playing card down between the springs. They should offer considerable resistance to the movement of the card. If the springs are not stiff enough they can be bent with a pair of pliers to give adequate stiffness to be perfectly sure that the springs will make good contact when the safety cover is removed.

A special recheck should be made of the connections between the line, the power transformers and the safety switch to avoid the possibility of the safety switch being inactive because of improper connections.

VOLTAGE TEST

If all connections are found to be correct, the most logical next step is to check the voltage that exists on each of the tube elements. Since one of the tubes to be checked has its socket inside of the safety compartment, the first checks should be made without the high voltage operating. In that manner, voltage tests on that tube can be made with safety.

With the primary of the high voltage transformer disconnected (and for safety's sake taped up) and with all tubes except the Cathode Ray Picture tube in place, turn the receiver upside down so that it will be convenient to work on and plug the line cord into a receptacle supplying 105 volts to 125 volts at 50 to 60 cycles. Turn the "Contrast Control" to its clockwise extreme of rotation. This turns the current on and adjusts the Picture I.F. amplifier for maximum gain. Turn the range switch to the counterclockwise extreme position (lowest band). The voltages between the various tubes elements and the chassis are listed in the table shown in Fig. 10. These measurements were made on the lowest possible range of a 0-705-75 300-600 voltmeter with a resistance of 1000 ohms per volt. All readings, unless marked negative, indicate that the tube elements are positive with respect to chassis by the amount shown.

A few important voltages that do not appear directly on any tube elements are shown on the Pictorial Wiring Diagram.

In order to measure the voltages on the 6F6 Video amplifier it is necessary to remove the safety cover. Removing this cover opens the line switch so that it will be necessary to have someone hold the line switch closed while the measurements are made. **Before having someone hold down the safety switch be sure the high voltage transformer primary is disconnected. Note: Some of the electrolytic condensers in the Safety Compartment are several hundred volts from chassis potential.** Do not touch their containers at the same time the chassis is touched if the voltage is on. As soon as the voltages are measured, restore the safety cover.

If the values measured are materially different from those shown on the Pictorial Diagram or in the table of voltages, turn off **the receiver, disconnect the power cord from the line, and recheck the wiring.**

Having completed the voltage check satisfactorily it is time to connect the primary of the high voltage power transformer and to insert the Cathode Ray tube. The front end of this tube is supported by the heavy rubber bands supplied with the kit.

PRELIMINARY ADJUSTMENT

Fig. 6 shows two views of the completed receiver giving the name and location of each control. To start the receiver turn on the current by rotating the "Contrast Control" clockwise, but turn it only far enough to snap the line switch. After a brief warm-up period, the picture tube should show some kind of a rectangular pattern of light, even if there is no television signal on the air. If no light is visible on the picture tube, turn the "Brilliance Control" clockwise until the picture tube shows some illumination. The "Framing Control" on the front surface of the Safety box should be adjusted to center the rectangle of light on the screen of the picture tube. The "Picture Size Controls" should be adjusted until the rectangle of light occupies the desired area on the screen of the picture tube. Note: The speed controls have some effect on the size of the picture and the "Horizontal Size Control" will have some effect upon the Horizontal speed. When adjusting the synchronizing on a signal it may require several adjustments of the horizontal controls to obtain both proper speed and proper size. The vertical dimension should be adjusted to be approximately three-fourths of the horizontal dimension. If the bottom and sides of the rectangle of light are not exactly horizontal and vertical respectively, proper position may be obtained by rotating the picture tube. Note: The receiver should be turned off while the picture tube is being rotated. Sufficient allowance has been provided in the wiring and mounting of the picture tube to permit this limited rotation. The "Brilliance Control" should be set at the lowest value that will give satisfactory illumination. The "Focusing Control" should be adjusted until the lines in the rectangle of light are as clear and sharp as possible. The above preliminary adjustments are all that can be made until the I. F. and R. F. circuits are adjusted and until a signal is on the air. Once adjusted, the picture size and centering controls seldom need readjustment.

Should the picture tube fail to behave as described above, disconnect the power cord, open the Safety box and carefully examine the wiring for possible short circuits, open circuits, or incorrect connections. Note that the screen may not show a solid rectangle of light until the speed controls are adjusted. If the speed controls are set too far from their proper position there may be wide spaces between lines. These gaps can be eliminated by rotating the speed controls and are automatically eliminated when the sweep circuits are synchronized with the transmitter. The rectangle of light will also show diagonal bright lines but these are suppressed entirely by the blanking impulse in the picture signal which completely darkens the tube momentarily as the beam retraces to start a new line or a new frame.

