PRACTICAL APPLICATION OF THE

OSCILLOGRAPH

TO MODERN RADIO SERVICING

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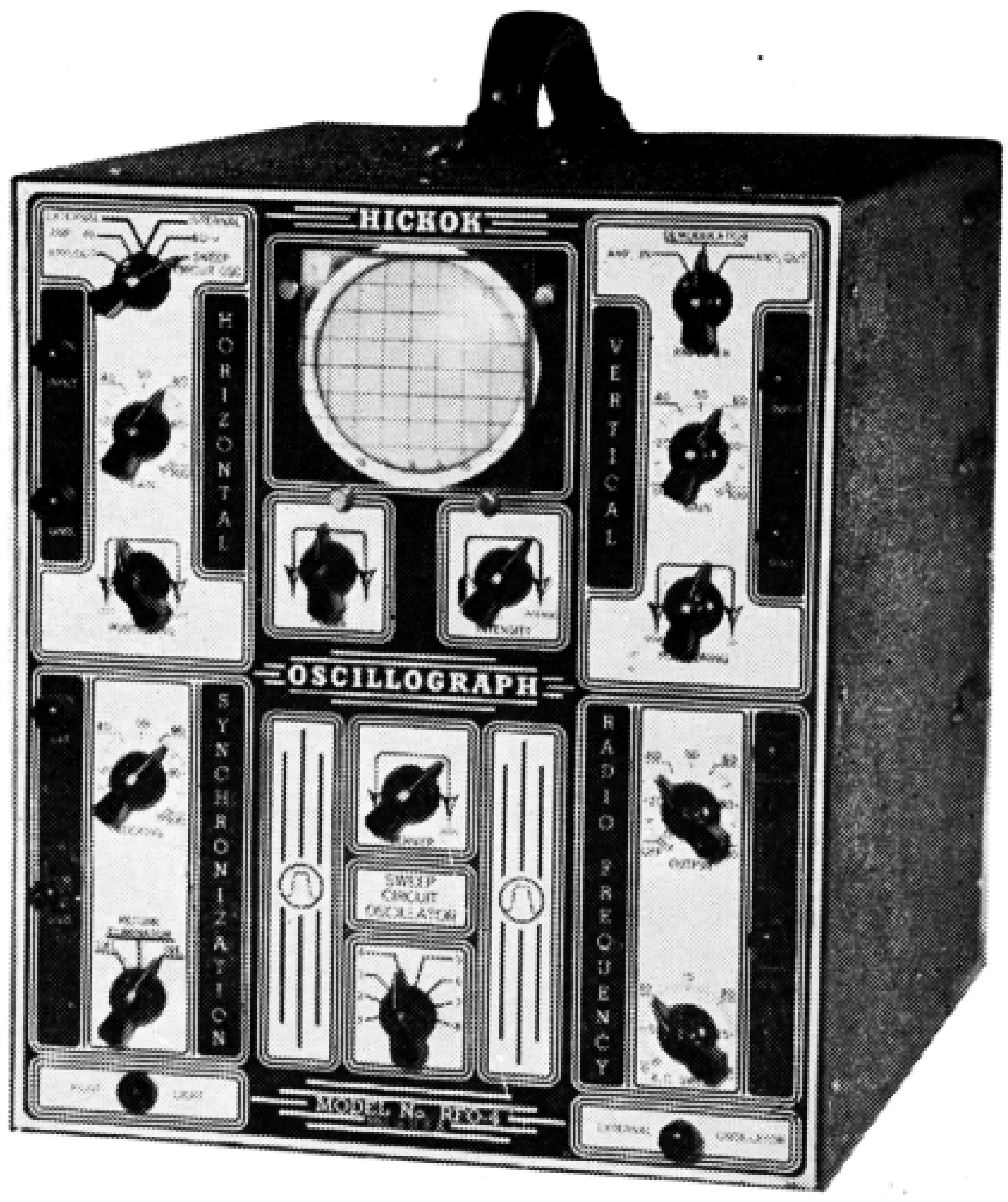
DYNAMIC VISUAL ANALYSIS

Dynamic visual analysis is now being accepted as the most rapid and thorough method of locating trouble in radio receivers. In older methods the indicating medium could only indicate the presence of a voltage or current and in some cases its magnitude. This method was necessarily slow and uncertain since the indicator could not differentiate between the nature of the voltage being measured whether it be 60 or 120 cycle hum, 400 cycle modulation, distorted or undistorted. All these and other signals look alike on the older type of indicator whether it be an old fashioned neon glow lamp, a magic eye indicator or a precision voltmeter or ammeter. The advent of the Cathode Ray Oscillograph and subsequent technical improvements which have been made on it have brought us away from the old fashioned method of groping in the dark wondering whether the indication on the magic eye tube or meter was hum, RF carrier, distortion, signal or what, and enabled us to immediately recognize it in its true form.



Model RFO-4

It is the purpose of this article to give enough concrete information along this line to enable the serviceman to immediately recognize from the appearance of the trace on the cathode ray tube screen faults or trouble which might occur in any section of a radio receiver.

The theory of operation of the Cathode Ray Oscillograph will not be covered in this article since it is dealt with in detail in the oscillograph instruction book entitled "Cathode Ray Oscillograph Operation and Application" published by the Hickok Electrical Instrument Co.

The oscillograph being used in this test is the Hickok Model RFO-4 and was chosen for the following reasons:

First, the Model RFO-4 is the only oscillograph with a self-contained **Visual Vacuum Tube Voltmeter.** The input circuit is calibrated directly from 0.2 of 1 volt to 1000 volts, this feature makes this unit more flexible in that an external A.C. voltmeter does not have to be used to determine the magnitude of an A.C. voltage being studied.

Second, it is the only oscillograph incorporating video (wide band) amplifiers. This makes it possible to directly study the radio frequency and intermediate frequency voltages on the cathode ray tube screen. Standard oscillograph amplifiers are limited to the audio and lower radio frequencies, and therefore, are not suitable for amplifying and viewing the higher frequencies encountered in the radio frequency and intermediate frequency sections.

Third, it is the only oscillograph incorporating a built-in demodulator. This demodulator which is similar to the second detector in the receiver makes it possible to demodulate and analyze the amplitude or frequency modulated signal throughout the entire range of the radio frequency and intermediate frequency stages in the receiver under test.

Fourth, it is the only oscillograph which incorporates a self contained frequency modulator with dual frequency sweep and variable width sweep. As a result of this feature it is not necessary in many cases to connect any external oscillator to the receiver under test, since the signal can be supplied directly from the built-in frequency modulated oscillator.

Fifth, it incorporates an internal sinusoidal sweep voltage which is available for horizontal plate deflection thereby increasing the usefulness of the oscillograph in the analyzation of frequencies of 60 cycles or some multiple thereof.

Sixth, it incorporates a return eliminator which can be used on the 60 cycle sinusoidal horizontal sweep. This makes it very convenient to separate and isolate wave distortion which might be encountered during 180 electrical degrees of the 60 cycle wave, but not found in the other 180 degrees.

Seventh, it is the only oscillograph which incorporates a calibrated screen with reference level for actual voltage indication.

Eighth, it incorporates a built-in mixing circuit so that when an external oscillator is used frequency mixing may be accomplished within the oscillograph. Any frequency modulated output may be delivered within the range of the external oscillator.

Ninth, it is the only oscillograph which is capable of producing a dynamic visual audio frequency response curve when used in connection with any external oscillator.

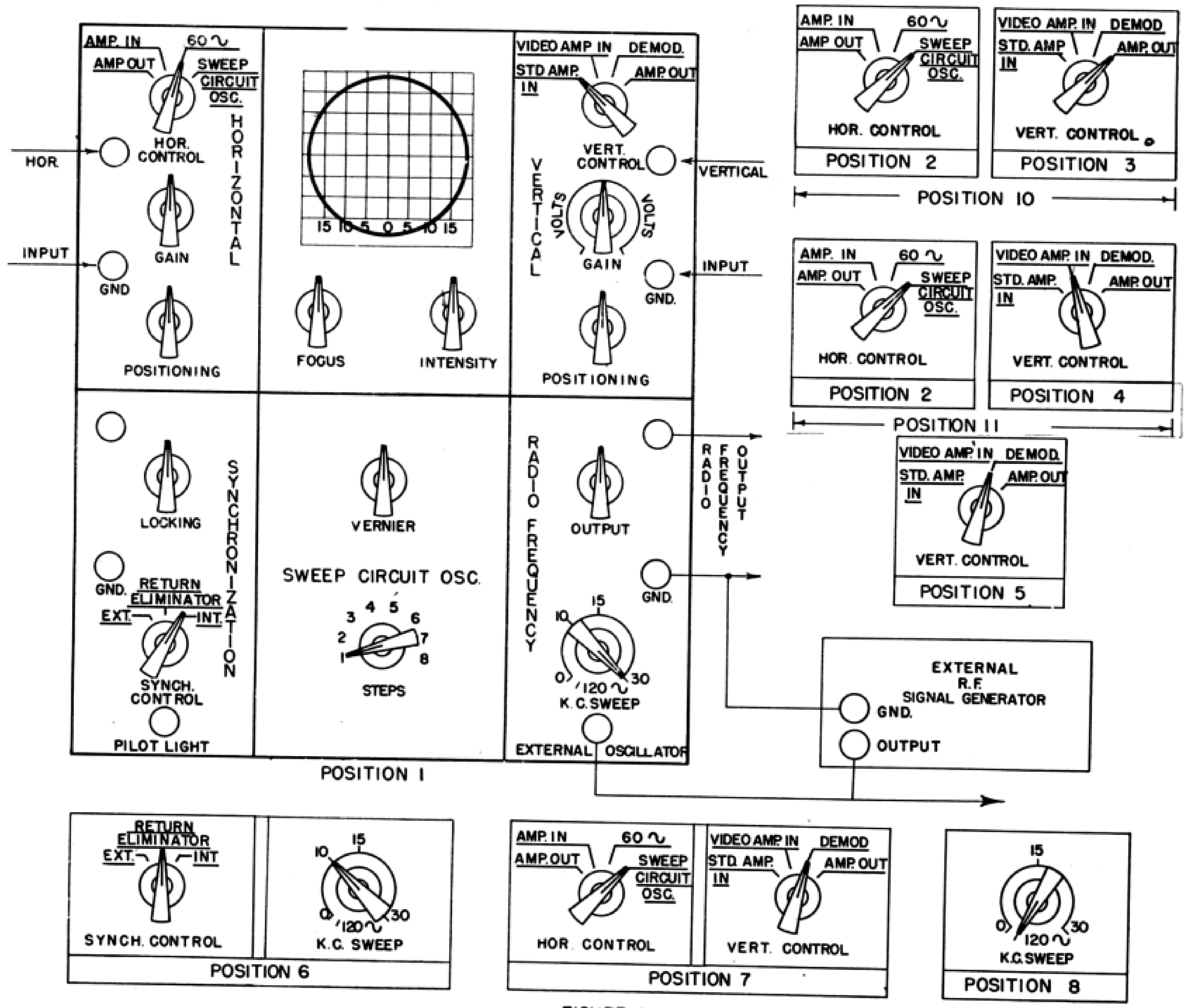


FIGURE I

For the convenience of explanation and simplicity, Fig. 1 shows the panel layout of the RFO-4, and sections of this panel, to illustrate the various control settings used in the following tests. The four controls, the focus control, intensity control and the two positioning controls can be preset before the test is started and no further change of these controls will be necessary. The proper method of setting these controls is, to advance the intensity control until suitable brilliancy is obtained. Adjust the focus control for the finest line which can be obtained. Adjust the horizontal and vertical positioning controls until the beam is centered vertically and horizontally on the cathode ray tube screen.

In cases where any of the following controls are used they thould be adjusted as follows:

GAIN CONTROLS: Advance to give suitable deflection.

R.F. OUTPUT: Advance to give suitable output.

LOCKING CONTROL: Used only with sweep circuit oscillator—Advance only far enough to give suitable locking to cause image to remain stationary on screen.

SWEEP CIRCUIT OSCILLATOR: STEP and VERNIER—Adjust step control to approximate frequency desired and make final adjustment with vernier control.

VISUAL VACUUM TUBE VOLTMETER

The vertical gain control has two calibrated voltage scales, the first range from .2 volts to 100 volts is to be used when the vertical control is in the "Standard Amplifier In" position. The other range from 100 to 1000 volts is used in the "Amplifier Out" position.

In both cases the voltage indicated would be correct when the gain control had been adjusted so that the vertical displacement of the beam was equal to the distance between the horizontal voltage reference lines on the calibrated screen. The calibration is based on the R.M.S. value of a sine wave.

All of the curves illustrated in this manual are not necessarily adjusted to the voltage reference lines.

With reference to the various oscillograph positions illustrated:

Position 1 illustrates what we will term the basic setting of all of the controls on the panel. In the case of positions other than position 1 all controls with the exception of those illustrated should remain the same as indicated in position 1.

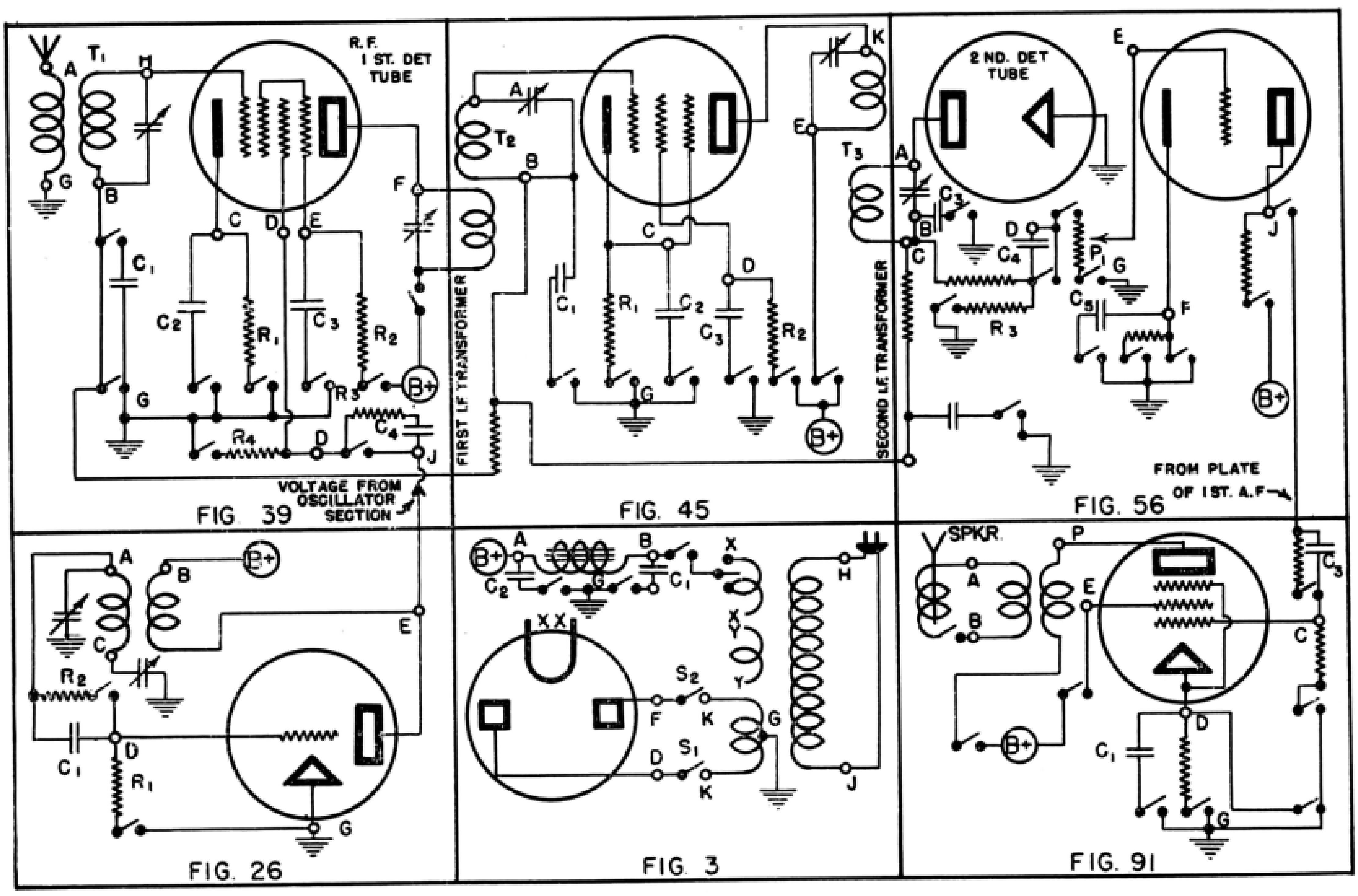


Fig. 2

In order to facilitate the demonstration we have constructed a modern 7 tube superheterodyne receiver and laid this receiver out on a panel as illustrated in Fig. 2. All of the connections to these tube elements, transformers, sockets, resistors, etc., are brought out to connections on the front of the panel so that they will be accessible for the test. You will also note that provision has been made for opening up or shorting out almost all component parts of the complete radio receiver.

This receiver has been divided into six sections, namely:

Section 1 — Power Supply
Section 2 — Oscillator Section
Section 3 — First Detector
Section 4 — Intermediate Frequency Amplifier
Section 5 — Second detector and first audio
Section 6 — Final Amplifiers
Section 7 — Vibrator Testing

We will take up each section independently and attempt to show any trouble which could develop in this section and how this trouble would be located and isolated through dynamic visual analysis.

POWER SUPPLY SECTION

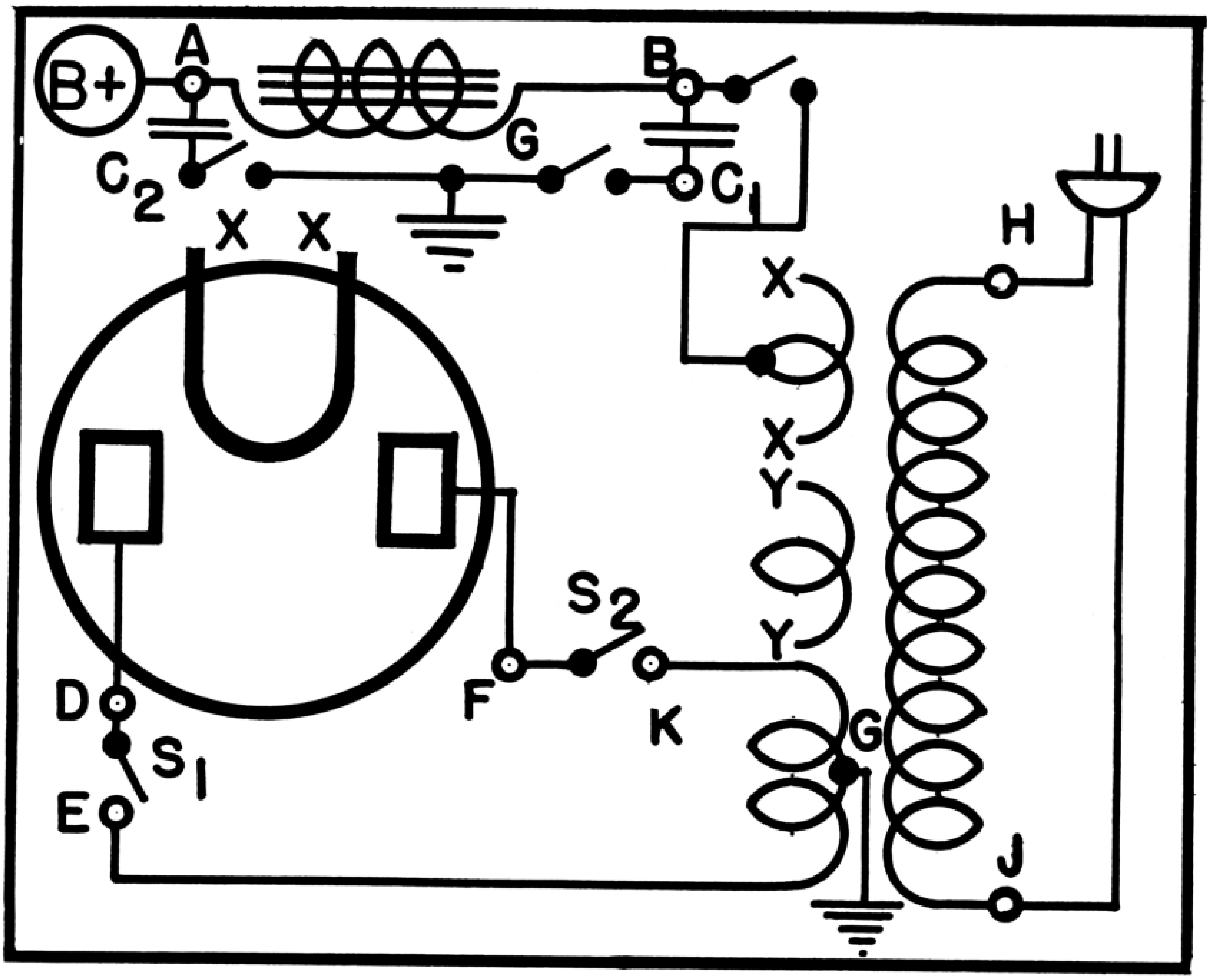


FIG. 3

Fig. 3 illustrates this section which consists of a power transformer, full wave rectifier tube, filter condensers and choke. While all of the tests taken up in this article would not be necessary in doing any one service job, we are going to consider the cases which could happen under any circumstances and therefore will omit no trouble which might not reasonably be encountered.

There are several types of traces which will be found quite often throughout the entire series of tests. These are being illustrated only once and they are as follows:

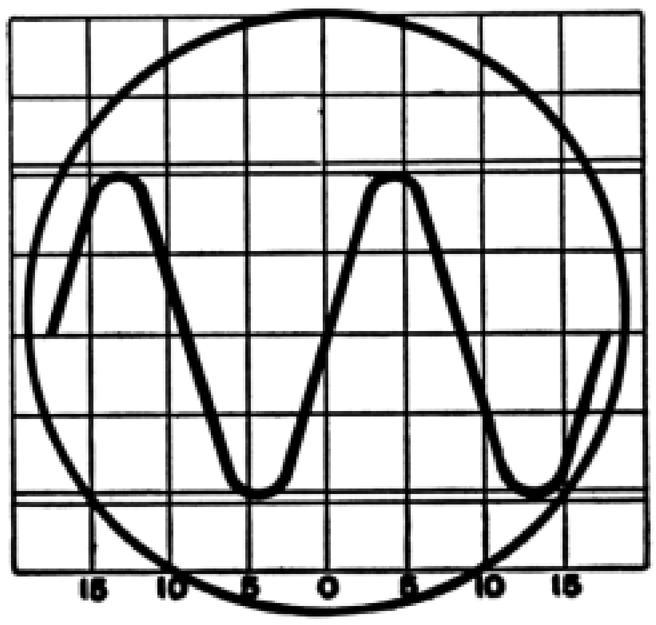


FIG. 4

Fig 4 represents a pure sine wave of any frequency being applied to the vertical plates. In this case the sweep circuit oscillator has been adjusted to a frequency which is one-half of the applied frequency thereby giving two sine waves on the screen. If the sweep circuit oscillator were adjusted to the same frequency as the applied frequency of course one sine wave would appear, or at one-third the frequency three sine waves etc.

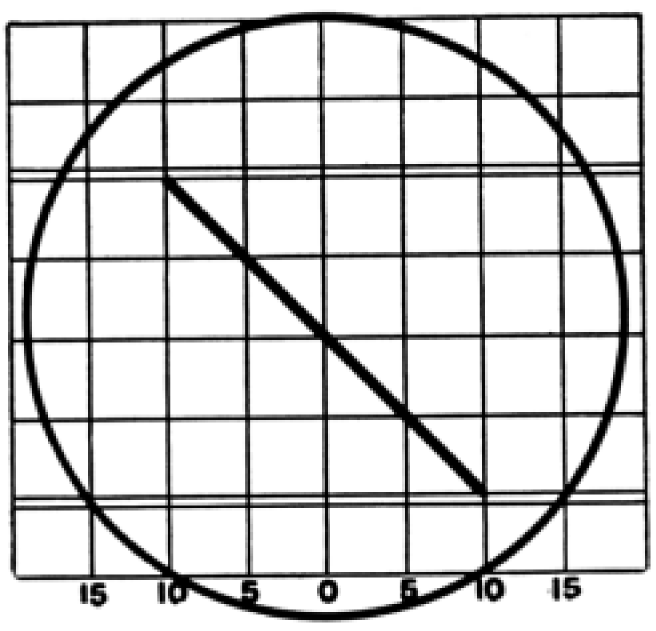


FIG. 5

Fig. 5 represents a sine wave applied to both horizontal and vertical plates, the two frequencies being in phase.

Fig. 5A represents the same condition as Fig. 5 but with a slight phase discrepancy between the two frequencies.

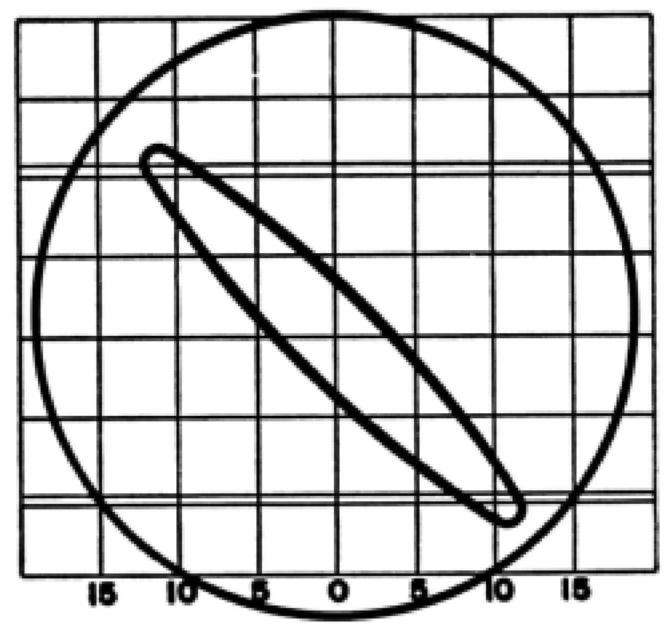


FIG. 5A

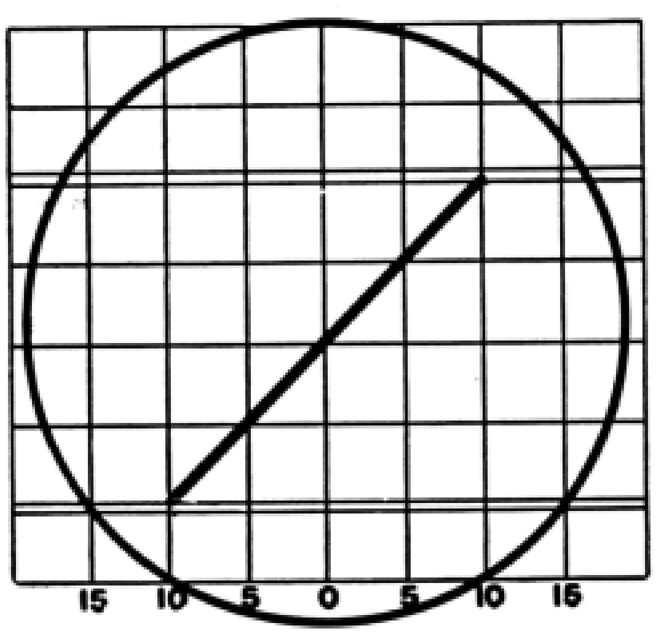


FIG. 6

Fig. 6 represents a sine wave applied to both horizontal and vertical plates but with the frequencies exactly 180 degrees out of phase.

Fig. 6A represents the same condition as Fig. 6 but with the frequencies slightly different than 180 degrees out of phase.

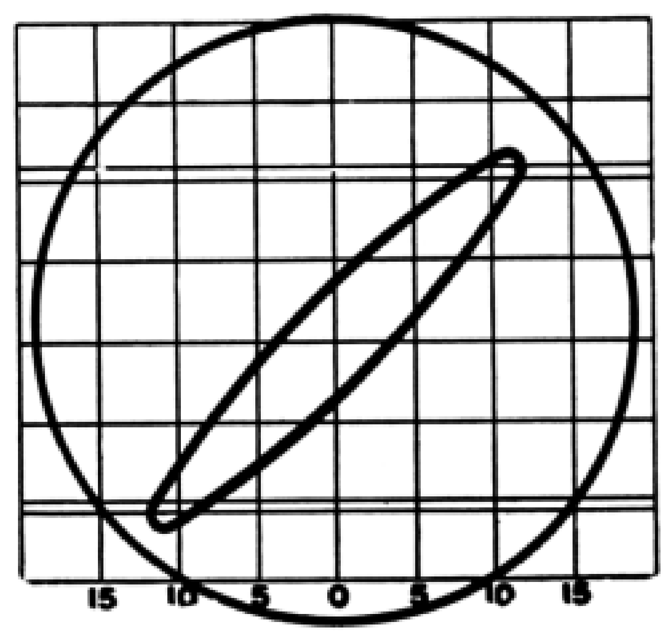


FIG. 6A

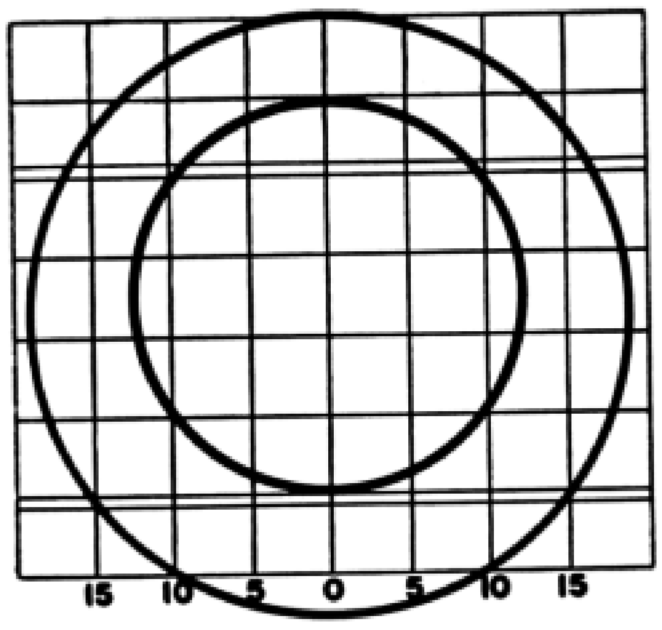


FIG. 7

Fig. 7 represents a sine wave applied to both horizontal and vertical plates but 90 or 270 degrees out of phase.

Fig. 7A represents sine waves applied to both plates with the frequency on the vertical plate double that of the frequency on the horizontal plate.

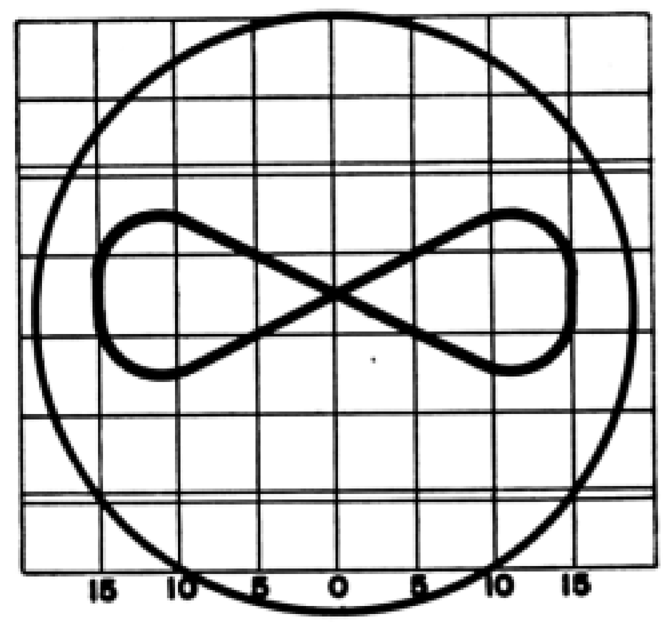


FIG 7A

Any of the following measurements of primary or secondary voltage could be made with a reliable A.C. voltmeter to determine the magnitude of the voltage. The oscillograph goes a step further and indicates not only the magnitude but the characteristics of this voltage. The following tests are given to demonstrate how the oscillograph might be used for this service.

PRIMARY VOLTAGE

Connection H-J — Oscillograph Position 10 Fig. 4

With the proper voltage at the primary of the transformer Fig. 4 should be obtained. The indicated voltage on the vertical gain control should correspond to the line voltage.

Connection H-J — Oscillograh Position 3 Figs. 5 to 7 Inclusive

Fig. 5 or Fig. 6 will be obtained if there is no phase discrepancy between the primary voltage and the internal 60 cycle sweep voltage. Slight phase discrepancies would show up as illustrated in Fig. 5A or Fig. 6A. Excessive phase discrepancies as illustrated in Fig. 7 would indicate the presence of a capacity or inductance between the supply line and the primary of the transformer.

SECONDARY VOLTAGE

Connections X-X or Y-Y — Oscillograph Position 2 Fig. 4

The results obtained should be identical to those outlined when checking primary voltage as shown in Fig. 4 with the exception that the indicated magnitude of the voltage should be in the neighborhood of 5 or 6 volts as indicated on the calibrated voltage scale. The vertical amplifier must be used and consequently position 2 rather than position 10.

Connections X-X or Y-Y — Oscillograph Position 1 Figs. 5 to 7

Results should be identical to those obtained when checking primary voltage with position 3 with the exception of the magnitude of the voltage.

Connections K-G, E-K, E-G — Oscillograph Position 10 or 3 Figs. 4 to 7 Inclusive

Results should be identical to those shown in Figs. 4 to 7 inclusive with the exception of the magnitude of the voltage indicated on the calibrated voltage scale.

In the foregoing tests no actual voltage readings have been given for the secondary voltages since these vary so much with various receiver designs. In general, however, the high voltage secondary should indicate approximately twice the rated D.C. voltage for the rectifier system when measured between E and K. The connections Y-Y which represent the heater voltage supply are in general found to be either 6.3 volts for the more modern receivers or 2.5 volts for the older type receivers. In measuring the voltage supply to the filament in the rectifier tube, this voltage should correspond to the voltage rating of the rectifier tube. Of course, voltage measured from center tap of the filament winding to either side would be one-half of the total voltage reading.

FILTER SYSTEM

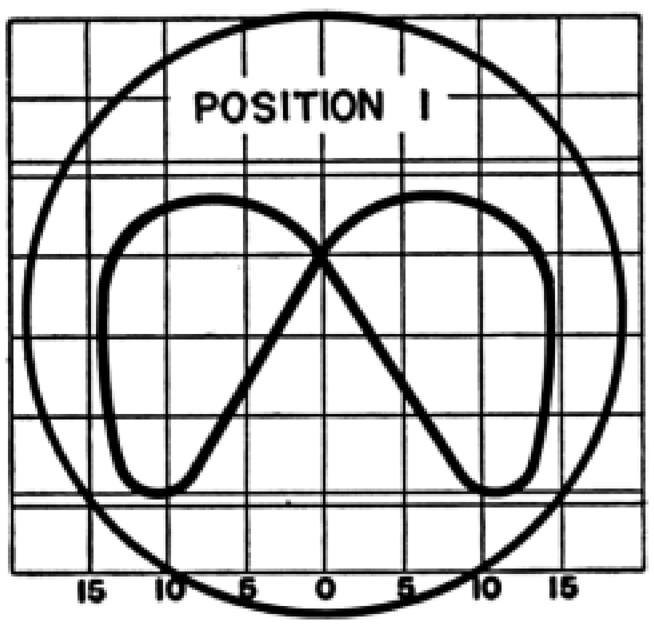


FIG. 8

Condition — Normal System, Full Wave Rectification. Normal Loading Condenser Input.

Connections G-B. (Fig. 3)

Oscillograph — Positions 1-2. (Fig. 1)

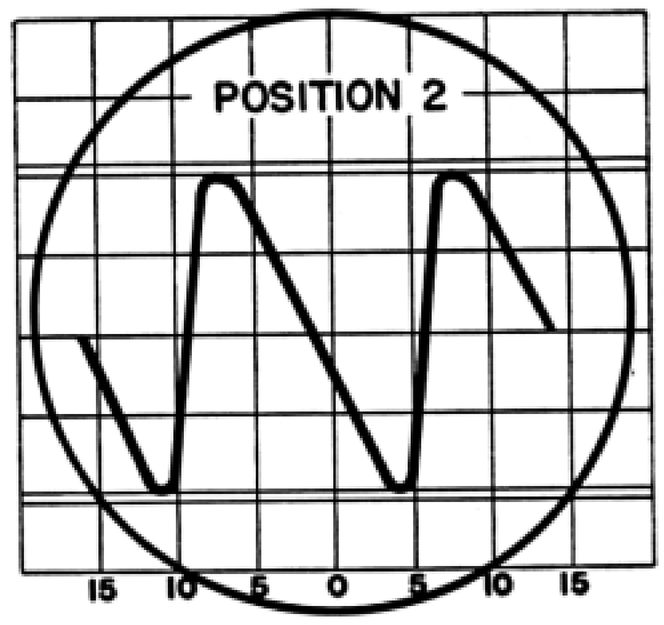


FIG. 9

Fig. 8 (Position 1) illustrates the curve as it should appear at the input of the filter section when using condenser input. Note the trace in Fig. 9 (Position 2) differs from a sine wave as illustrated in Fig. 4 in that one side of the curve is almost vertical whereas the other side has a distinct slope. The magnitude of the voltage will normally be between 5 and 15 volts R.M.S. A.C. Should the voltage be found to be considerably higher than this it would probably be an indication of excessive loading on the output of the filter system. This might be caused by a shorted output filter condenser or any short from a B plus connection in the receiver back to ground. In general, the effect of such a loading on the trace would be to cause a smoothing out of the corners in the trace illustrated in Fig. 8 or to cause the trace illustrated in Fig. 9 to be more nearly a pure sine wave as illustrated in Fig. 4.

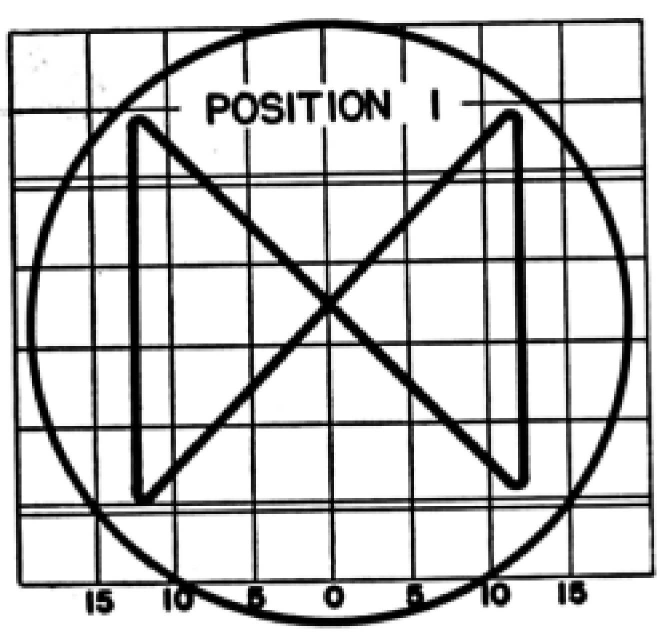


FIG. 10

Condition — Normal System, **No Loading.** Full Wave Rectification. Condenser Input.

Connections G-B.

Oscillograph — Positions 1-2.

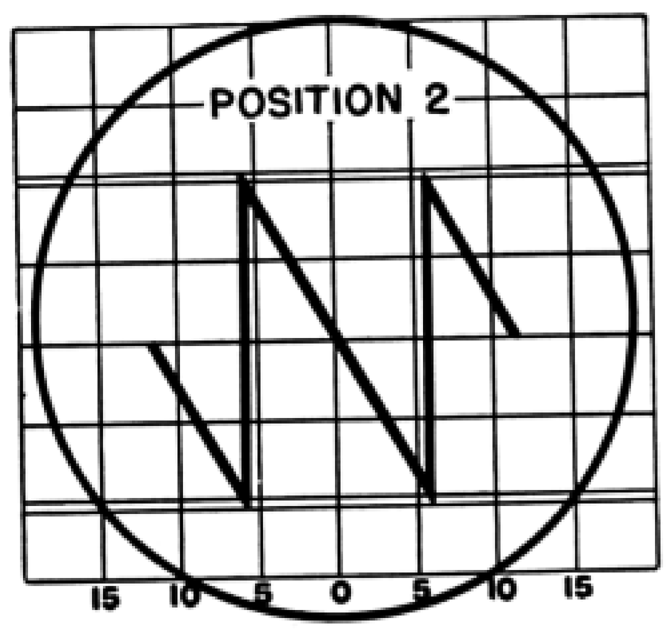


FIG. 11

If as a result of defective wiring or broken connection the loading caused by the plate current, bleeder system etc., on the filter system was relieved or lightened we would have traces as illustrated in Fig. 10 (Position 1) and Fig. 11 (Position 2). In Fig. 10 note the extremely sharp corners on the curve which are in exact contrast to the smooth rounded corners illustrated in Fig. 8. Fig. 11 illustrates the same condition when using the sweep Circuit oscillator and it will be noted that the curve no longer resembles the sine wave since it has very sharp corners and straight sides, the voltage rising almost vertically during the first half of the cycle and descending quite gradually during the other half of the cycle.

In many sets the greater part of the load on the filter system is caused by the audio stages, especially the final amplifier and when such a condition has been encountered it would be well to check this stage first.

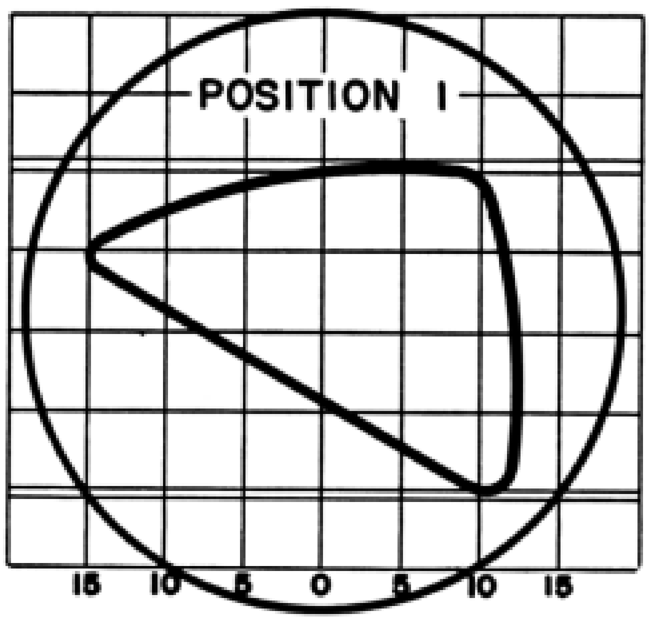


FIG. 12

Condition — Normal System, Half Wave Rectification. **Normal Loading.** Condenser Input.

Connections G-B.

Oscillograph — Positions 1-2.

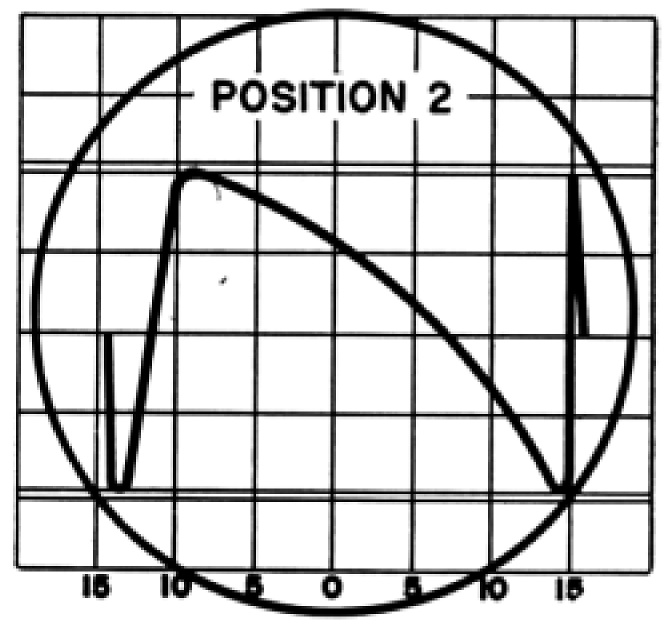


FIG. 13

In the case of half wave rectification in a filter system which we can simulate by merely opening up either S1 or S2, we obtain Fig. 12 (Position 1) or Fig. 13 (Position 2). This is under a condition of normal loading and in this case it will be found that the A.C. voltage developed across the input condenser will be somewhat higher, in fact almost twice as great as might be expected from full wave rectification. The magnitude of this voltage being generally between 15 and 30 volts.

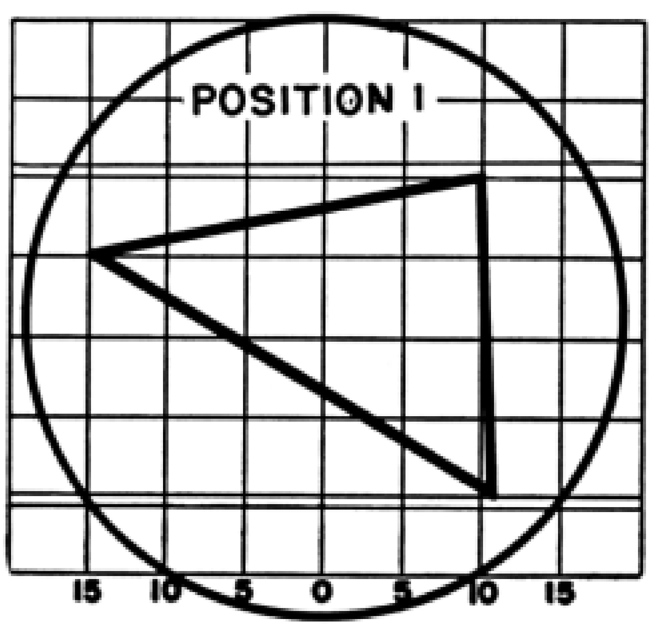


FIG. 12 A

Condition — Normal System, Half Wave Rectification. **No Loading** Condenser Input.

Connections G-B.

Oscillograph — Positions 1-2

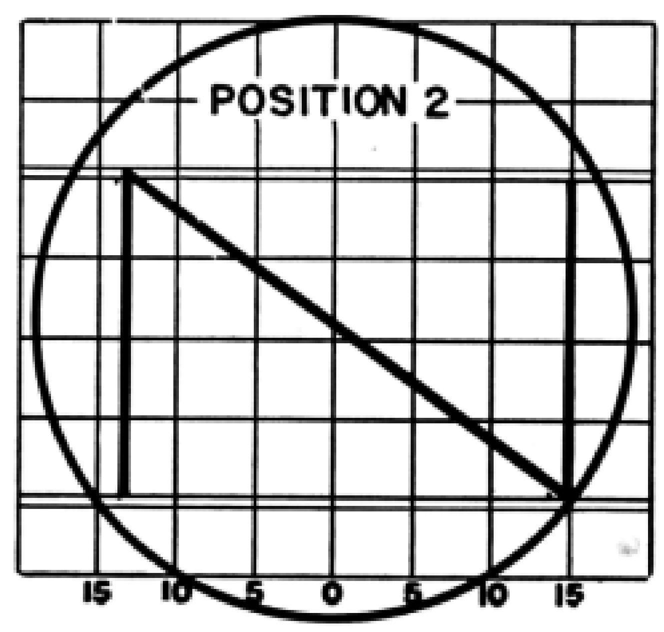


FIG. 13 A

Figs. 12A and 13A are illustrative of a case of no loading on the filter system with half wave rectification. The voltage will drop down to a considerably lower value, probably not over 1 volt R.M.S.