ALIGNMENT

The alignment of this television receiver is similar in many respects to the alignment of a conventional Superheterodyne, with the exception that the peaks on the circuits are not sharp since the receiver must pass a very wide band of frequencies in order to give satisfactory detail. The instruments required are possessed by practically every reasonably well-equipped Service Man. An oscillator covering at least the range 8 MC to 15 MC with an output voltage of .15 to .2 volts (150,000 to 200,000 microvolts) and an output meter having a low scale of 1.5 volts form a good combination.

The first step in aligning the receiver is to **disconnect the primary of the high voltage power transformer.**

The second step is to attach an output indicator to the Picture channel. Since the picture channel has very little amplification following its detector, it is a convenient aid in alignment to add to the picture channel the amplification available in the Sound Audio System. This temporary change in the circuit can be made by running a wire from the junction of the two 15-7501 chokes through a coupling condenser of any convenient capacity between .01 and .25 MFD to the high end of the audio volume control which is the terminal nearest the speaker. The lead already connected to this lug is permitted to remain. The output meter should be connected between plate (No. 3 pin) and screen (No. 4 pin) on the 6V6G tube socket, with a blocking condenser of any convenient capacity between 0.1 and 1.0 MFD in series. (No leads are removed from the socket when making these connections.)

The third step is to loosen the adjusting screws on all of the adjustable trimmer condensers mounted on the bottom of the Picture I. F. transformers. These trimmers should be set approximately 5 turns from the tight position.

The fourth step is to remove the 6J5 high frequency oscillator tube.

The fifth step is to connect the signal generator and begin the actual adjustment. The low potential or ground side of the generator output should be connected to chassis and the high side connected through a blocking condenser of .01 MFD capacity (or greater) to the grid (pin No. 4) of the second Picture I. F. amplifier tube. No connections need be removed when making this temporary connection. The generator should be set to 12.75 MC, the audio and contrast controls advanced to their clockwise extreme of rotation, the output of the signal generator turned up until a signal is audible, and the adjusting screws on top of the 17-3463 transformer rotated for maximum output. The signal generator frequency should be shifting successively to both sides of 12.75 MC to see that the transformer shows only one hump in the selectivity curve. If more than one hump is evident, the adjustable trimmer should be opened several turns more and the transformer again realigned for maximum output. Having obtained a single hump at 12.75 MC, the adjustable condenser should be screwed in slowly, meanwhile shifting the generator frequency until a second hump appears in the selectivity curve. Still further increase the adjustable capacity until one hump moves down to 10 MC. The other hump will not have shifted noticeably.

The signal generator high potential lead should now be shifted to the grid (No. 4 terminal) of the first Picture I. F. amplifier tube and the second Picture I. F. transformer aligned in the following manner: Set the signal generator to 12.75 MC and adjust both adjusting screws in transformer No. 17-3462 for maximum output. Slowly increase the capacity of the ceramic base coupling condenser on the bottom of the I. F. transformer until again two humps are obtained in the response curve, one at 10 MC and the other at 12.75 MC exactly in the same manner as the output picture I. F. transformer was adjusted. Note that if one peak is materially higher than the other a slight readjustment of the four adjusting screws will permit the high peak to be reduced somewhat and the low peak to be increased a little. When the adjustment is completed so far, remove the leads connecting the signal generator to the grid of the first Picture I. F. tube and prepare to align the input picture I. F. transformer.

First turn the adjusting screw in the 14 MC trap (part No. 15-7500) until it is as far out as possible, and the adjusting screws of the second I. F. transformer No. 17-3464 and the sound input grid coil No. 17-3467 are as far in as possible.

At the grid of the mixer tube disconnect the lead that runs from the grid (No. 4 pin) to the high frequency coil assembly. Temporarily connect any convenient resistor of 10,000 or more ohms from the grid to the wire just removed, and connect the signal generator between chassis and the grid of the mixer tube through a blocking condenser of any convenient capacity above .001 MFD. The leads used for connecting the generator to the receiver should be shielded when aligning the mixer stage to avoid regeneration.

Temporarily connect across the secondary terminals (green and yellow dots) of the interstage picture I. F. transformer No. 17-3462, and across the primary terminals (blue and red dots) of the output picture I. F. transformer No. 17-3463, resistors of approximately 2000 ohms each.

Set the generator at 12 MC, not 12.75 MC, and turn the adjusting screws of the input picture I. F. transformer No. 17-3461 for maximum output. Now slightly increase the capacity of the coupling condenser, but in this case the capacity should be increased only enough to cause the selectivity curve to lose its sharpness and begin to show evidence of flattening out as the generator is shifted above and below the 12 MC setting. If the amplifier starts to oscillate as the input picture I. F. transformer is brought into alignment, the contrast control can be rotated slightly to reduce the gain of the amplifier, but the gain should not be reduced if shielding on the leads to the receiver will stop the oscillation. Finally, the two 2000-ohm resistors temporarily installed should be removed. A check of the selectivity of the entire amplifier should now show a peak at 10 MC and at 12 MC and the response should be fairly uniform between peaks, with the amplification about one-half as much at 12.75 MC as it is at 12 MC. If these results are not obtained, the curve shape can be altered by slight readjustment of any or all of the six adjustments concerned.

If the output of the signal generator cannot be reduced sufficiently to give a convenient indication on the output meter, the audio gain being used may be reduced by moving one end of the temporary lead (between the 15-7501 choke and the audio volume control) from the volume control to the grid (pin No. 5) of the 6V6G sound output tube, thus removing the gain of the 6SQ7 first audio tube.

The generator should next be set at 14.25 MC and the trap No. 15-7500 adjusted for minimum response. This trap really need not be adjusted unless there are two stations on adjacent television channels receivable at the location of the receiver. If any difficulty is encountered in getting enough signal to properly adjust this wave trap, and only one station is receivable, the coil may be left with its adjusting screw all the way out.

The generator should next be set for 8.25 MC and the sound I. F. transformer No. 17-3464 and the sound grid input circuit No. 17-3467 adjusted for maximum response. The two heavy wires extending away from the terminal strip of transformer No. 17-3464 constitute a small coupling condenser of a capacity too small to be obtained in a condenser of more conventional construction. They may be moved closer together to expand the sound I. F. channel if desired.

The over-all picture selectivity curve should again be checked to see that adjusting the sound trap and sound I. F. system has not changed the picture selectivity curve shape, or if it has changed, the adjustments may be touched up again to obtain the best picture selectivity curve shape.

The leads from the signal generator to the grid of the mixer should be removed and the connection from the mixer grid to the coil assembly restored to its original condition. The temporary connection from the junction of the two No. 15-7501 chokes to the sound volume control should be removed.

Plug in the 6J7 oscillator tube and the receiver is ready for operation. The antenna coil trimmer and the mixer grid trimmer shown in Fig. 8 may best be adjusted on an actual television signal since few generators will reach the television frequencies and still fewer have a frequency calibration that can be relied upon at such frequencies. An antenna of the general characteristics discussed in the section "Antenna" should be connected to the two end terminals on the antenna terminal strip and a ground connection attached to the middle terminal. A television signal should be tuned in as described in "Operation" and the antenna and mixer grid circuit alignments touched up. This adjustment is best made with an insulated screwdriver since the capacity of the screwdriver is appreciable compared to the tuning capacities employed.

ANTENNA

The most satisfactory, and the only recommended antenna for this receiver is a short wave doublet antenna. There are several commercial antenna kits available that are very convenient to assemble and install, and which give excellent results. The dealer from whom this receiver was purchased probably has complete information on them. If you desire to make your own antenna, directions are given herewith. Excellent results can be obtained from either type of antenna if the following considerations are followed.

With television antennas, the important points to consider are:

1. To place the antenna as far as possible away from automobile traffic, elevator control panels, diathermy machines, and any other type of electrical equipment that may produce interference.
2. To place the antenna in a position that is, if possible, above all surrounding objects. It should not be in the radio shadow of any large building, bridge, trestle or similar structure; in other words, there should be no tall metallic structure between the antenna and the transmitter, especially if the obstruction is close to the antenna, in which case it will cast a deep shadow, that is, give very low signal level.
3. To make the antenna length the optimum for the signal frequency to be received.
4. To point the antenna in the direction giving the best results. If the antenna is well up in a clear space the best position will usually be with the antenna wire at right angles to a line connecting the receiver and the telecasting station. If the antenna is between some tall buildings and the telecasting station, there may be both direct and reflected signals reaching the antenna. When this occurs there may be double images on the picture tube. The antenna usually can be then rotated until one of the images is very clear and the "echo" images disappear.
5. The directive property of the antenna can sometimes be used to advantage to cut out a strong source of interference, because the antenna receives poorly through a small angle on either side of the direction in which the antenna conductors point, but receives reasonably well for a large angle on either side of the line perpendicular to the direction of the antenna conductors. The region of poor reception frequently may be aimed at the interference (unless it is directly in line with the transmitting station) thereby greatly reducing the interference, yet receiving the desired signal with reasonable strength.

The following table gives the length of the antenna, over-all, for best reception of the different channels.

44—50 MC	119 inches
50—56 MC	105 inches
66—72 MC	81 inches
78—84 MC	69 inches
84—90 MC	64 inches

Where one antenna must work on several bands, the antenna length should be the average of the best working length for each of the desired bands or it should be adjusted to give greatest improvement to the station delivering the poorest signal.

The antenna itself can be made either self-supporting, in which case thin-wall metal tubes form the antenna conductors which extend out from a central insulating support, as in the case of several commercially available designs, or the antenna may be of ordinary wire supported on a simple wooden framework. Fig. 9 shows a suggested antenna construction.