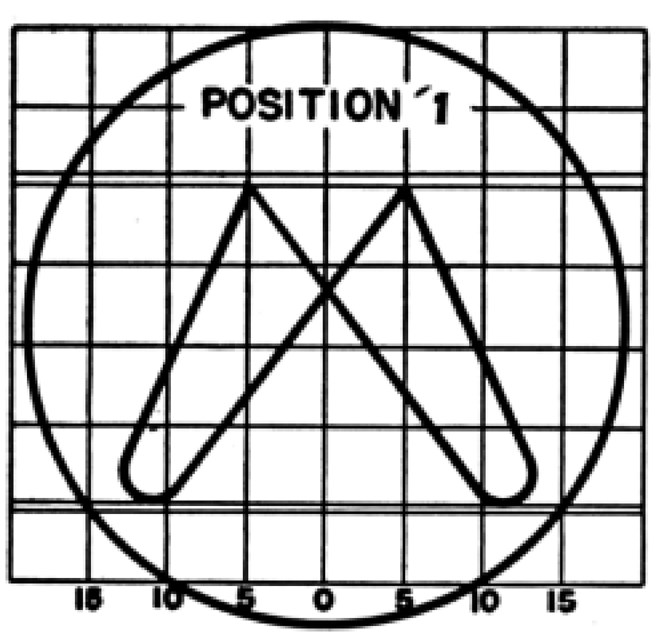


FIG. 14

Condition — Normal System. Normal Loading. Full Wave Rectification. **Choke Input.**

Connections G-B.

Oscillograph — Positions 1-2.

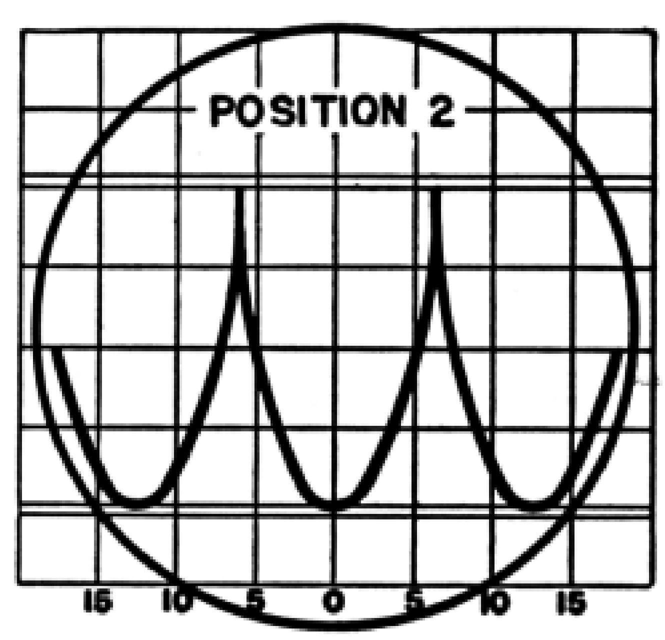


FIG. 15

Fig. 14 (Position 1) and 15 (Position 2) are illustrative of the above condition. The magnitude of the A.C. voltage appearing at point B in this case will be probably over 100 volts if the D.C. supply system is desinged for 250 to 300 volts supply.

It would be well to remember that if the system were designed for condenser input but the input condenser "C1" had become defective and opened up the resultant condition would be the same as illustrated for choke input. This same thing would also apply for the following condition of half wave rectification.

If the voltage is found to be over 100 volts it would be advisable to change from position 1 to position 3 or from position 2 to position 10. Since the vertical amplifier would not be required.

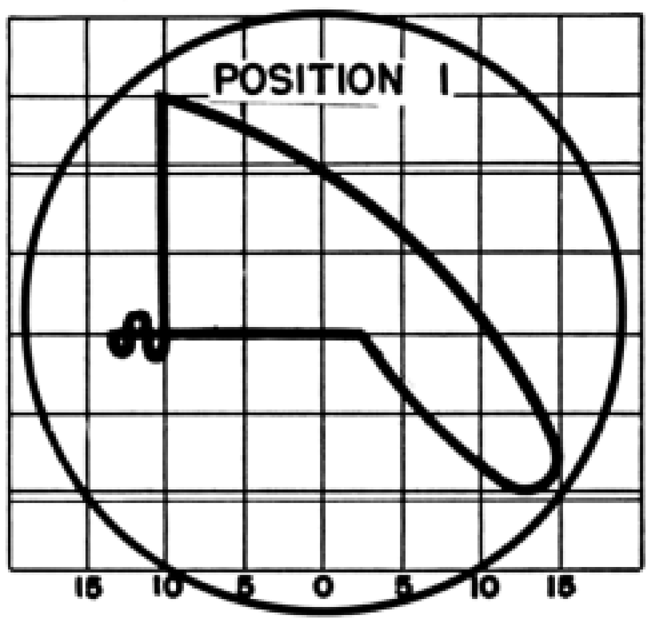


FIG 16

Condition — Normal System, Normal Loading. **Half Wave Rectification.** Choke Input.

Connections G-B.

Oscillograph — Positions 1-2.

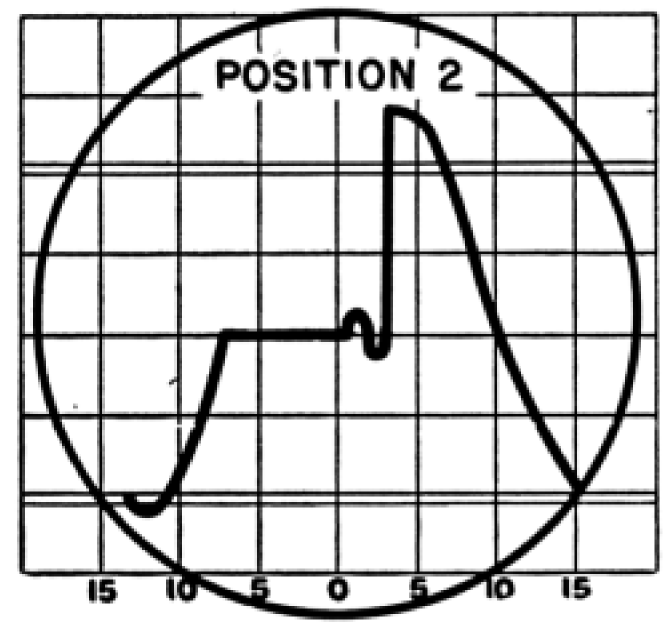


FIG 17

Fig. 16 (Position 1) and 17 (Position 2) are illustrative of the foregoing condition. The magnitude of the voltage appearing at the input section in this case will probably be approximately 100 volts R.M.S. A.C., if over this value use positions 3-10.

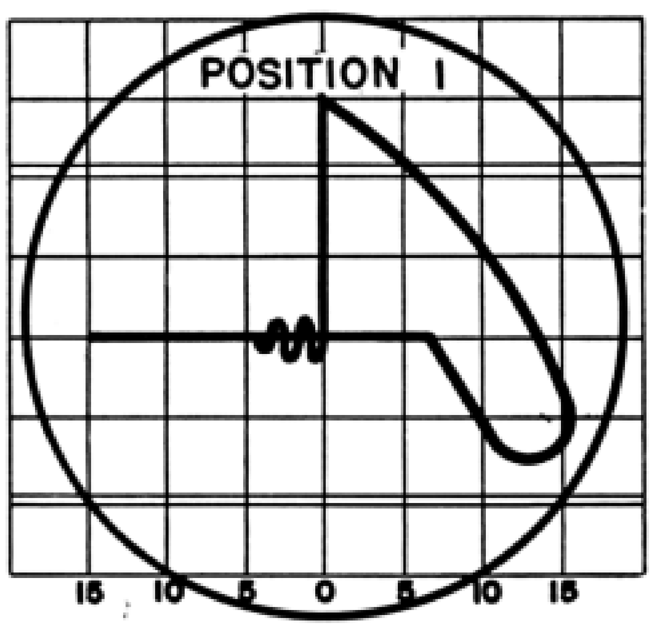


FIG. 16A

Condition — Normal System, **No Loading.** Half Wave Rectification. Choke Input.

Connections G-B.

Oscillograph — Positions 1-2.

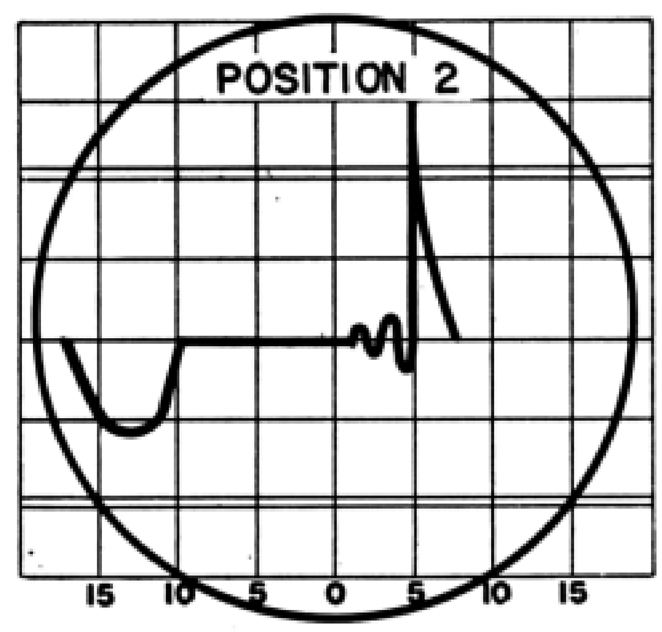


FIG. 17 A

The effect of lack of loading under the above condition will tend to greatly reduce the A.C. voltage present in the input of the filter system, probably bringing it down to 1 or 2 volts. The effect on the curve will be as illustrated in Fig. 16A (Position 1) and 17A (Position 2).

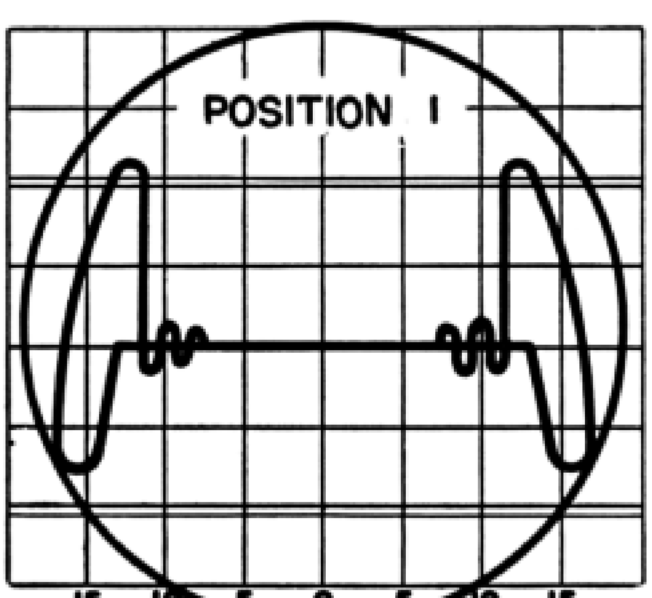


FIG 18

Condition — Normal System, **No Load,** Full Wave Rectification. Choke Input.

Connections G-B.

Oscillograph — Positions 1-2.

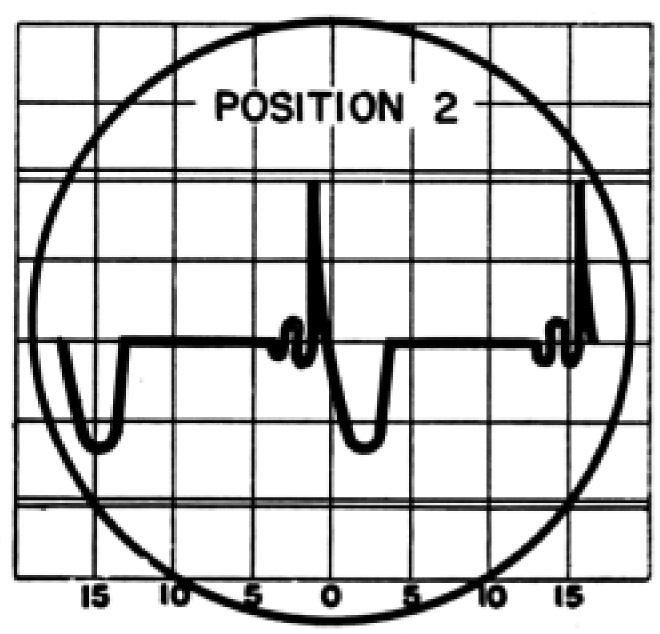


FIG 19

Fig. 18 (Position 1) and 19 (Position 2) are illustrative of the above condition with no loading. The magnitude of voltage developed would depend upon the extent of the loading. In the case of absolute zero loading on the output of the filter system the magnitude of the voltage would probably be in the neighborhood of 5 volts whereas any increase in loading would naturally give a corresponding increase in voltage developed.

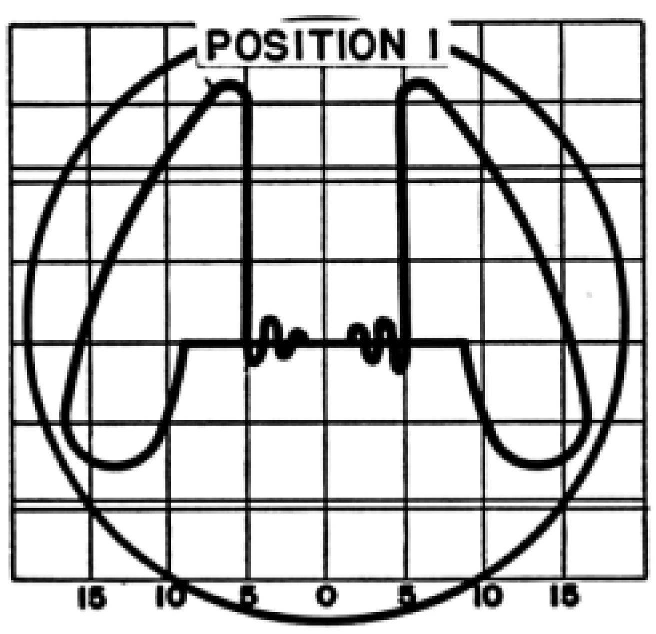


FIG. 18 A

Condition — Normal System, **Light Loading.** Full Wave Rectification. Choke Input.

Connections G-B

Oscillograph — Positions 1-2

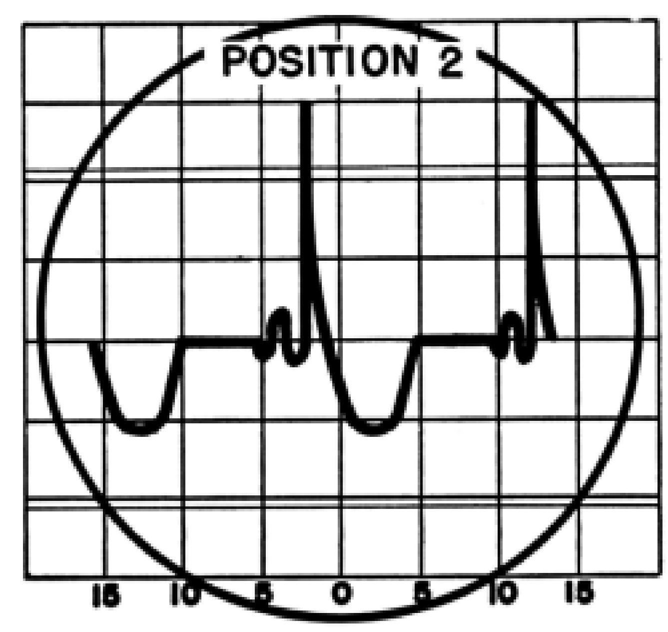


FIG. 19 A

Fig 18A (Position 1) and 19A (Position 2) are taken under the same conditions as Fig. 18 and 19 but are illustrative of light loading.

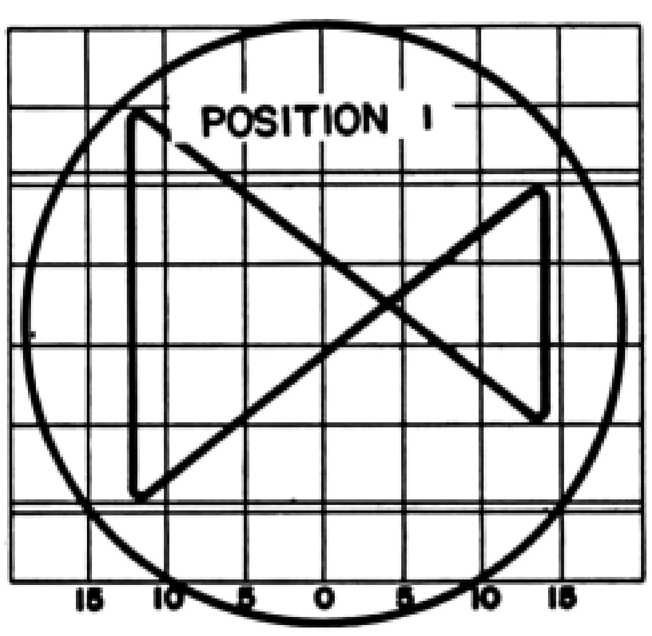


FIG. 20

Condition — Normal System, No Loading. **Rectifier Tube Filament Not Center Tapped.** Full Wave Rectification. Condenser Input.

Connections G-B.

Oscillograph — Positions 1-2.

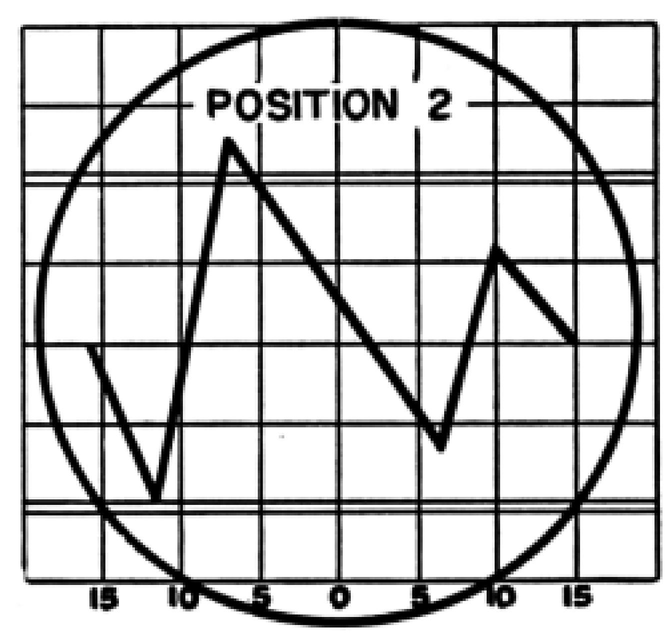


FIG 21

Fig. 20 (Position 1) and 21 (Position 2) are illustrative of the above condition. With reference to Fig. 20 the difference in the height of the two sides of the curve will vary depending upon the amount of loading. If the loading is very light or no loading at all there will be an extreme difference between the heights of the side of these two curves whereas if the loading is increased the difference in the heights will be reduced and the trace will more nearly approach a uniform pattern as illustrated in Fig. 10. It is perfectly normal in some receiver design not to center tap the filaments for the rectifier tube in which case the foregoing curve would indicate normal operation. However, in cases where the rectifier tube filament is supposed to be center tapped the above type curves are an indication of defective connection or transformer winding.

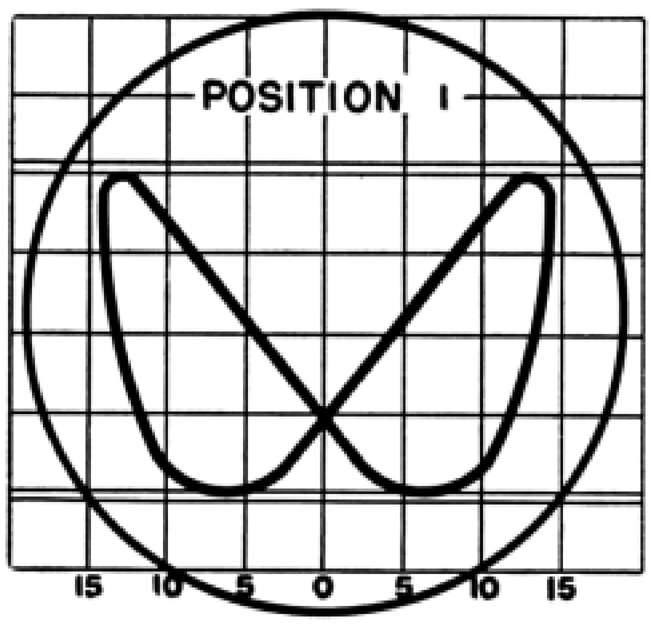


FIG. 22

Condition — Normal System, **Normal Loading.** Full Wave Rectification, Condenser Input.

Connections G-A.

Oscillograph — Positions 1-2.

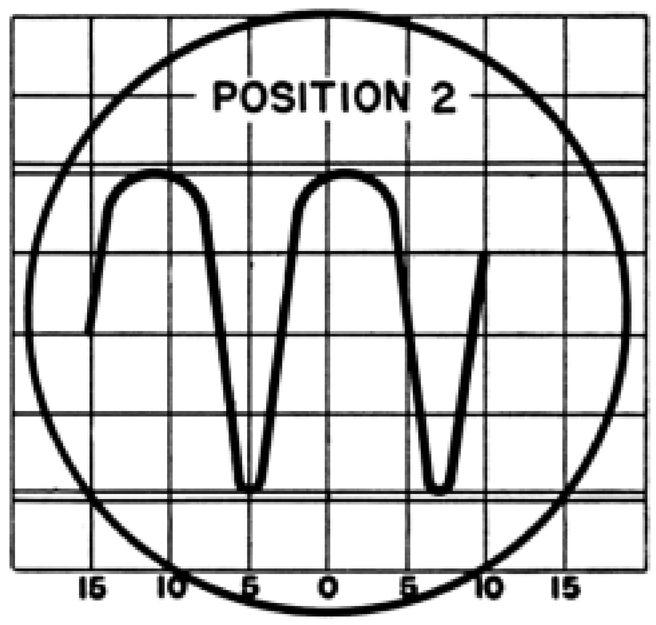


FIG. 23

Fig. 22 (Position 1) and 23 (Position 2) are illustrative of the above condition under the basis of normal loading. The voltage at this point will probably be in the neighborhood of .2 of 1 volt or less. Should the output condenser be opened which would result in lack of filtering, the shape of the traces would not change appreciably, however, the voltage as indicated at this point will probably increase to the neighborhood of 1½ to 2½ volts.

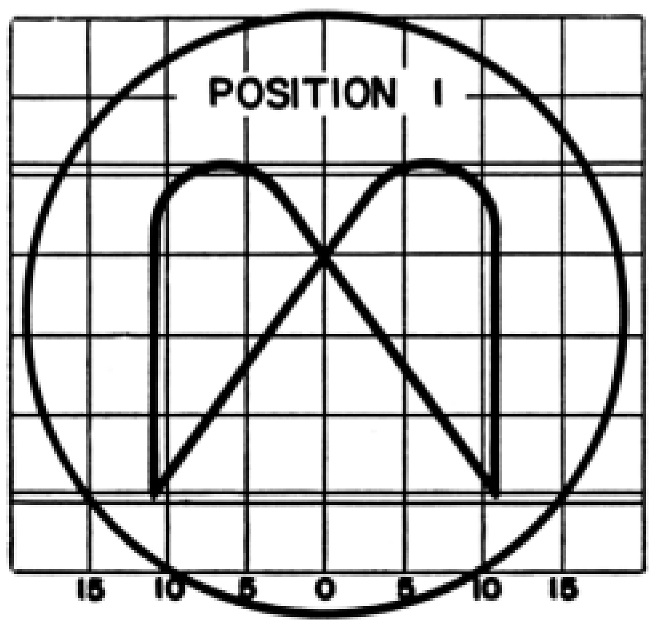


FIG. 24

Condition — Normal System, Normal Loading. **Filter Choke Shorted Out.** Full Wave Rectification. Condenser Input.

Connections G-A or G-B.

Oscillograph — Positions 1-2.

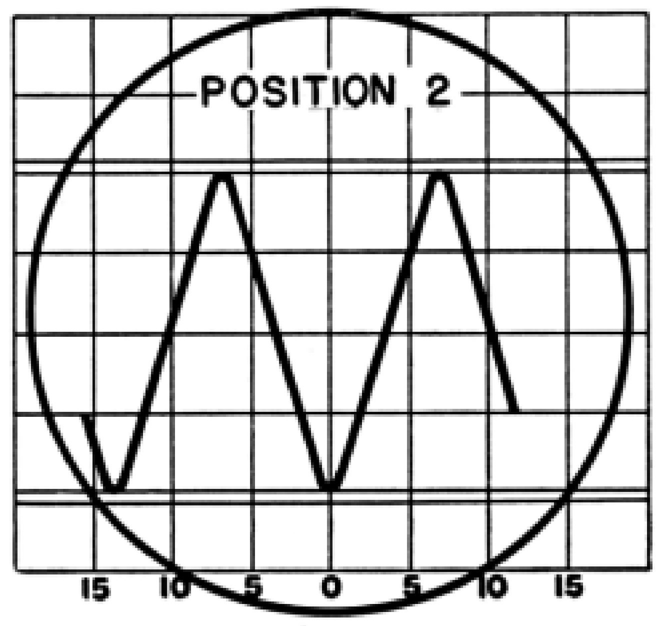


FIG. 25

In this case of course the pattern observed at either point A or point B would be identical due to the fact that the choke was shorted out. The mangitude of the R.M.S. A.C. voltage under this condition would probably be in the neighborhood of 4 to 8 volts. Should this condition be encountered in a case where choke input was used the trace would be approximately identical to those illustrated in Fig. 24 (Position 1) and 25 (Position 2) but the measured voltage would probably be between 10 and 15 volts R.M.S.

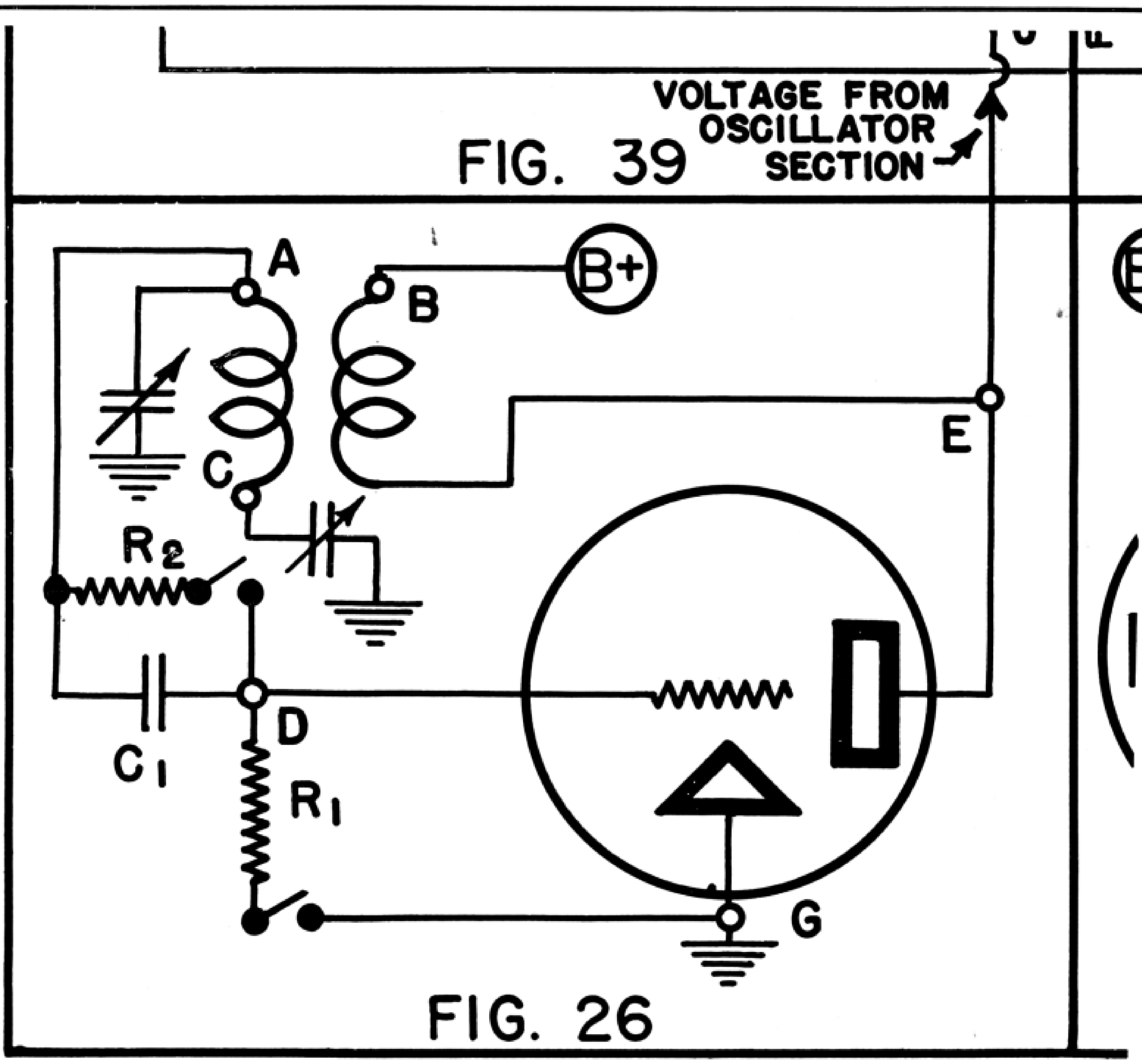


FIG. 39

FIG. 26

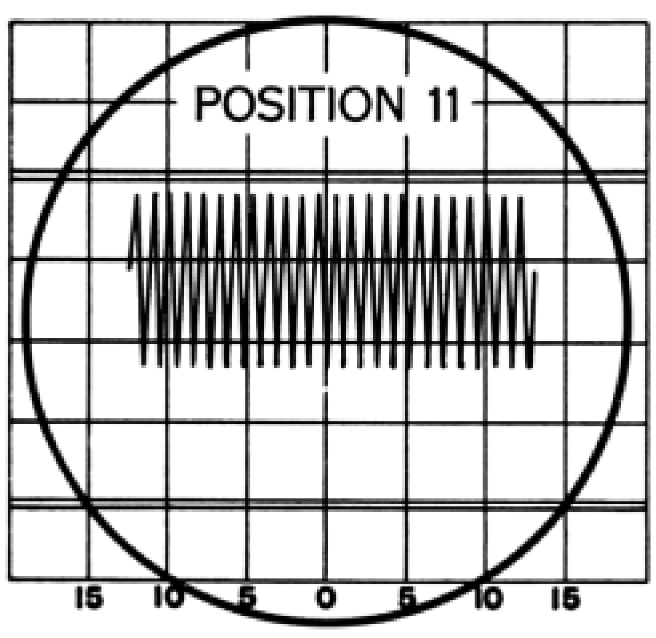


FIG. 27

Condition — Normal System. Oscillator Output Voltage.

Connections E-G.

Oscillograph — Position 11.

Figure 27 (Position 11) is illustrative of the above condition. It will be noted that it will probably be impossible to obtain sufficient vertical deflection on the cathode ray tube screen to have the trace reach the voltage reference lines. The vertical deflection from the video amplifier is lower than that from the standard amplifier. In general, the vertical deflection should be from 1 to 2 divisions on the calibrated scale with the vertical amplifier gain control turned to a maximum sensitivity. Note the sine waves are evenly spaced and producing a uniform density of illumination throughout the trace. The amplitude of the wave will vary as the main tuning dial is rotated from one end of the band to the other. If oscillation fails entirely at either end or any portion of the rotation, it indicates a defective oscillator circuit. If an abrupt failure is noticed at any point it would be well to check the oscillator variable condenser plates as they might be shorting out at this point. If oscillation is relatively weak and it is impossible to get sufficient amplitude, especially at the low frequency end of the band, check the "B" supply voltage to make certain that this is up to the specified voltage. Also, check the oscillator tube for mutual conductance, as low mutual conductance would result in low output at the lower frequencies.

Identical results should be obtained when connected between A.G. or D.G. with the exception that at D.G. the vertical displacement will probably be somewhat less than with the other connections.

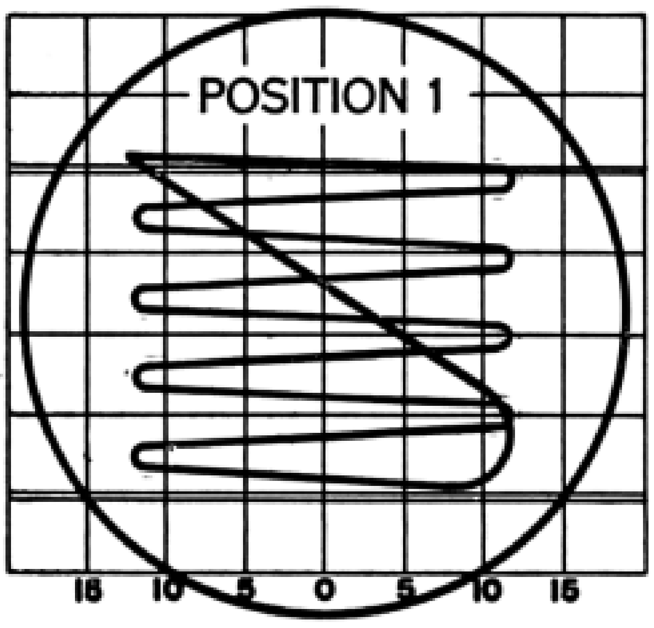


FIG. 28

Condition — Open Grid Leak.

Connections E-G.

Oscillograph — Positions 1-2. Sweep Circuit Oscillator—Step 1.

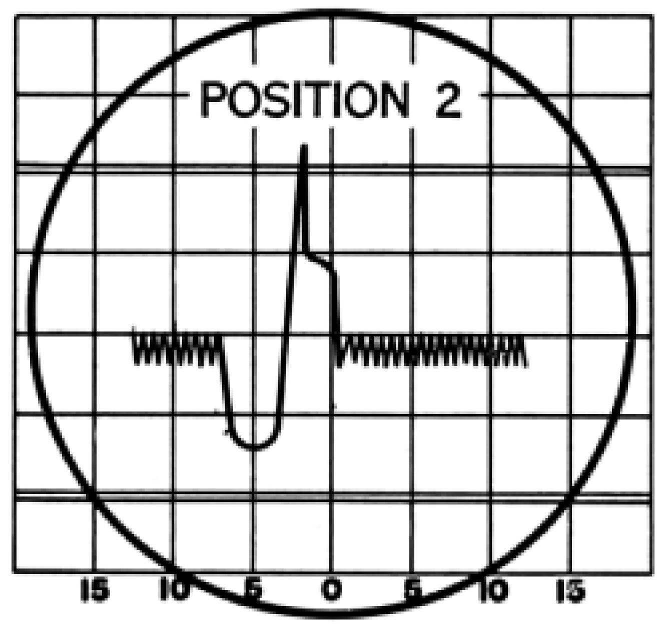


FIG. 29

In the case of an open grid leak which would result in the control grid obtaining no bias voltage, no oscillation as illustrated in Fig. 27 will be noticed.

The trace will periodically change from a straight line of no vertical displacement to a trace as illustrated in Fig. 28 (Position 1). The rate at which it changes would depend on the amount of leakage from the control grid of the tube back to ground. The normal period of this would probably be one second. This condition, of course, would necessitate the replacement of the grid resistor R1. In position 2 the curve would appear as illustrated in Fig. 29.

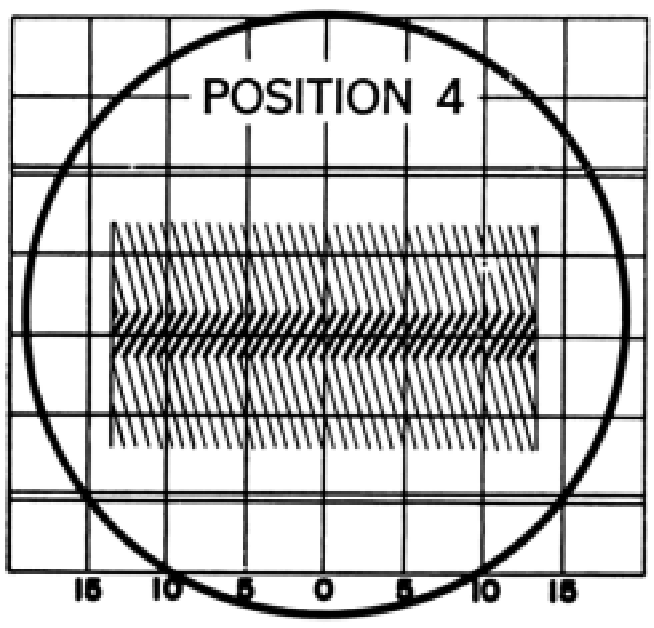


FIG. 30

Condition — Leaky or Shorted Grid Condenser C1.

Connections E-G.

Oscillograph — Positions 4-11.

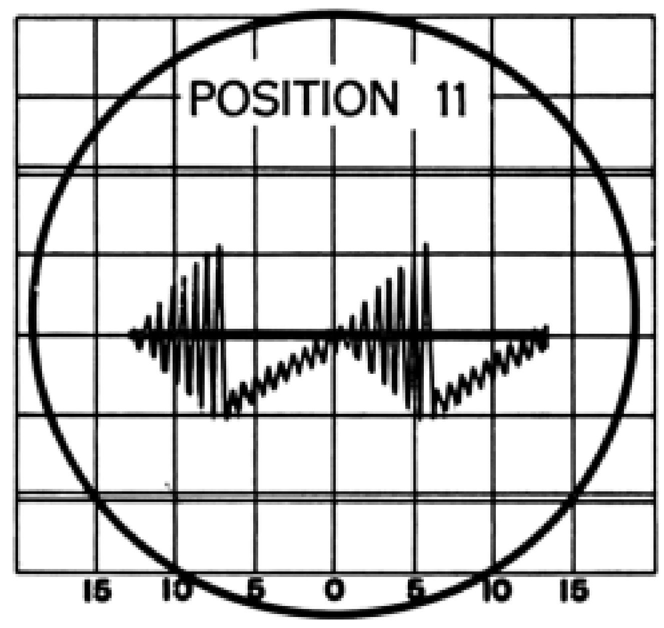


FIG. 31

In Fig. 30 (Position 4) note the extremely heavy or dark band near the center of the horizontal sweep and the lighter band extending upward and downward from this. This is a definite indication that Grid condenser C1 is either leaky or shorted causing excessively heavy regeneration with consequent distortion. Fig. 31 (Position 11) illustrates the type of trace which would be obtained with the same condition using the sweep circuit oscillator. The number of waves appearing on the screen would be determined by the sweep circuit oscillator frequency. In the figure given the sweep circuit oscillator had been adjusted to approximately 8000 cycles.

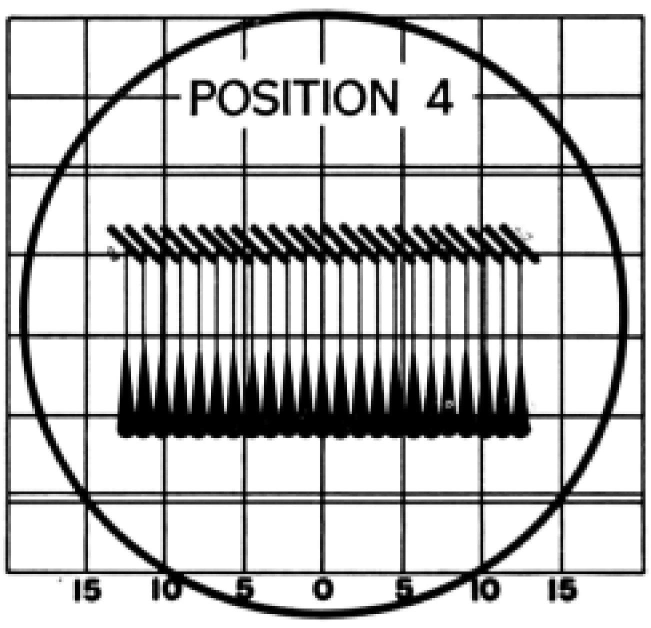


FIG. 32

Condition — Grid Condenser C1—Leaky or Shorted Out.

Connection G-A or G-D.

Oscillograph — Positions 4-11.

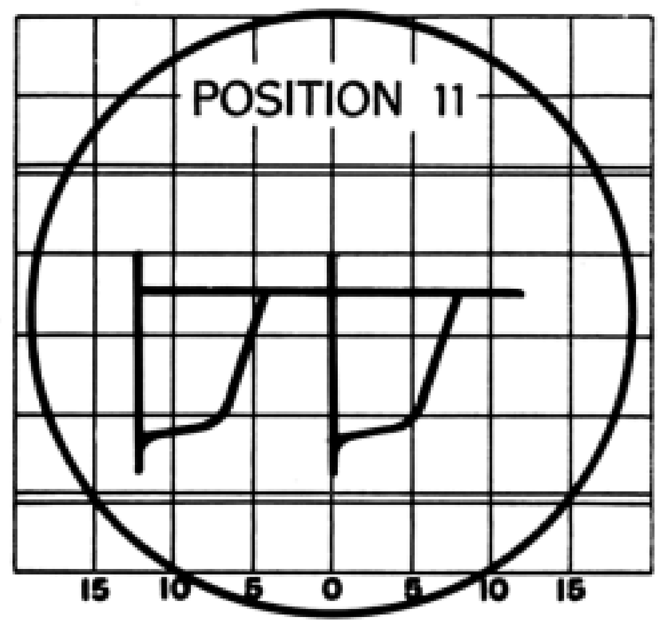


FIG. 33

The above condition is similar to that previsouly described Figs. 30-31 but with the oscillograph connected at the grid of the oscillator tube rather than at the plate. It will be noted that when using (Position 4) Fig. 32 with the 60 cycle sweep that the dark area changed from the center of the screen as illustrated in Fig. 30 to the outer edges. Also note Fig. 33 (Position 11) the change of wave shape when using the linear sweep from that observed when the voltage was viewed at the plate of the tube.

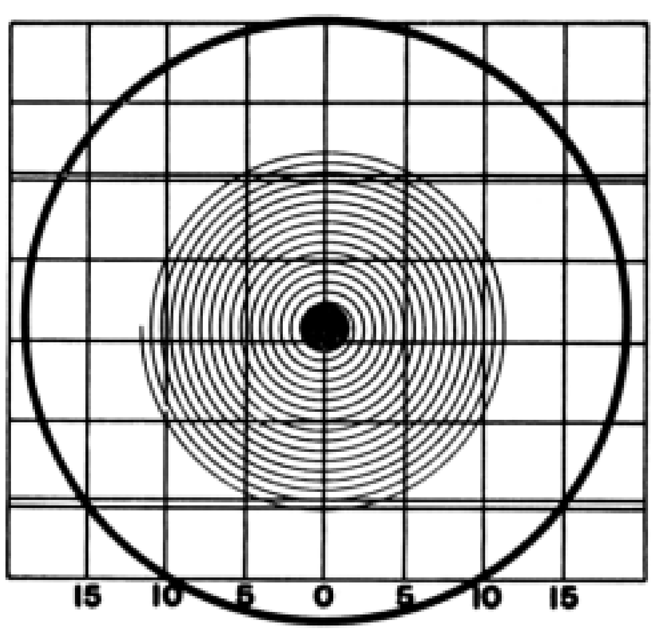


FIG. 34

Condition — Leaky Grid Condenser C1.

Connections E-G.

Oscillograph — Position 4. See note below for change.

By turning the horizontal control to the amplifier out position, rather than to 60 cycle sweep as indicated in Position 4 and connecting a jumper between the horizontal input binding post and the vertical input binding post the Figure 34 may be obtained. Normally, this type of test would seldom be used for trouble shooting but it does present a very interesting figure. The figure appears to be a spiral starting from a very intense spot on the center of the screen and extending spirally outwards to form almost a complete circle.

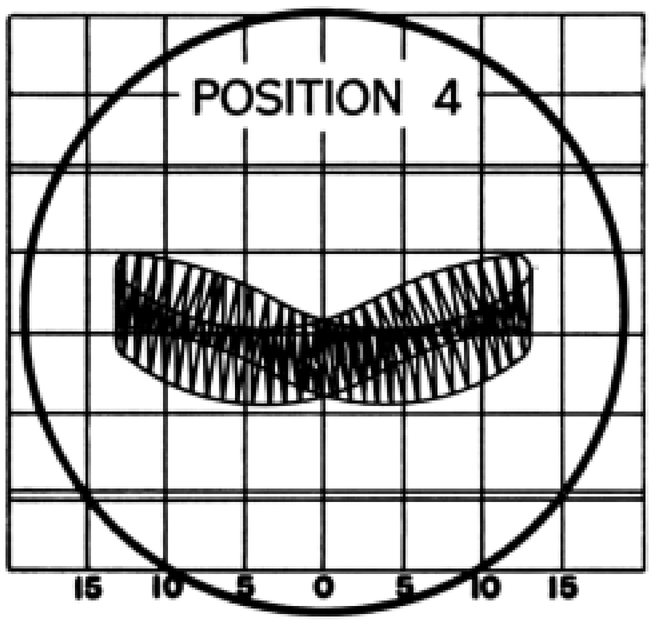


FIG. 35

Condition — Normal Oscillator Section with Improperly Filtered D. C. Supply Voltage. Full Wave Rectification.

Connections E-G.

Oscillograph — Positions 4-11.

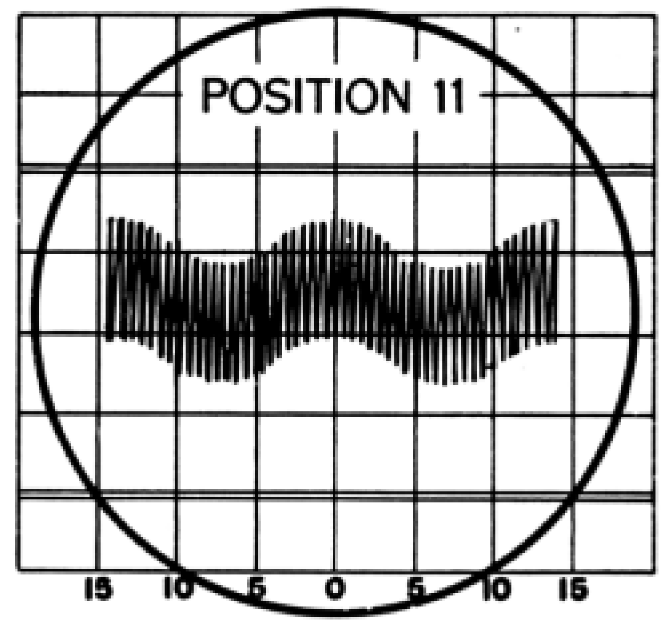


FIG 36

Traces as illustrated in Fig. 35 (Position 4) and Fig. 36 (Position 11) would be obtained if through the lack of filtering in the power supply section the voltage delivered to the oscillator tube was not a pure D.C. but contained an A.C. ripple.