Probably the most convenient plan is to make the antenna and lead-in in one piece without any splices or soldered joints. The lead-in can well be the conventional two conductor twisted lamp cord available at almost every hardware or electrical supply store. The antenna can most conveniently be made by untwisting the required length of lamp cord and then winding the cord with strong string or tape to prevent further untwisting. The ends of the antenna wires should be fastened to porcelain insulators or equivalent.

The lead-in should run to the set in as short and direct a path as possible unless such a path passes through a zone of high interference, in which case a detour of reasonable length to avoid the interference is desirable.

Where the lead-in enters the house, a porcelain insulating tube is recommended. This tube should run uphill as it enters the house so that there will be no tendency for rain to run into the house after running down the lead-in. If the lead-in makes a small loop below the level of the outside end of the porcelain tube the rain should drip off this loop with practically no tendency to run into the porcelain tube.

RECEIVER LOCATION

The receiver should be located in a place where the screen of the picture tube can readily be seen by a group of people, and where the light is subdued. In direct sunlight the picture on the tube will hardly be discernible, in subdued light the picture will be clearly visible, but the optimum results will be obtained when the lighting corresponds closely to that very subdued light present in the average movie theater.

ADJUSTMENT OF PICTURE

When it is known that a picture signal is on the air, and the receiver has been aligned and the adjustments described under "Preliminary Adjustments" have been made, the "Television Station Selector" should be set for the channel on which the station is telecasting, the "Contrast Control" advanced, and the "Vernier Control" tuned to produce a strongly mottled pattern on the picture tube. One speed control should then be slowly rotated until the mottled appearance of the screen begins to assume some semblance of stationary spots on it, then rotate the other speed control until the pattern stands still and a picture is visible. If there are two pictures, one above the other, the **Vertical** speed control should be rotated until there is only one picture. If the picture seems to be torn apart or to be slipping sideways, or if there are two pictures side by side, the **Horizontal** speed control should be turned to obtain proper operation. Detail in the picture may sometimes be improved by rotating the "Vernier Control." Audio volume is controlled in the conventional manner by means of the "Sound Volume Control."

PICTURE DEFECTS

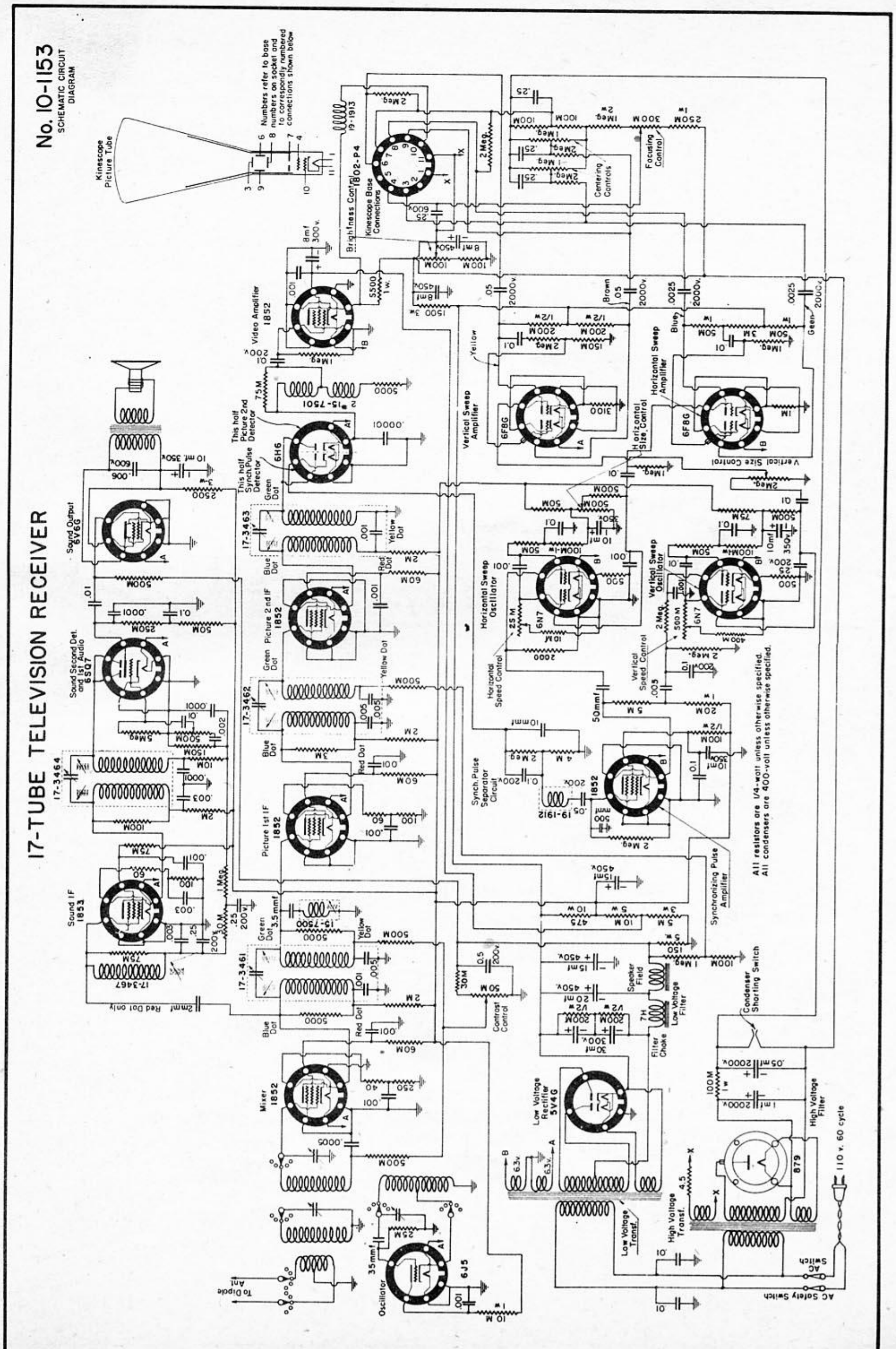
If the picture appears right side up but reversed right for left so that all printed matter is reversed, the leads from the Cathode Ray tube deflecting plates to the plates of the Horizontal amplifier have been interchanged. Reversing these leads at the plates of the horizontal amplifier will give correct scanning. If the picture is inverted, the leads to the Vertical amplifier have been reversed. Interchanging them at the plates of the vertical amplifier will turn the picture over.