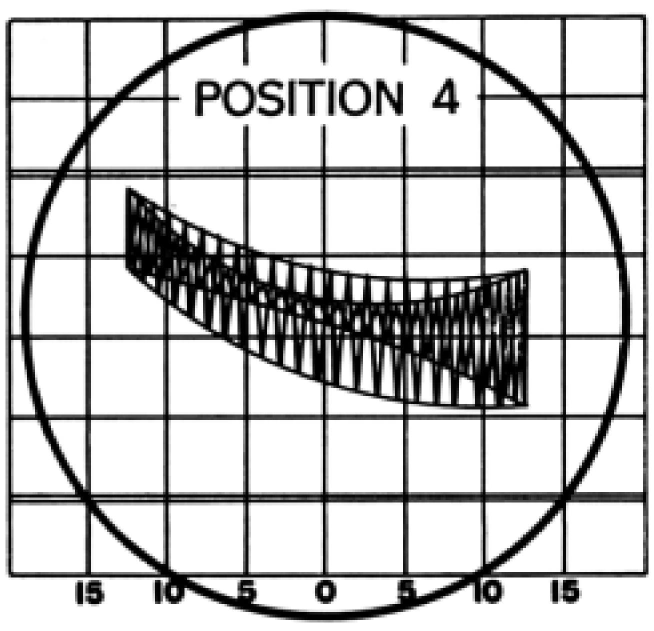


FIG. 37

Condition — Normal Oscillator Section. Improperly Filtered D.C. Supply Voltage. Half Wave Rectification.

Connections E-G.

Oscillograph — Positions 4-11.

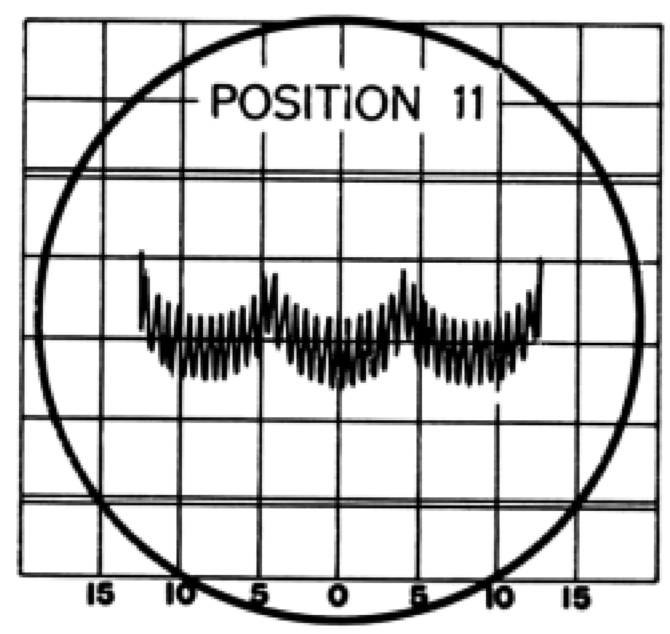


FIG. 38

Figures 37 (Position 4) and 38 (Position 11) are illustrative of the above condition and are similar to Fig. 35 and Fig. 36 with the exception that the rectifier system in the receiver was designed for half wave rectification rather than full wave rectification.

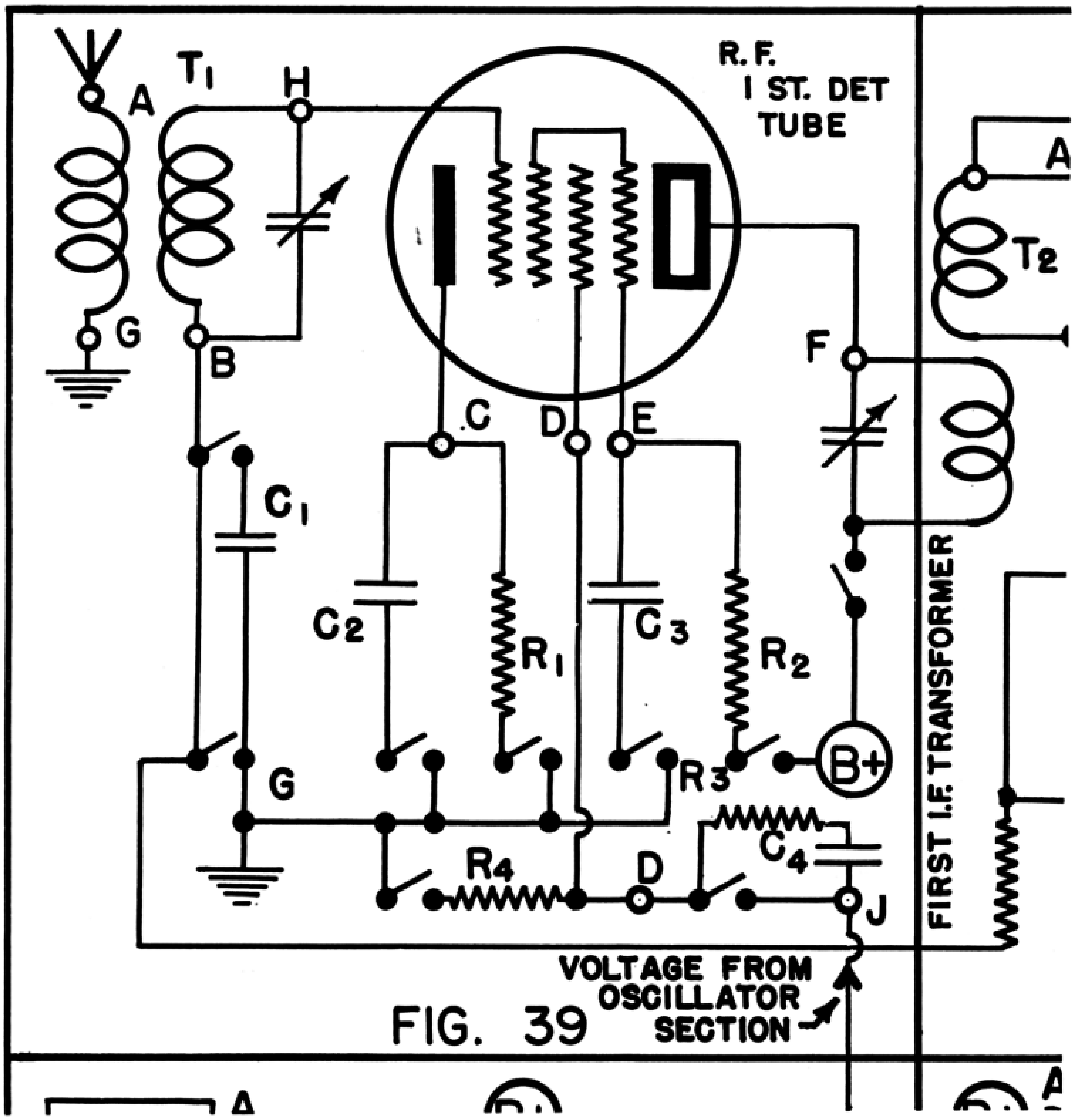


FIG. 39

In general any defects which might be found in the radio frequency section will not contribute to changing the shape of the observed trace but will merely change its amplitude. There are several fundamental types of traces which will be observed in the radio frequency of first detector section and these are listed as follows:

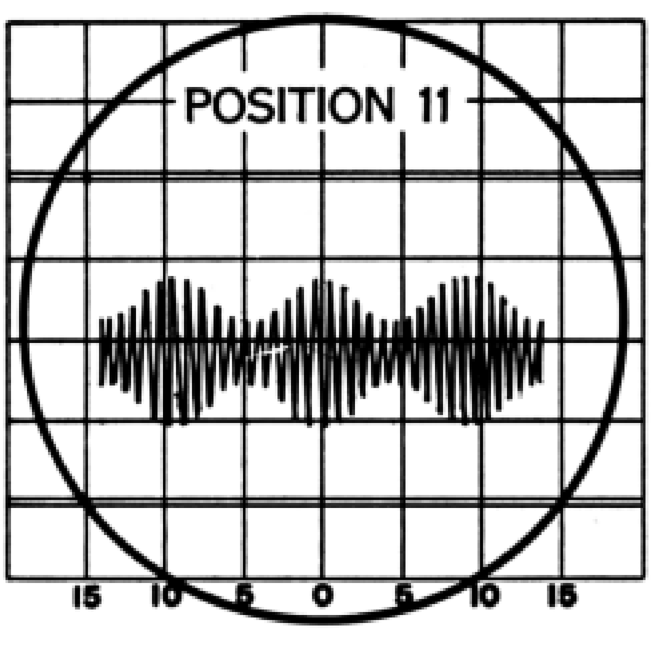


FIG. 40

Condition — Amplitude modulated radio frequency applied to the vertical plate of the oscillograph (Modulation 50%). Fig. 40.

Oscillograph — Position 11.

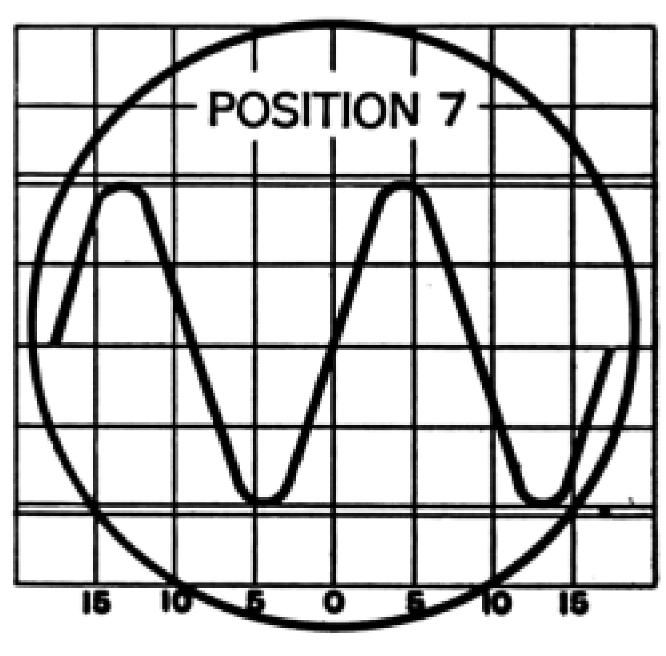


FIG. 41

Fig. 41 (Position 7)— **Condition** Amplitude modulated radio frequency applied to vertical input of the oscillograph.

The following checks on the radio frequency section will be made to determine primarily whether or not an actual voltage exists at the point under test. The nature of the voltage being supplied from the signal generator is optional. In checking radio frequency stages it is not advisable to use a frequency modulated signal, due to the lack of selectivity in a single radio frequency stage there would be little tendency for the circuit to discriminate in amplification between the various frequencies being generated.

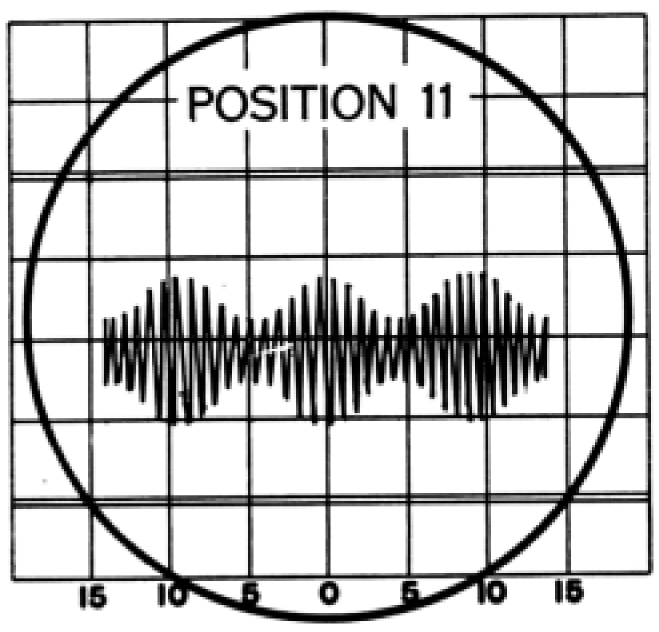


FIG. 40

Condition — Open By Pass Condenser C1.
Signal Supplied. Amplitude Modulated R.F.
Signal Connections A-G.
Oscillograph Connection B-G.
Oscillograph — Positions 7-11.

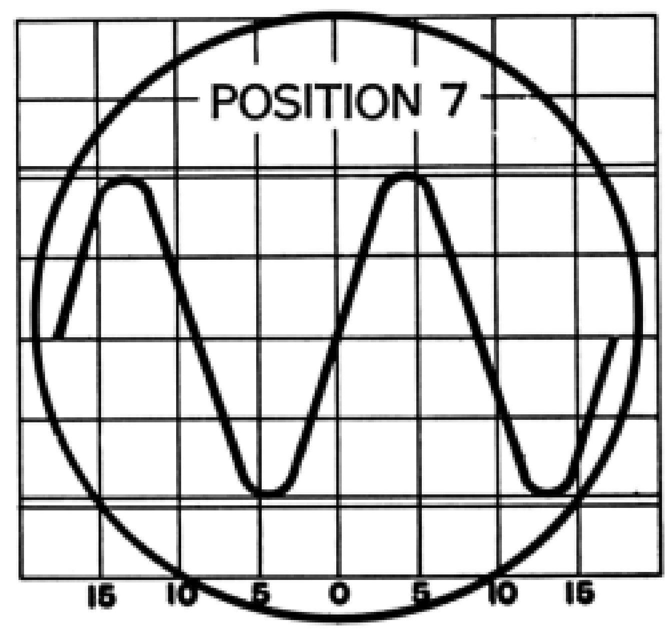


FIG. 41

If by pass condenser C1 were opened up this would result in a radio frequency voltage being built up between "B" and ground with the result that Fig. 40 (Position 11) would be obtained, or Fig. 41 (Position 7). The magnitude of the voltage in this case would probably be quite low giving a maximum of one-half inch or so deflection on the screen in either case.

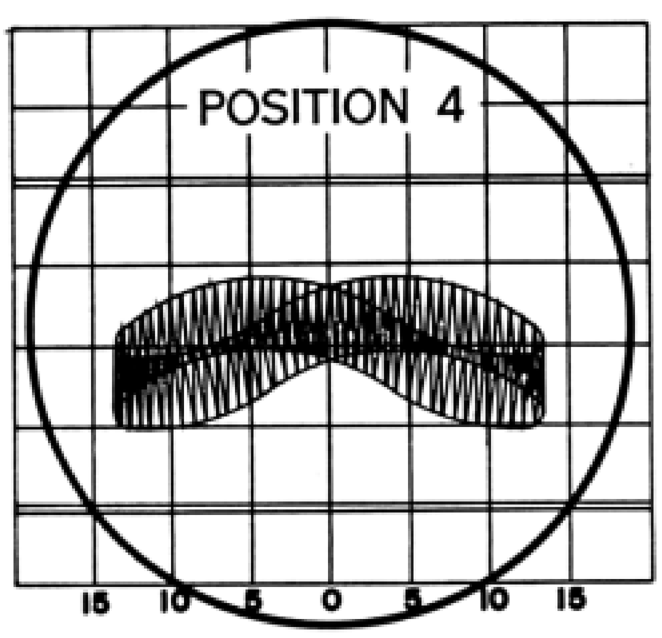


FIG 42

Condition — Injector Grid Resistance R4 Open. Signal Generator not used.
Oscillograph Connections D-G.
Oscillograph — Positions 4-11.

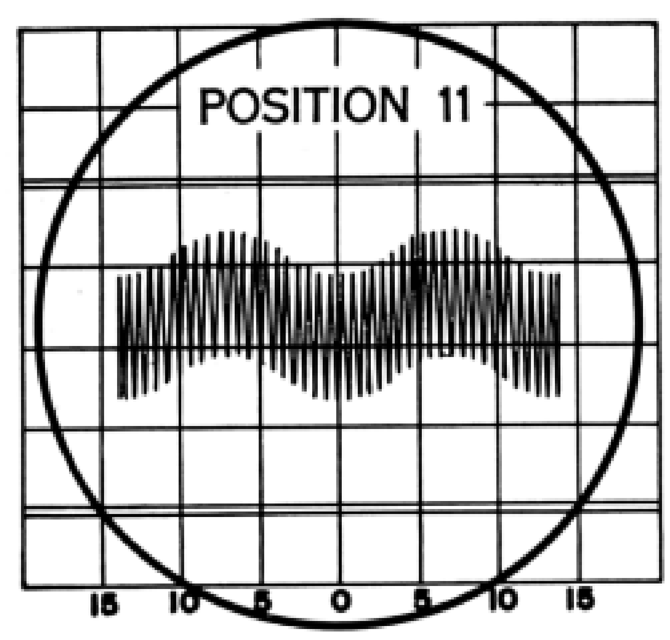


FIG. 43

In case the injector grid resistance R4 were opened up this would allow the injector grid to float at a negative potential above ground. The result would undoubtedly be an A.C. hum pick-up on this grid which will give a trace similar to Fig. 42 (Position 4) or Fig. 43 (Position 11).

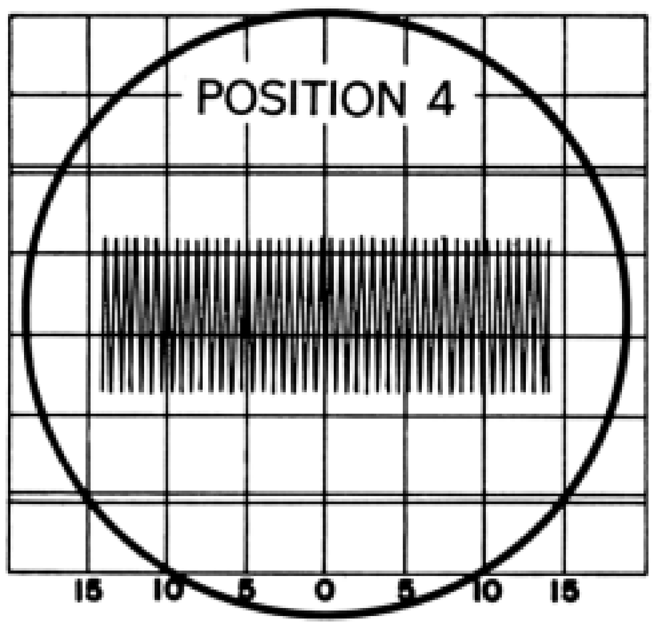


FIG. 44

Condition — Coupling Condenser C4 Leaky or Shorted. Signal Generator not used.

Oscillograph Connections D-G or J-G.

Oscillograph — Position 4.

A trace similar to Fig. 44 (Position 4) should be obtained when checking either from D-G or J-G however, if capacitor C3 is operating normally the amplitude of the trace should be approximately ½ to ⅔ as great when checking from D to G. as that obtained from J. to G. If the condenser were leaky or shorted out the amplitude of the trace as viewed on either side of this coupling capacitor would be approximately equal.

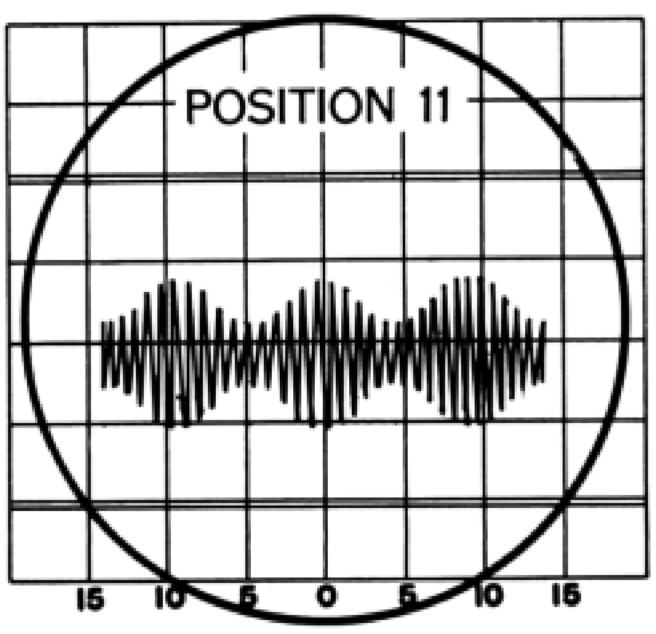


FIG. 40

Condition — Screen By-Pass Condenser C3 Open.
Signal Supplied — Amplitude Modulated R.F.
Signal Connections A-G.
Oscillograph Connections E-G.
Oscillograph — Positions 7-11.

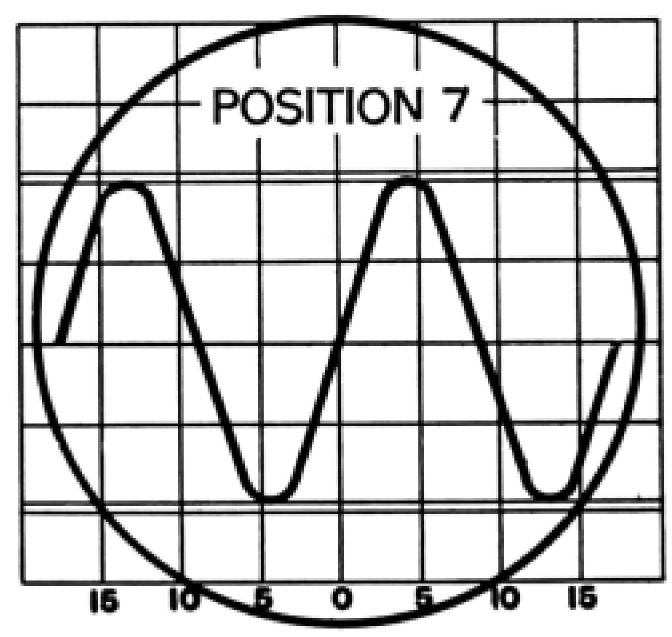


FIG. 41

In the case illustrated there is no stage of preselection and consequently the control grid circuit of the first detector stage is tuned to a different frequency than the plate circuit. The plate, of course, is tuned to the frequency of the intermediated frequency stages, and the control grid tuned to the frequency of the oncoming signal. In such a case there would be no tendency for this tube to oscillate as a result of open screen connection.

Therefore, the effect of an open screen condenser would manifest itself only in the presence of radio frequency voltage between point E and ground as illustrated in Fig. 40 (Position 11) and Fig. 41 (Position 7). If, however, we consider the case of a stage of R.F. preselection in which the control grid of the tube is tuned to the same frequency as the plate circuit an open screen condenser would normally cause serious oscillations. Cases of this nature are taken up in the chapter on intermediate frequency and the effect would be identical to the case where the screen by-pass in the intermediate frequency stages would become open.

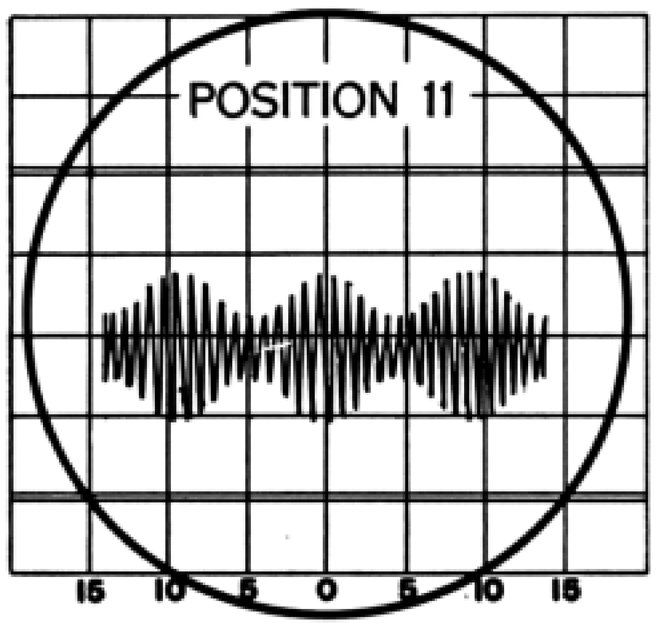


FIG. 40

Condition — First Detector Tube: Normal Operation.

Signal Supplied — Amplitude Modulated R.F.

Signal Connections A-G.

Oscillograph Connections H-G or F-G.

Oscillograph — Positions 7-11.

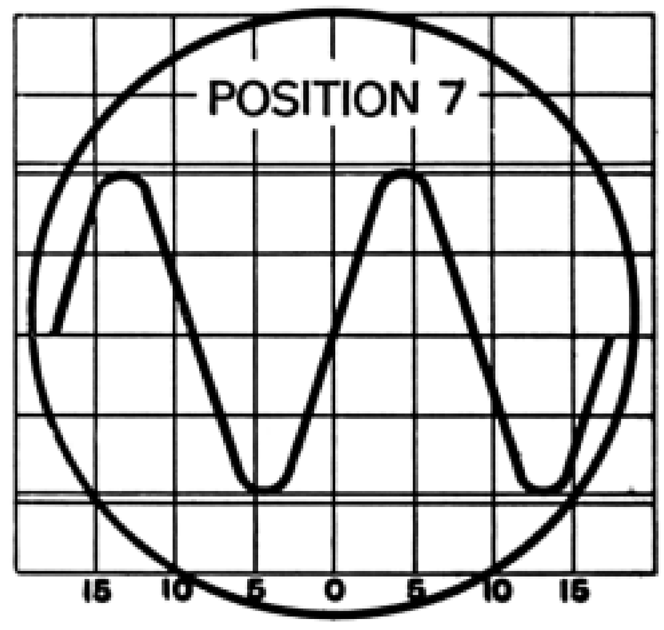


FIG. 41

The signal generator should be adjusted to a frequency equal to that of the intermediate frequency of the receiver under test. The oscillograph will be first connected between point H and ground and the deflection noted. The oscillograph is then connected between F and ground and the wave form should remain the same but an increase in amplitude noted. Fig. 40 (Position 11) and Fig. 41 (Position 7) are again illustrative of the proper trace.

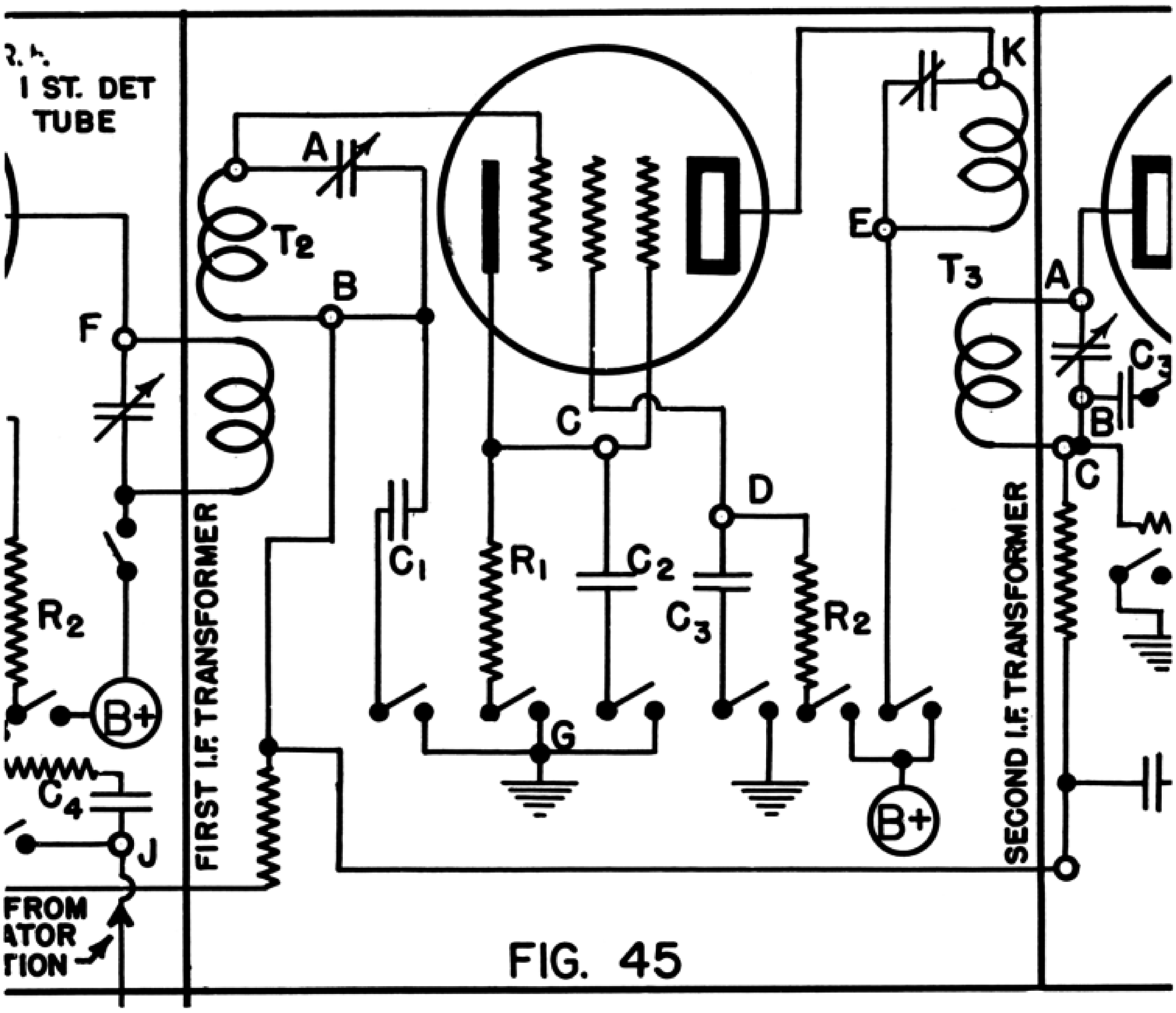


FIG. 45

Signal Supplied

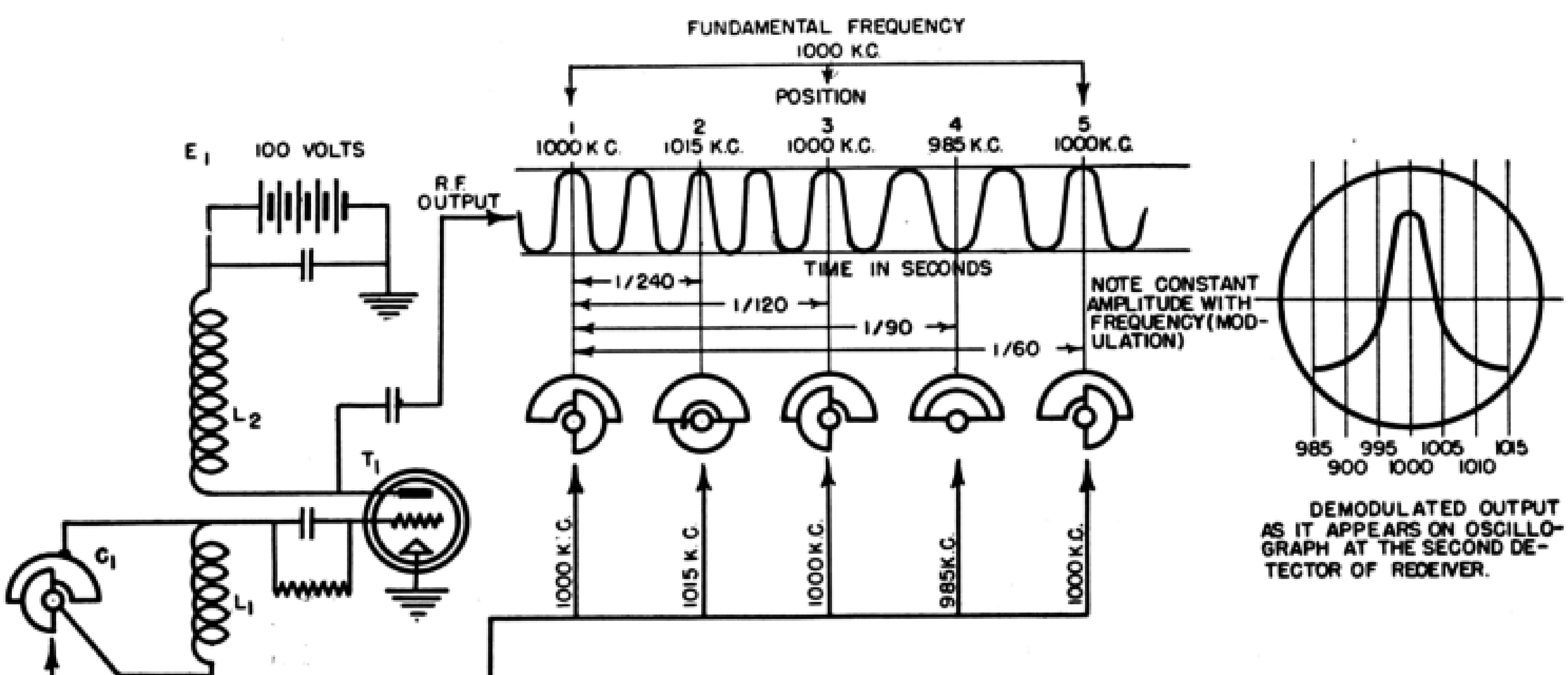
The signal generator output could be fed in at the primary of the intermediate frequency transformer between point F and ground. However, the deflections obtained would be very low if this procedure was followed and consequently the trace more difficult to study. The output from the signal generator may be fed in at point "H" (R.F. section) which is the grid of the first detector tube, and the frequency of the signal generator adjusted to correspond to the intermediate frequency of the receiver under test. With this connection we get the amplifying action of the first detector tube and consequently higher voltage in the intermediate frequency stages. With this connection it is recommended that the oscillator tube be removed or the oscillator section shorted out so that there will be no interference between the voltage developed by the oscillator section of the receiver, and the voltage being supplied directly from the signal generator.

Another option, would be to feed the output from the signal generator in at the antenna post at some frequency within the range of the receiver. Adjust the main tuning dial to correspond to this frequency so that the resultant mixed output between the signal generator and the local oscillator would produce the proper intermediate frequency. If frequency modulated output is to be used and fed to the antenna and ground of the receiver this could be supplied directly from the built in frequency modulated oscillator in the oscillograph. In this case the receiver should be tuned to the frequency of the oscillator (665 KC) or some harmonic.

In the following tests on the intermediated frequency stages the type of signal (frequency or amplitude modulated) only is specified. It may be fed into the receiver either at the antenna or first detector grid at the discretion of the operator.

FREQUENCY MODULATION (See Figure 46)

The characteristics of a frequency modulated signal are that the frequency is constantly changing. Starting with a fundamental frequency the frequency gradually increases to a value 15 kilocycles higher than the fundamental then reduces at the same rate to the fundamental, then decreases at that same rate to a value 15 kilocycles below the fundamental and then increases again to the fundamental frequency, completing the cycle.



FREQUENCY MODULATION
FIG. 46

The rate at which this cycle is completed is 60 cycles per second with the "K.C. Sweep" control as illustrated in Position 1, or 120 cycles per second with the K.C. Sweep control in Position 8.

The amplitude or output voltage of a frequency modulated signal remains constant throughout the entire cycle. Fig. 46 is an illustration of the principles involved in producing frequency modulation. Actually the varying of the capacity is not accomplished by a rotating condenser but is effected electronically by vacuum tubes in the RFO-4.

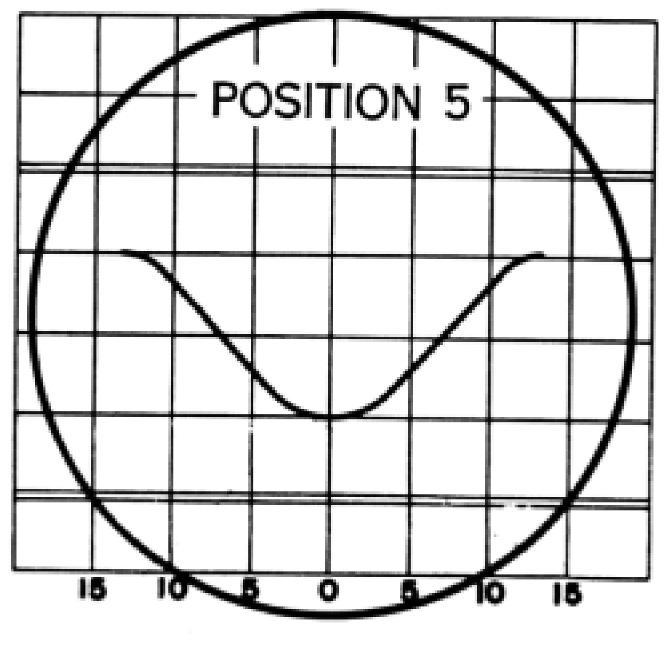


FIG 47

Condition — Normal Operation. First Intermediate Frequency Transformer.
Signal Supplied — Frequency Modulated R.F.
Signal Connections Antenna-Ground. (Recommended).
Oscillograph Connections F-G, A-G.
Oscillograph — Position 5.

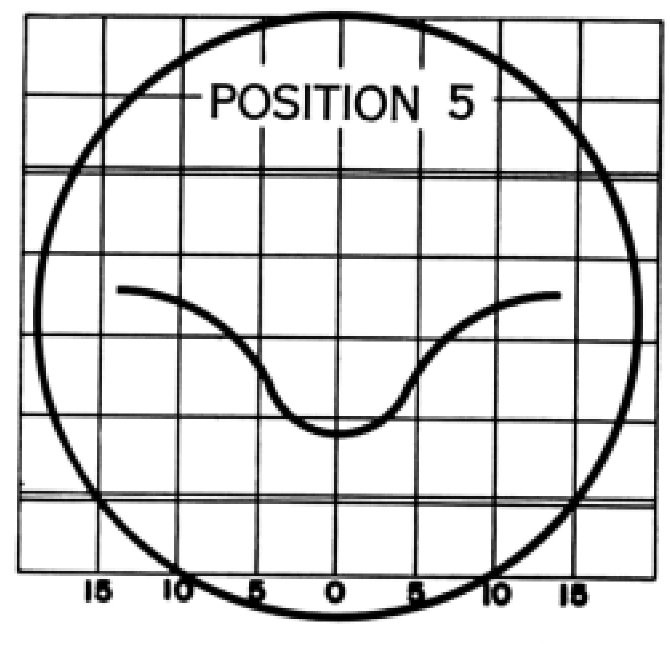


FIG 48

Fig. 47 (Position 5), connection F-G and Fig. 48 (Position 5), connection A-G are illustrative of the above condition for checking the first intermediate frequency transformer. In this case, however, we are using a frequency modulated output from the signal generator or oscillograph Fig. 47, connection F-G illustrates the selectivity trace as it will be obtained at the primary of the first intermediate frequency transformer when using the demodulator in the oscillograph. Fig. 48, connection A-G is an illustration of the trace which should appear at the secondary of the first intermediate frequency transformer showing increased selectivity.

The actual voltage delivered at the secondary will, of course, be somewhat lower than that delivered to the primary, but the selectivity will be correspondingly greater.

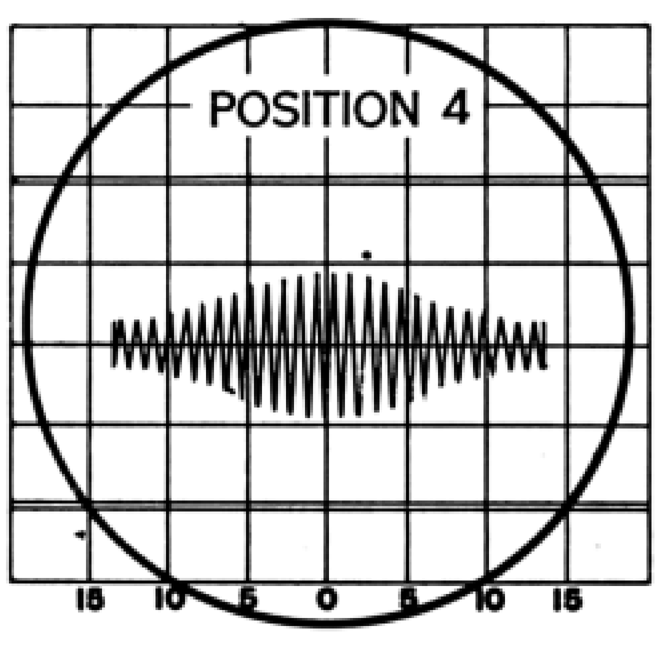


FIG. 49

Condition — Normal Operation. First Intermediate Frequency Transformer.
Signal Supplied — Frequency Modulated R.F.
Signal Connections Antenna-Ground. (Recommended).
Oscillograph Connections F-G, A-G.
Oscillograph — Position 4.

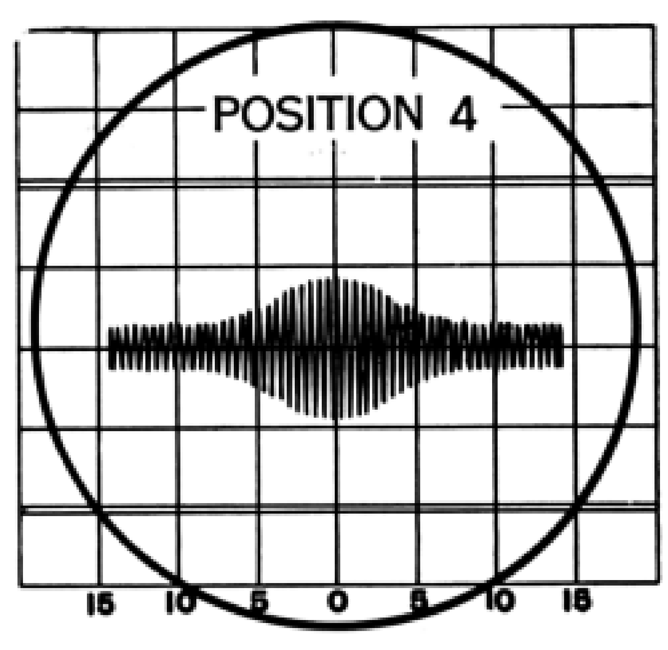


FIG. 50

The following Fig. 49 (Position 4), connection F-G and Fig. 50 (Position 4), connection A-G illustrate the same condition as previously outlined on the intermediate frequency transformer, however, in this case the video amplifier is used. It will be noted that the center of the traces show greater amplitude than the outer edges. This is indicative of the fact that the transformer tends to amplify the frequency to which it is tuned more than it does the frequencies either above or below this value. It is not recommended that the first intermediate frequency transformer be aligned with connections as previously outlined. This test is purely a test to determine whether or not the intermediate frequency transformer is operating properly.

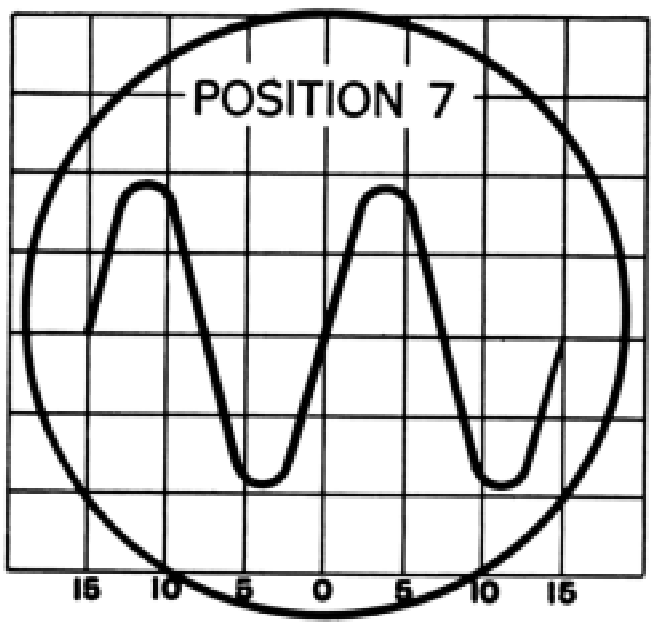


FIG. 51

Condition — By-Pass Condenser C1. Open.
Signal Supplied — Amplitude Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections B-G.
Oscillograph — Positions 7-11.

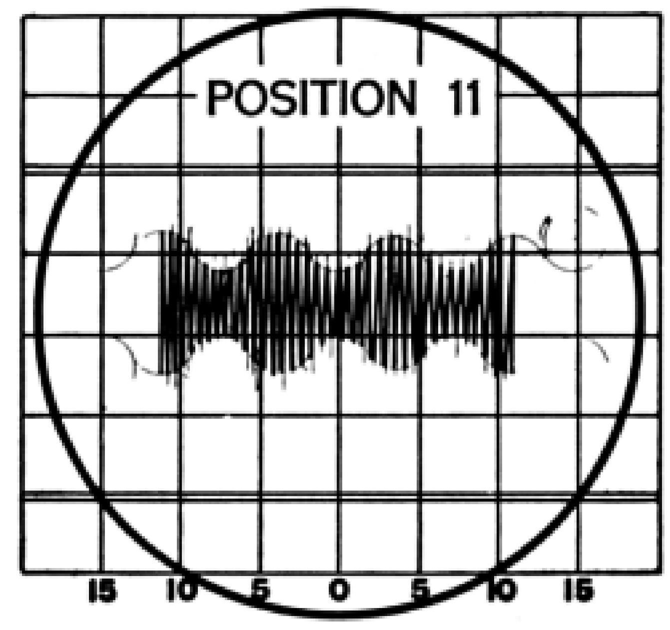


FIG. 51 A

Should the by-pass condenser C1 be open this would permit a radio frequency voltage to be built up between point B and ground. The oscillograph connected as indicated would give a trace similar to Fig. 51A (Position 11) or Fig. 51 (Position 7) if this condition existed.

It is quite possible that if condenser C1 were the only condenser in the filter system of the AVC voltage, the audio frequency voltage developed at the second detector would feed back through the AVC line causing an audio voltage to be developed between point B and ground. This can be readily checked by changing the oscillograph to Position 2 in which case the standard amplifier would be in the circuit. This amplifier will pass only audio frequency and would amplify the audio frequency being fed back from the second detector thereby giving an indication that the foregoing condition existed. If this condition did not exist no vertical deflection would be obtained.

See Fig. 51 above

Condition — Cathode By-Pass Condenser C-2. Open.
Signal Supplied — Amplitude Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections C-G.
Oscillograph — Positions 7-11.

See Fig. 51A above

If the cathode by-pass condenser C2 becomes open a radio frequency voltage would appear between C and ground and could be checked by the oscillograph as outlined in the foregoing connections. The resultant trace as viewed at point C would correspond to Fig. 51 (Position 7) or Fig. 51A (Position 11). If the condenser were normal no R.F. voltage would be present between C and ground.