The connections shown in the Pictorial Diagram are arranged for the picture to be in the proper position when viewed from the front of the receiver when the receiver is placed in the conventional position. If it is desired to view the tube by means of a mirror, the necessary reversal of picture can be accomplished as described above.

Numerous wavy lines in an essentially vertical direction are the result of interference. If the wavy lines appear and disappear in a reasonably rapid rate the interference may be from code transmissions. When code is suspected, it may readily be recognized by the pulsating appearance.

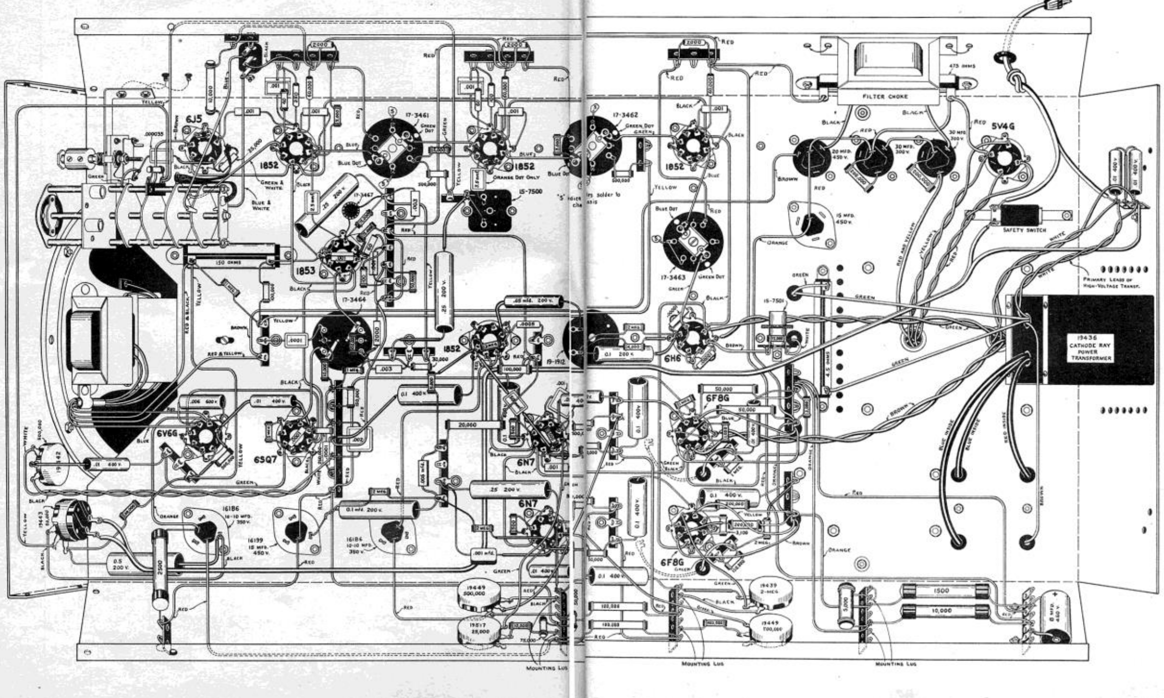
Picture distortion in the form of wavy lines that do not have the sharp definite pulses characteristic of code interference is sometimes present. It is probable that this interference is from some sound service such as speech or music. The simple circuit change employed to add the amplification and speaker of the sound system to the sight channel may be used to listen to the interference with the probability that it can be easily identified.