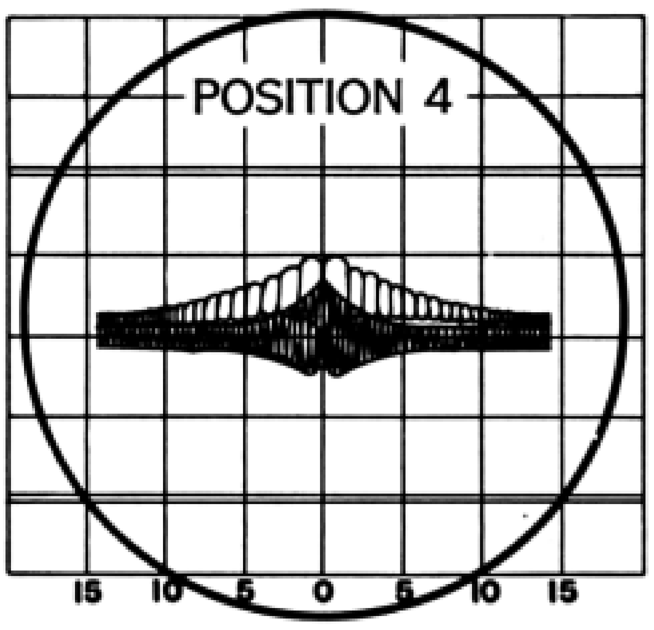


FIG. 52

Condition — Screen By-Pass Condenser C3 Open.
Signal Supplied — Frequency Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections D-G.
Oscillograph — Position 4.

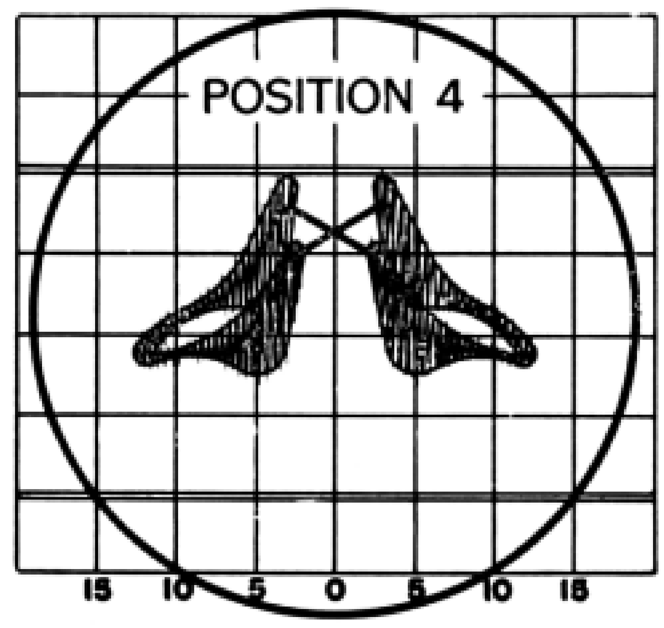


FIG 53

The opening up of the screen by-pass condenser in intermediate frequency stages almost invariably result in oscillation to a varying degree. Overloading of the I.F. stage will generally show up this condition more readily. The oscillation may be very slight, just barely showing up in the trace as illustrated in Fig. 52 (Position 4). or may vary from this to an extreme degree as illustrated in Fig. 53 (Position 4).

It is generally advisable to use the video amplifier in checking for oscillation rather than the demodulator since it shows up the state of sustained oscillation much more readily than when using the demodulator which actually removes most of the R.F. oscillation and leaves only the resultant modulated envelope. Tests made at the second detector will illustrate the trace under a condition of oscillation in I.F. stages when using the demodulator.

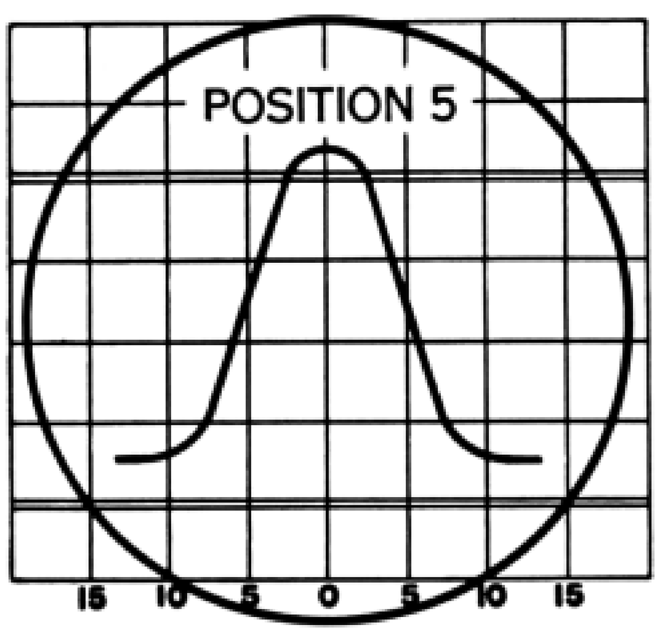


FIG 54

Condition — Normal Operation. Second Intermediate Frequency Transformer.
Signal Supplied — Frequency Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections K-G, A-G.
Oscillograph — Position 5.

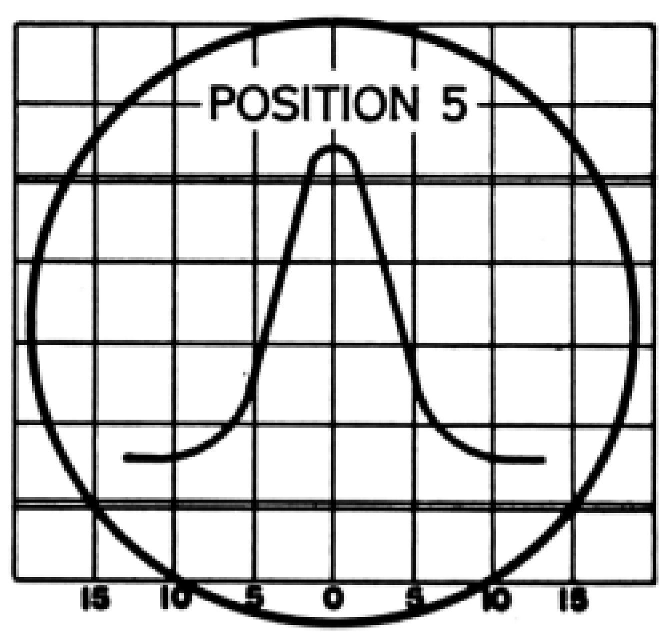


FIG. 55

Fig. 54 (Position 5) is illustrative of the trace as it should appear at the primary of the second I.F. transformer, connections K-G. Fig. 55 (Position 5) shows the increase in selectivity resulting from the signal passing through the second I.F. transformer, connection A-G.

SECOND DETECTOR, R.F.-I.F. ALIGNMENT, AND FIRST AUDIO AMPLIFIER

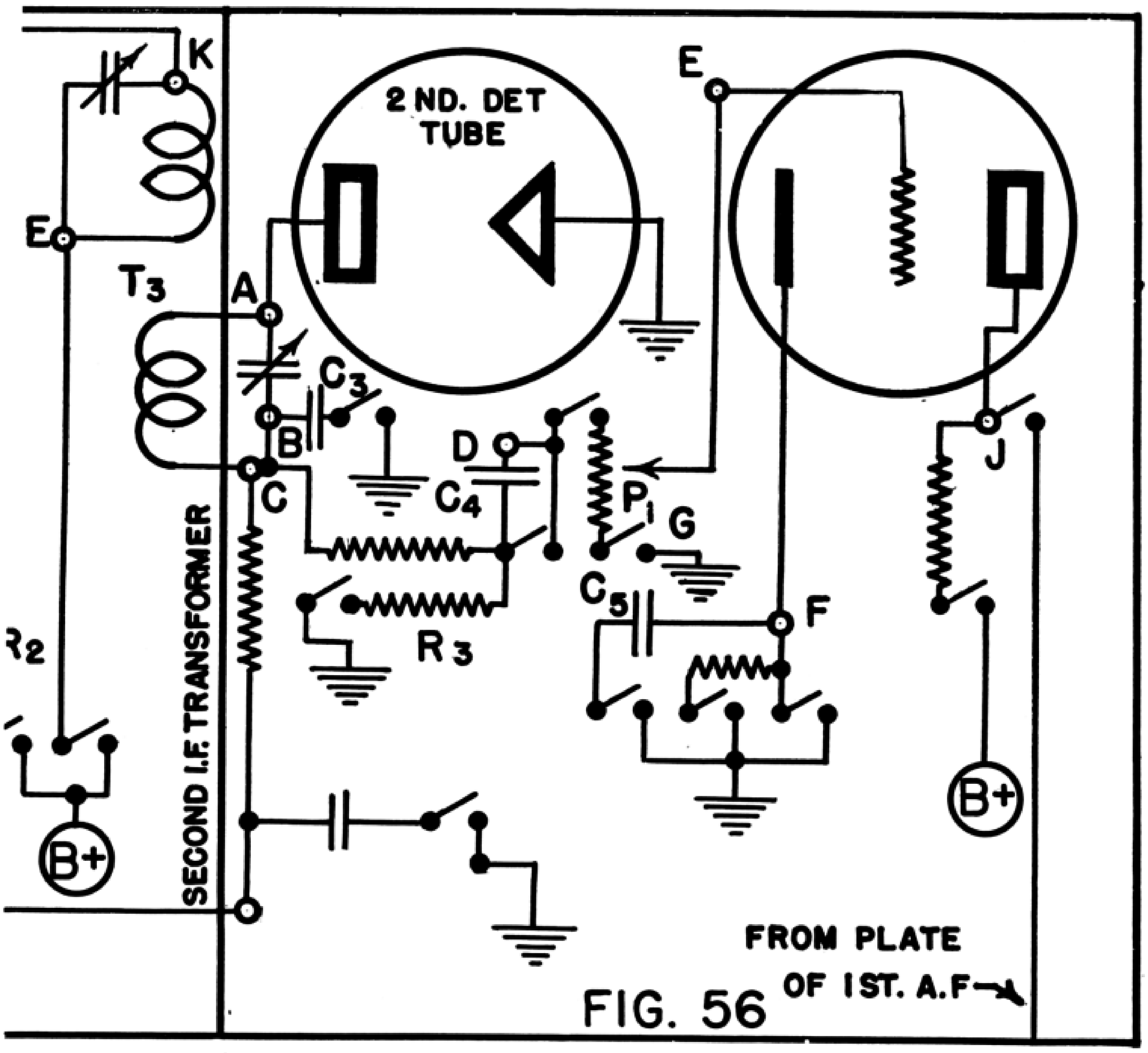


FIG. 56

SECOND DETECTOR

Signal Supplied: If the signal to be supplied for the test is frequency modulated R.F. this could be obtained from the oscillograph or from a suitable signal generator outlined in the chapter on I.F. stages. If amplitude modulated R.F. it must be supplied from a signal generator.

Signal Connections: Connections from the signal source to receiver; Signal could be fed to the receiver in a manner identical to that outlined in the chapter on I.F stages with the addition that it might be fed to the grid of the First I.F. Amplifier tube at the proper I.F. frequency. In the following tests we have indicated the signal to be supplied at the antenna or ground connections. This could be altered in accordance with the foregoing if so desired.

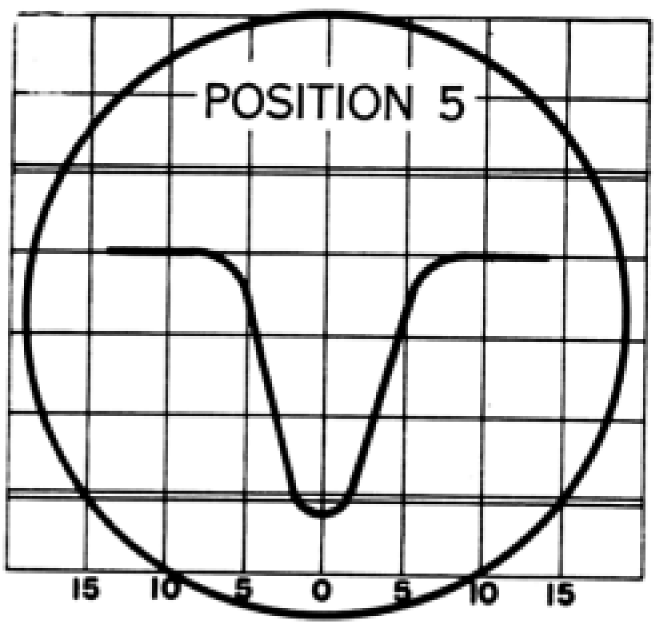


FIG. 57

Condition — Defective Diode Detector Tube.
Signal Supplied — Frequency Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections C-G.
Oscillograph — Positions 1-5-4.

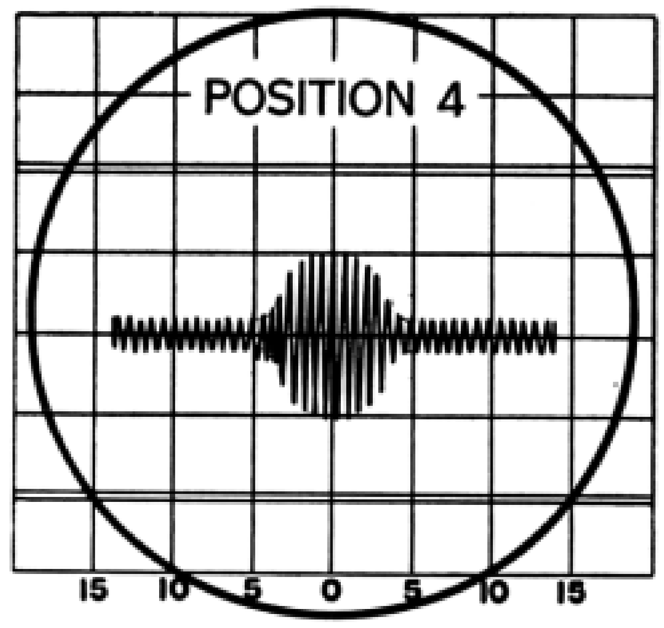


FIG 58

If, the second detector were defective and not rectifying the R.F. carrier at Position 1 no deflection will be obtained due to the fact that standard amplifiers are not capable of amplifying the high frequency encountered in intermediate frequency stages. By switching to the demodulator, Position 5 the trace as illustrated in Fig. 57 will be obtained, thereby giving an immediate indication that the second detector were defective. By using Position 4 a trace as illustrated in Fig. 58 would be indicative of the same condition.

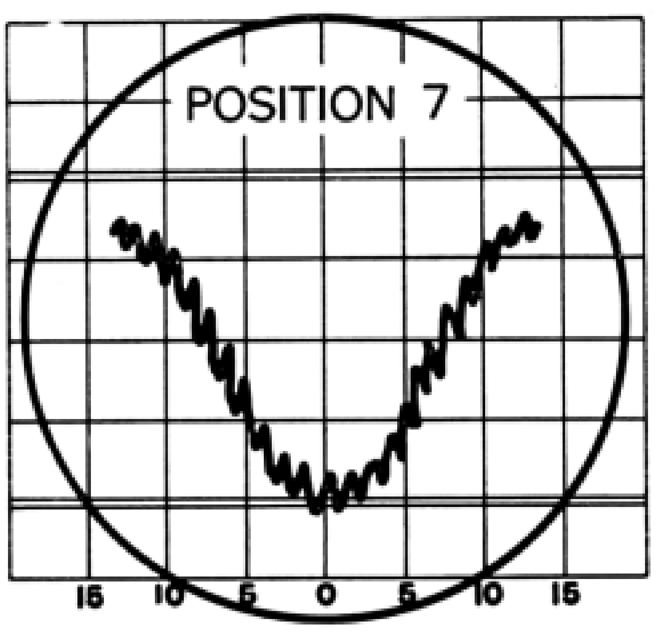


FIG 59

Condition — By-Pass Condenser C3 Open.
Signal Supplied — Frequency Modulated R.F. and Amplitude Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections C-G.
Oscillograph — Positions 1-2.

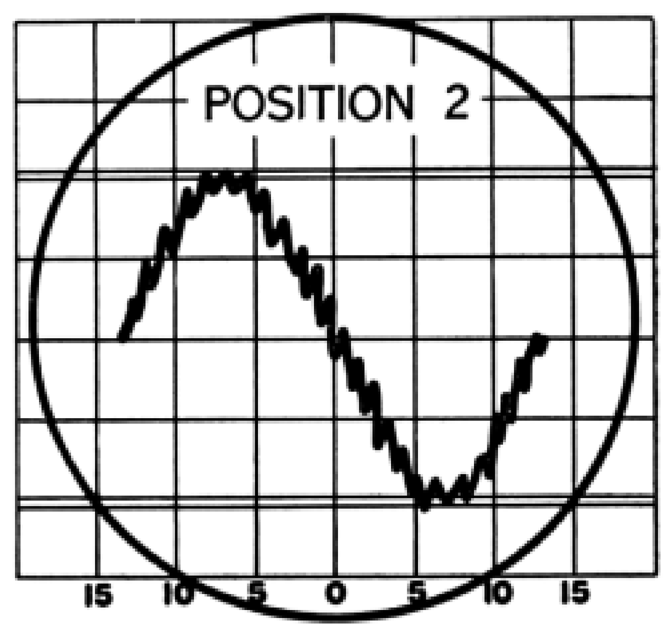


FIG 60

If R.F. By-pass Condenser C3 were to become opened this would allow a decided amount of radio frequency to appear on the demodulated R.F. carrier as shown in Fig. 59 (Position 1). Fig. 60 (Position 2) is illustrative of the same condition but with amplitude modulated signal supplied rather than frequency modulated. The remedy in this case, of course, is to replace the condenser or to install a condenser of higher value.

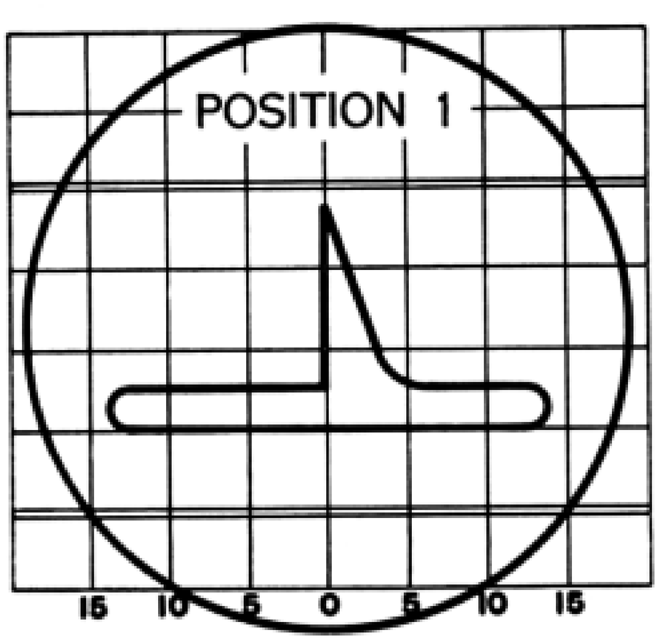


FIG. 61

Condition — Open Load Resistance R3.
Signal Supplied — Frequency Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections C-G.
Oscillograph — Positions 1-2.

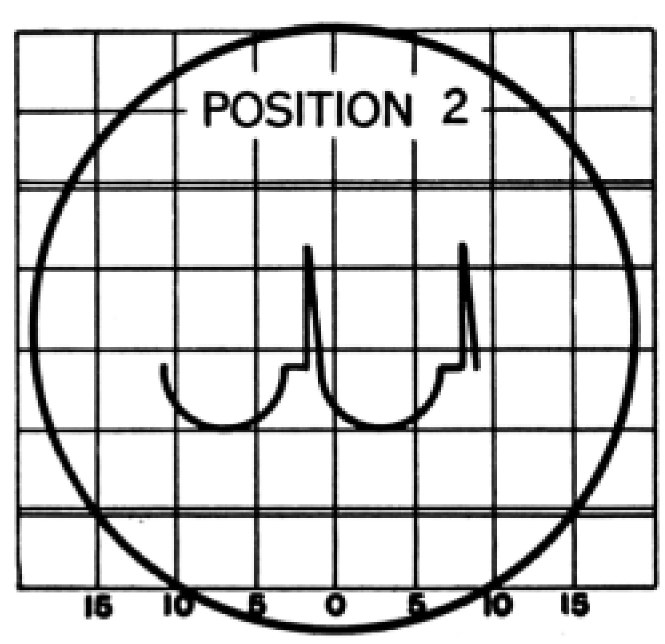


FIG 62

Fig. 61 (Position 1) illustrates this condition when using the 60 cycle sweep. Fig. 62 (Position 2) is the same condition when using the sweep circuit oscillator.

INTERMEDIATE FREQUENCY
RADIO FREQUENCY ALIGNMENT

Alignment procedure for the radio frequency intermediate frequency stages on superheterodyne receivers are thoroughly covered in the oscillograph instruction manual for the RFO-4 oscillograph. This manual is entitled "Cathode Ray Oscillograph Operation and Application." The following is a brief resume of the types of traces which will be obtained as a result of correct and incorrect alignment in these stages.

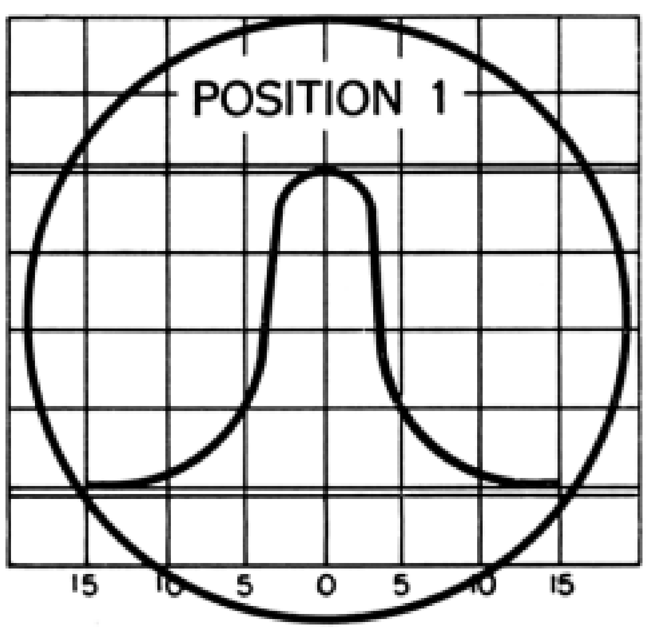


FIG 63

Condition — Correct Alignment.
Signal Supplied — Frequency Modulated R.F.
Signal Connections Antenna-Ground. (R.F.) First Detector Grid (I.F.)
Oscillograph Connections C-G.
Oscillograph — Positions 1-8.

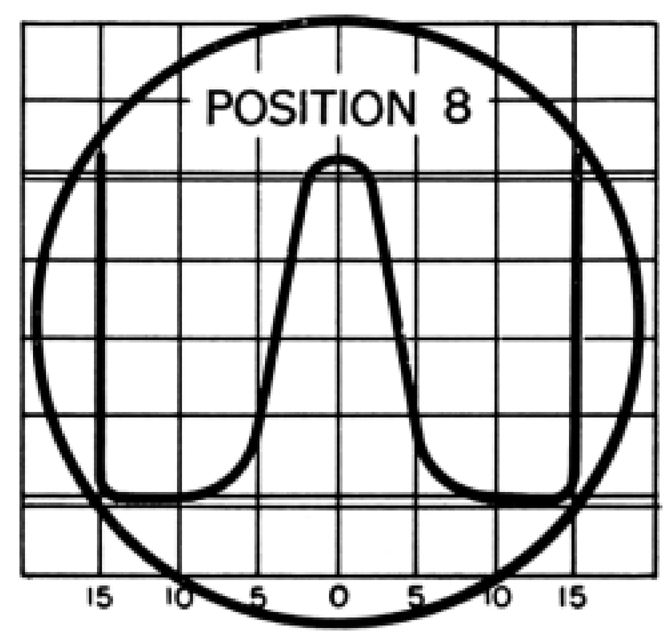


FIG 64

The above are used for all Alignment Procedure.

Fig. 63 (Position 1) illustrates the trace as it should appear when using 30 KC sweep with the receiver in normal operating condition. Fig. 64 (Position 8) illustrates this same condition when using the 120 cycle sweep.