Distortion in the picture is sometimes the result of setting both the "Brilliance Control" and the "Contrast" too far clockwise. Readjusting both of these controls sometimes improves picture quality. The best position for the "Brilliance Control" will usually be found most quickly by revolving the "Contrast Control" counterclockwise as far as possible without snapping the line switch off, and then adjust the "Brilliance Control" until the rectangle of light is just barely visible. Then advance the "Contrast Control" to obtain satisfactory picture reproduction. Before turning off the receiver, the "Brilliance Control" should be rotated to the extreme counterclockwise position.


17-TUBE TELEVISION RECEIVER
No. 10-1153
SCHEMATIC CIRCUIT DIAGRAM
Kinescope Picture Tube
Numbers refer to base numbers on socket and to correspondingly numbered connections shown below
All resistors are 1/4-watt unless otherwise specified.
All condensers are 400-volt unless otherwise specified.

PICTORIAL WIRING DIAGRAM — FIG. I.

10-1153



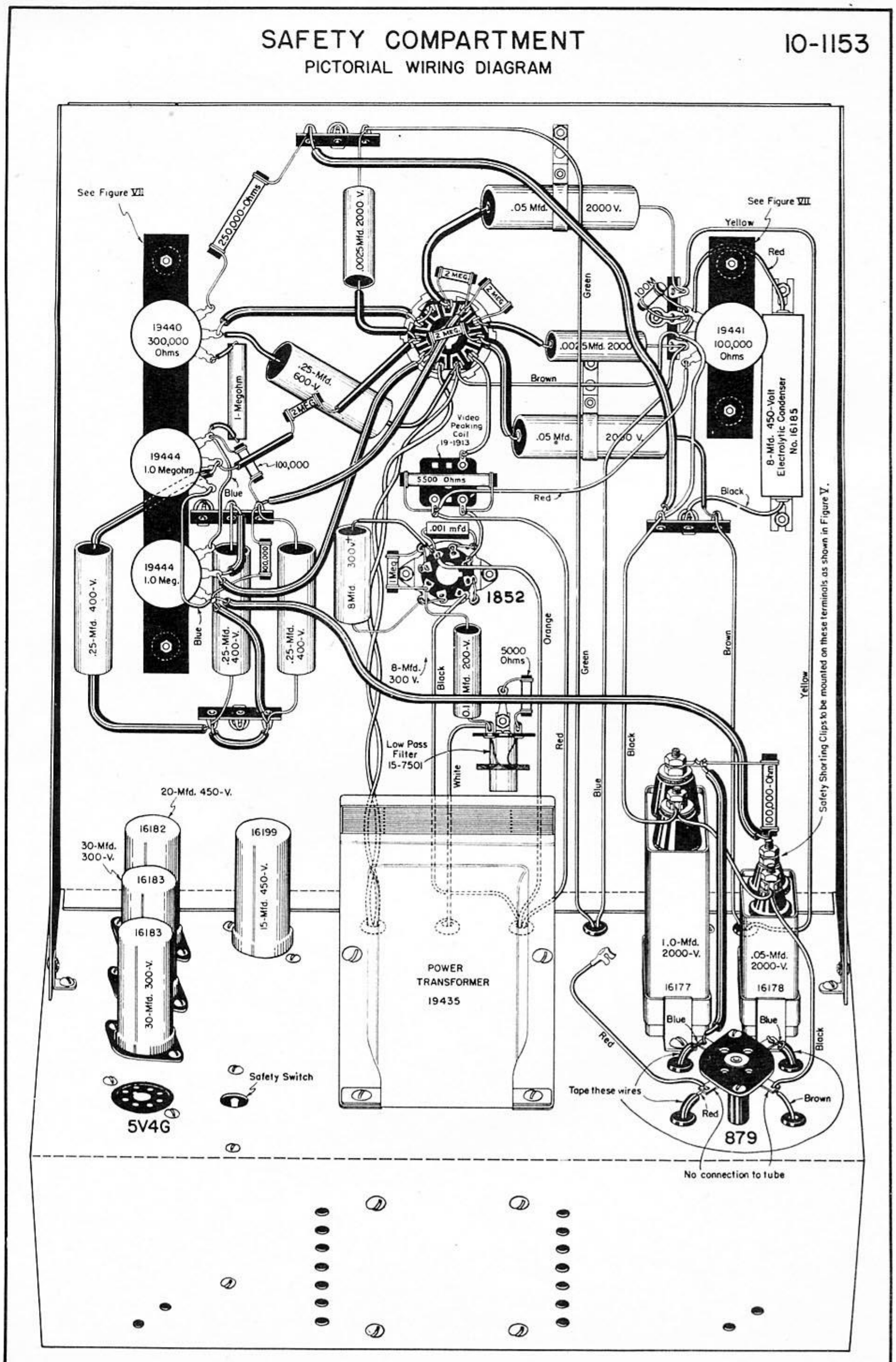

SAFETY COMPARTMENT
PICTORIAL WIRING DIAGRAM
10-1153
See Figure VII
250,000 Ohms
.0025 Mfd 2000 V.
.05 Mfd. 2000 V.
See Figure VII
Yellow
Red
Green
100M
19440
300,000
Ohms
19441
100,000
Ohms
2 MEG.
.0025 Mfd. 2000
.25-Mfd.
600-V.
1-Megohm
Brown
8-Mfd. 450-Volt
Electrolytic Condenser
No. 16185
Video
Peaking
Coil
19-1913
.05 Mfd. 2000 V.
19444
1.0 Megohm
100,000
5500 Ohms
Red
Black
Blue
.001 mfd
19444
1.0 Meg.
.25-Mfd. 400-V.
.25-Mfd. 400-V.
.25-Mfd. 400-V.
8 Mfd. 300 V
1852
Blue
8-Mfd. 300 V.
Black
.1 Mfd. 200-V.
5000 Ohms
Orange
Green
Brown
Yellow
Safety Shorting Clips to be mounted on these terminals as shown in Figure V.
Low Pass
Filter
15-7501
White
Red
Blue
Black
100,000-Ohm
20-Mfd. 450-V.
16182
16199
30-Mfd.
300-V.
16183
16183
15-Mfd. 450-V.
30-Mfd. 300-V.
POWER
TRANSFORMER
19435
1.0-Mfd.
2000-V.
16177
.05-Mfd.
2000-V.
16178
Blue
Blue
Red
Black
Safety Switch
Tape these wires
Red
Brown
5V4G
879
No connection to tube

FIGURE II

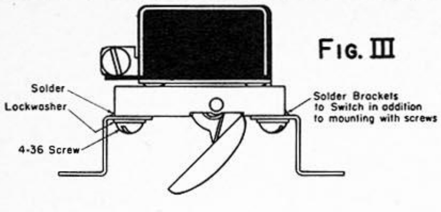


FIG. III

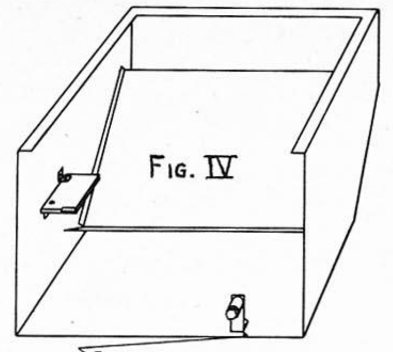


FIG. IV

External tooth lockwasher to be placed between bracket and safety cover.

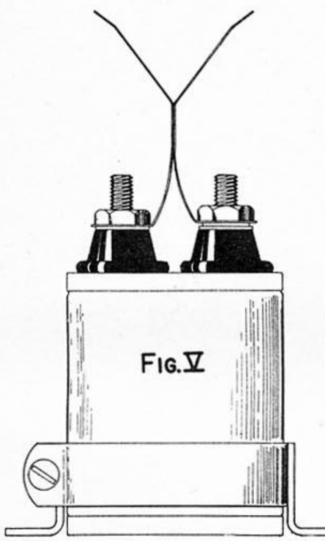


FIG. V

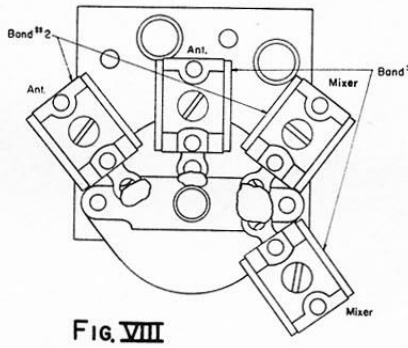


FIG. VIII

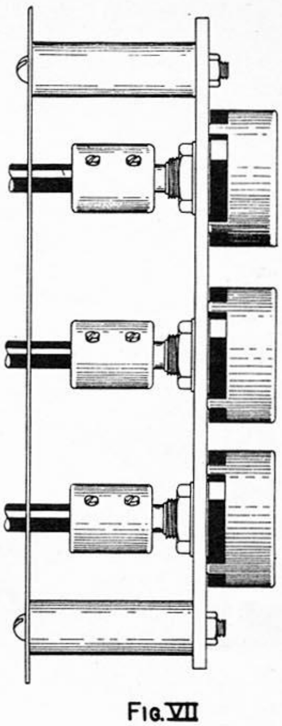


FIG. VII

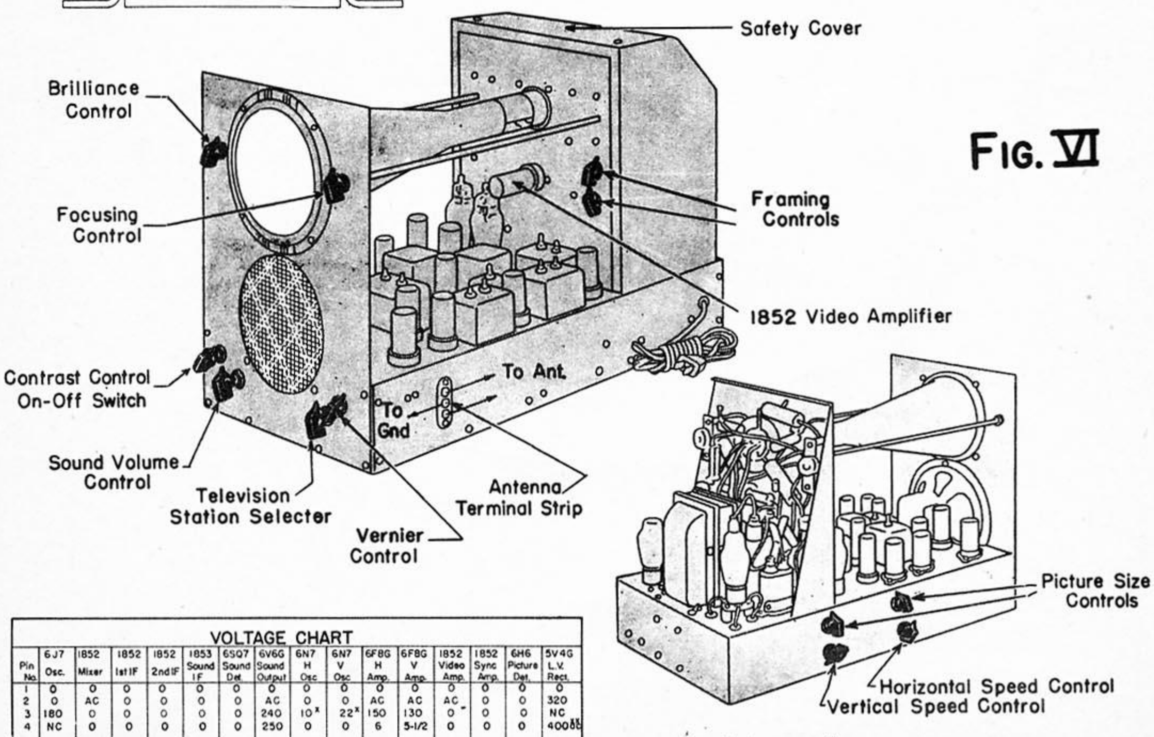


FIG. VI

VOLTAGE CHART

Pin No.	6J7 Osc.	1852 Mixer	1852 1st IF	1852 2nd IF	1853 Sound IF	6SQ7 Sound Det.	6V6G Sound Output	6N7 H Osc	6N7 V Osc	6F8G H Amp.	6F8G V Amp.	1852 Video Amp.	1852 Sync Amp.	6H6 Picture Det.	5V4G L.V. Rect.
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	AC	0	0	0	0	AC	0	0	AC	AC	AC	0	0	320
3	180	0	0	0	0	0	240	10 x	22 x	150	130	0	0	0	NC
4	NC	0	0	0	0	0	250	0	0	6	5-1/2	0	0	0	400 AC xx
5	-1	3	2	0	1.5	0	-1/2	0	0	0	0	0	0	0	NC
6	NC	130	130	130	140	80	NC	40 x	37 x	150	130	85	70	NC	400 AC xx
7	AC	0	AC	AC	AC	AC	0	AC	AC	0	0	0	AC	AC	NC
8	0	260	260	260	260	0	0	1/2	1/2	6	5-1/2	250	100	0	320

NC = No connection x = 75 range on meter xx = Voltage from plate to center tap of transf. secondary

FIG. X

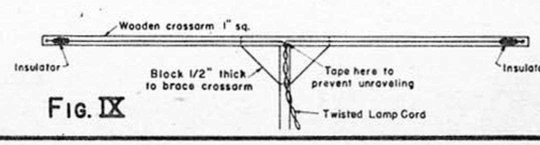


FIG. IX