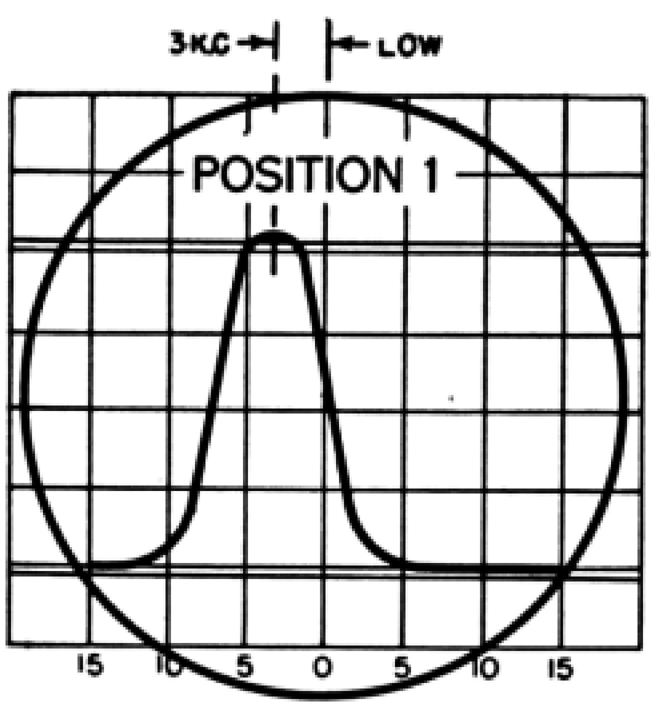


FIG 65

Condition — Intermediate Frequency Stages Aligned at Wrong Frequency.

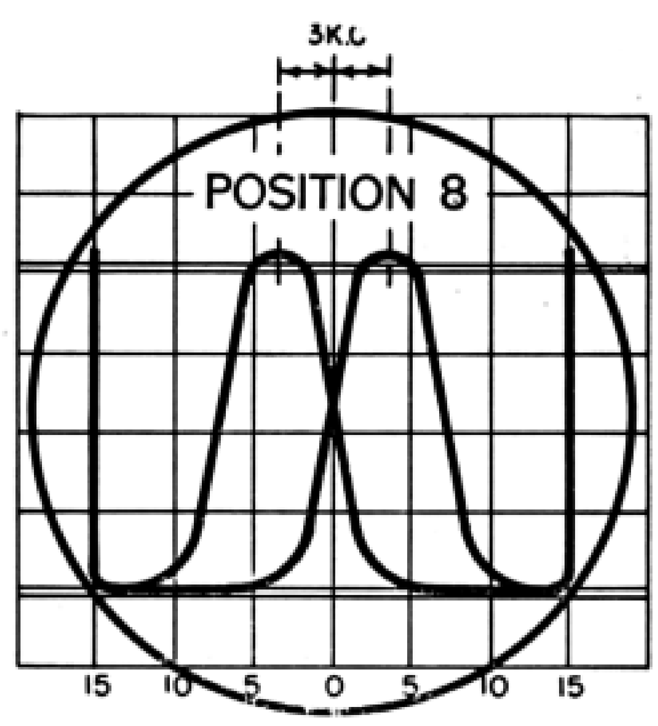


FIG 66

Alignment at the wrong frequency when using a 60 cycle sweep will result in both traces moving an equal distance to the left or right. Alignment at 3 KC below the correct frequencies is illustrated in Fig. 65 (Position 1). Fig. 66 (Position 8) is illustrative of the same condition with the exception that the 120 cycle sweep is being used rather than a 60 cycle sweep. It will be noted that the two traces separate rather than both traveling together in the same direction across the screen.

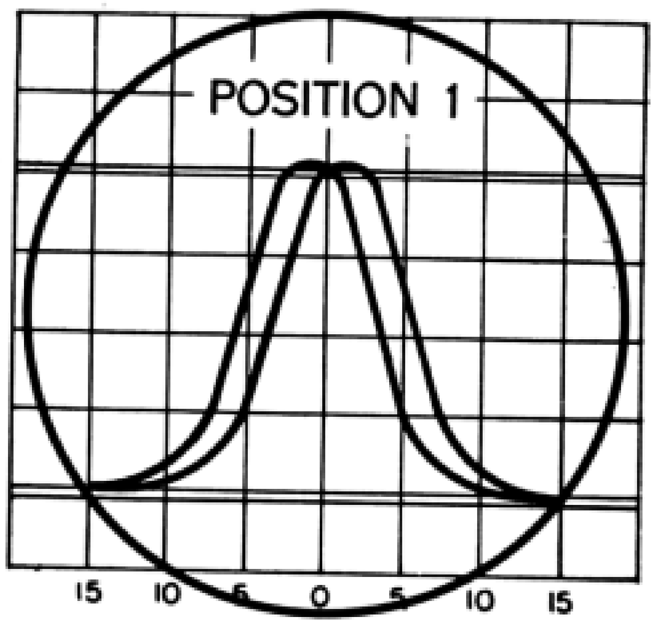


FIG. 67

Condition — Phase Distortion in Intermediate Frequency Stages.

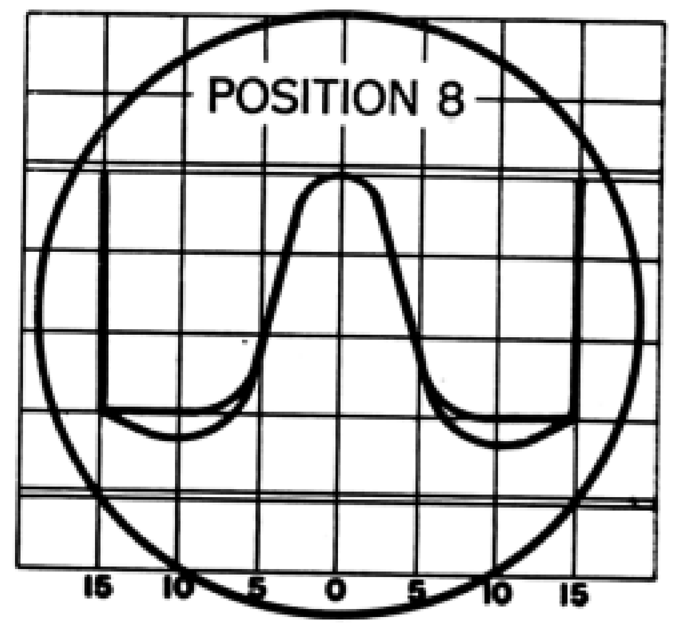


FIG 68

Fig. 67 (Position 1) is illustrative of a condition of phase distortion when using 60 cycle sweep and it will be noted that the two traces tend to open up from each other. Fig. 68 (Position 8) is illustrative of the same condition when using 120 cycle sweep. In the latter case it is necessary to note the departure of the response curve from the correct curve as being indicative of phase distortion since mistuning the receiver would cause the two peaks to overlap as illustrated.

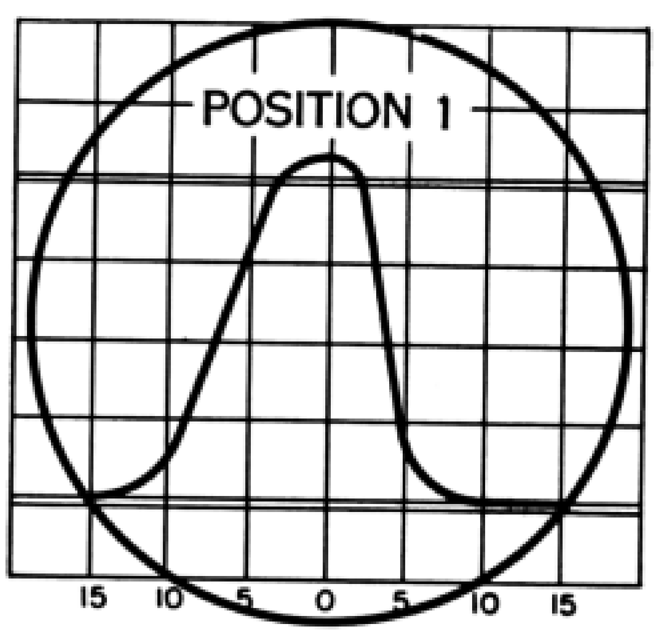


FIG. 69

Condition — Misalignment of One or Two Tuned Circuits in Intermediate Frequency Stages.

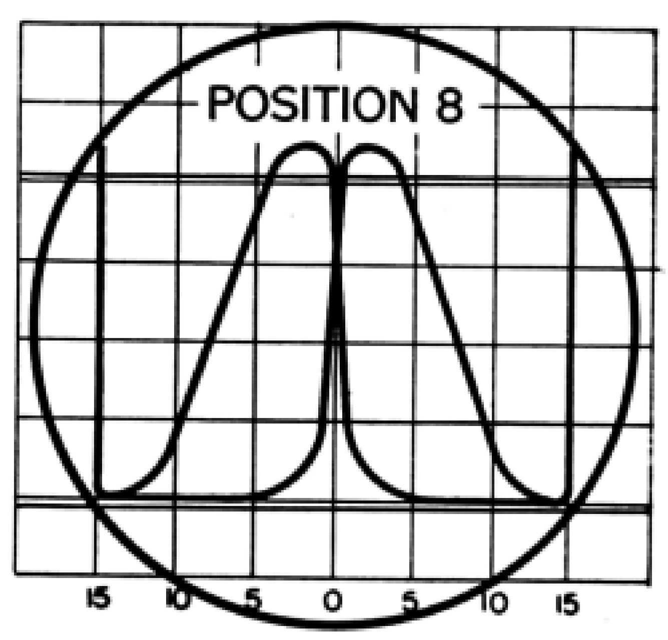


FIG 70

In cases of misalignment of some of the intermediate or radio frequency stages there will be a tendency for the response curve to appear as illustrated in Fig. 69 (Position 1) or Fig. 70 (Position 8). Note the curve is no longer symmetrical.

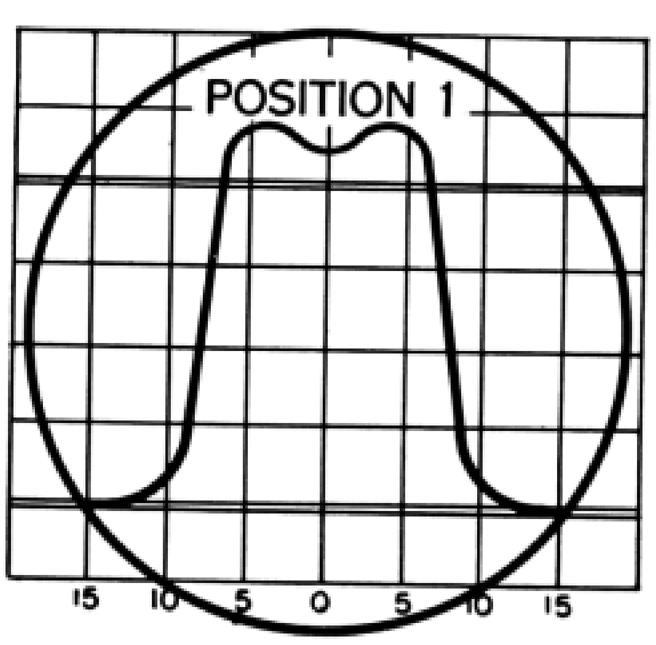


FIG 71

Condition — Flat Topping High Fidelity Receivers.

Fig. 71 (Position 1) is illustrative of correct alignment curves in cases of receivers adjusted for high fidelity reception. It will be noted that the wide band pass characteristics are quite in contrast to the relatively sharp peak obtained when adjusting receiver for maximum selectivity.

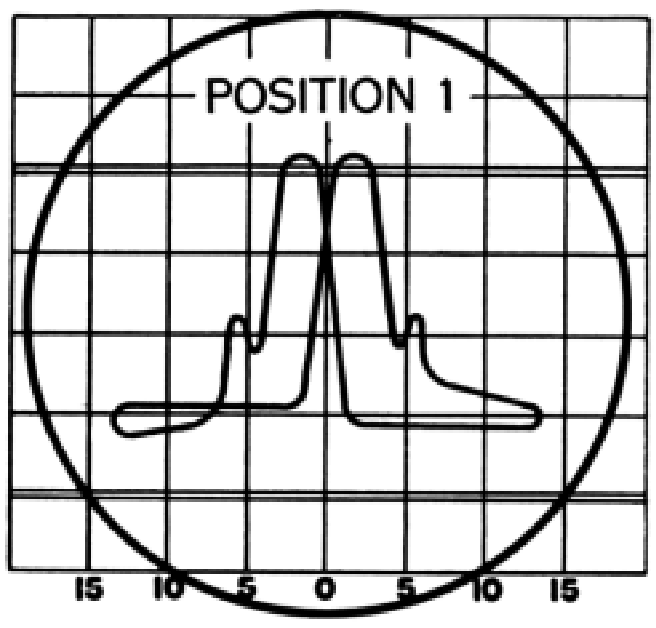


FIG. 72

Condition — Regeneration In I.F. Stages.

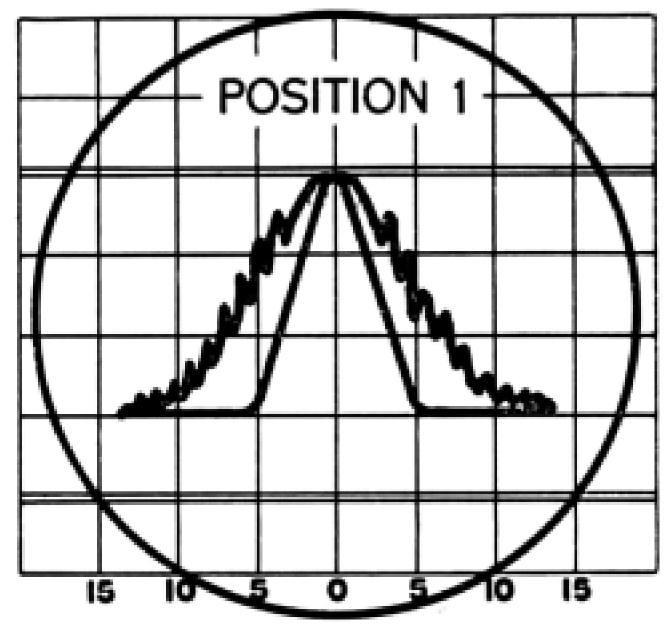


FIG 73

Fig. 72 (Position 1) is illustrative of slight regeneration in the I.F. stages. Fig. 73 (Position 1) illustrates severe regeneration.

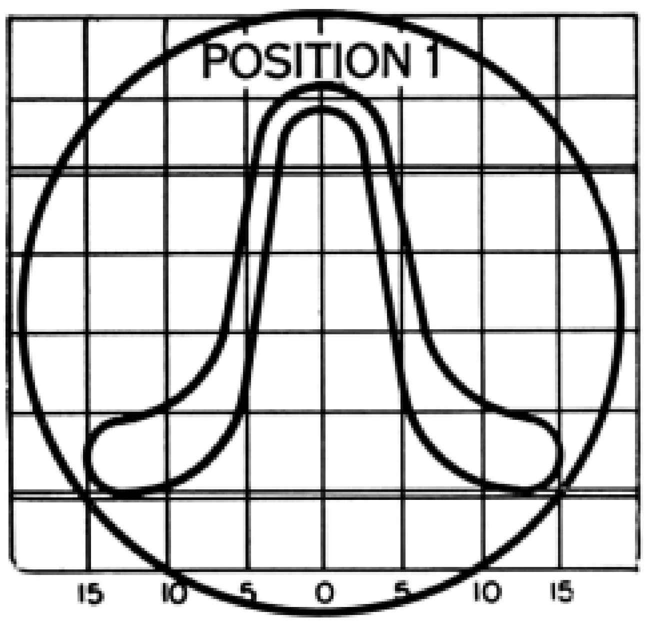


FIG 74

Condition — Hum.

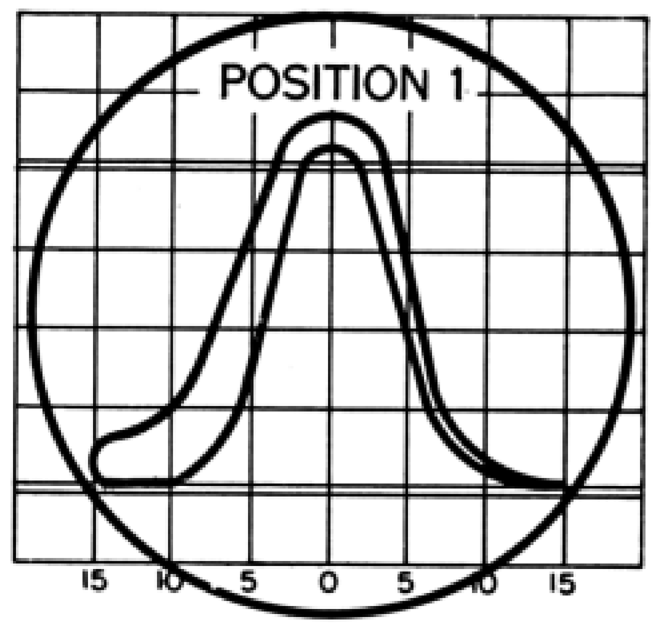


FIG 75

Fig. 74 (Position 1) illustrates hum as it would effect the response curve where the receiver is using full wave rectification.

Fig. 75 (Position 1) is the same condition in case where the rectifier system is half wave.

FIRST AUDIO AMPLIFIER

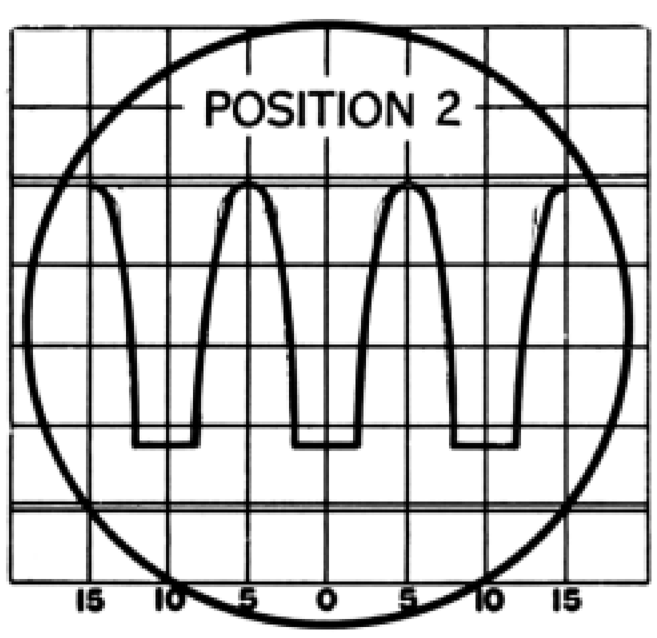


FIG 76

Condition — Leaky Coupling Condenser C4.

Signal Supplied — Amplitude Modulated R.F.

Signal Connections Antenna-Ground.

Oscillograph Connections E-G.

Oscillograph — Position 2.

In checking leaky coupling condenser C4 it is only necessary to increase the output of the signal generator to a relatively high output and with the oscillograph connections at E-G Fig. 76 (Position 2) should be obtained if the coupling condenser C4 is normal. It will be noted how the bottom of the sine wave tends to flatten off indicating that the control grid is being swung positive with respect to the cathode thereby drawing current and reducing the voltage during this half of the cycle. If, however, coupling condenser C4 were leaking an increase in negative voltage at point E. would bias the control grid negative as the signal increases and will not permit the grid to be swung positive with respect to the cathode. A pure sine wave would result.

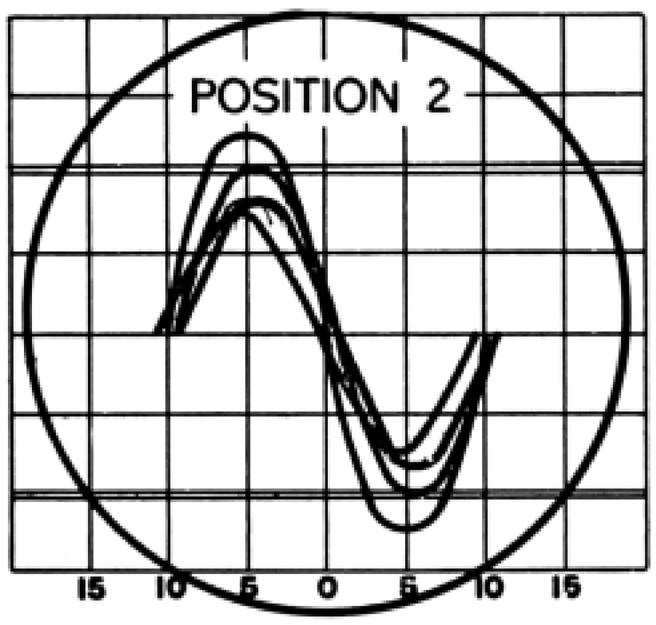


FIG. 77

Condition — Open Volume Control P1.
Signal Supplied — Amplitude Modulated R.F.
Signal Connections Antenna-Ground.
Oscillograph Connections E-G.
Oscillograph — Position 2.

If the volume control labeled P1 were either disconnected at the low end or had become opened so that there was no direct current return back to ground this would allow the grid to float at an infinite D.C. impedance above ground and the result, of course, would be a certain amount of A.C. pick-up on the grid. The resultant trace is illustrated in Fig. 77 (Position 2) and shows the effect of an A.C. ripple on the 400 cycle demodulated voltage.

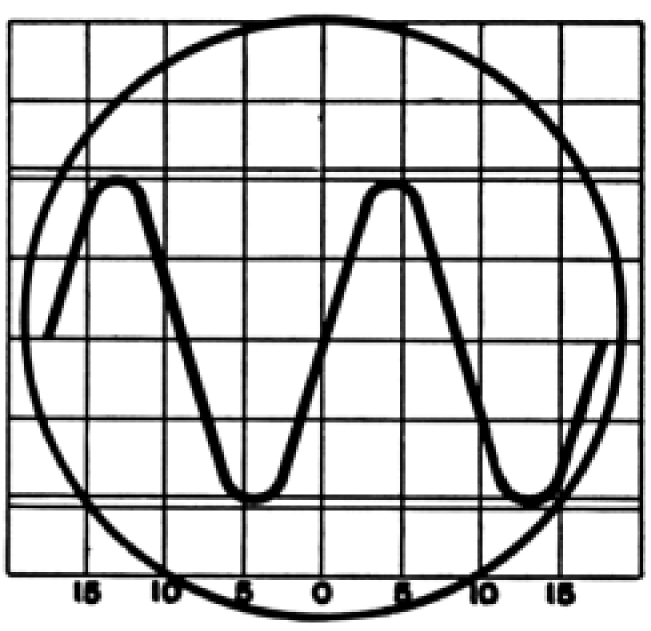


FIG. 4

Condition—Cathodde By-Pass Condenser C5 Open.
Signal Supplied — Variable Audio from 100 to 10,000 Cycles.
Signal Connections D-G.
Oscillograph Connections F-G.
Oscillograph — Position 2.

If the by-pass condenser C5 has become open an audio frequency voltage would be built up between point F and ground which would be approximately equal to the voltage supplied to the grid of the first audio amplifier by the signal generator. This voltage would appear as a pure sine wave. (Fig.4) This will probably be about 1 or2 volts as indicated on the calibrated voltage Scale.

If condenser C5 were operating normally a very small voltage could be built up from F to ground, the magnitude of this voltage would depend largely upon the frequency impressed. When the variable audio signal were reduced to approximately 50 or 100 cycles a relatively large voltage would probably be built up, .2 of 1 volt or greater, whereas if the frequency from the signal generator were increased towards 10,000 cycles the magnitude of the voltage would decrease rapidly until at 10,000 cycles it would hardly be perceptable on the cathode ray tube screen.

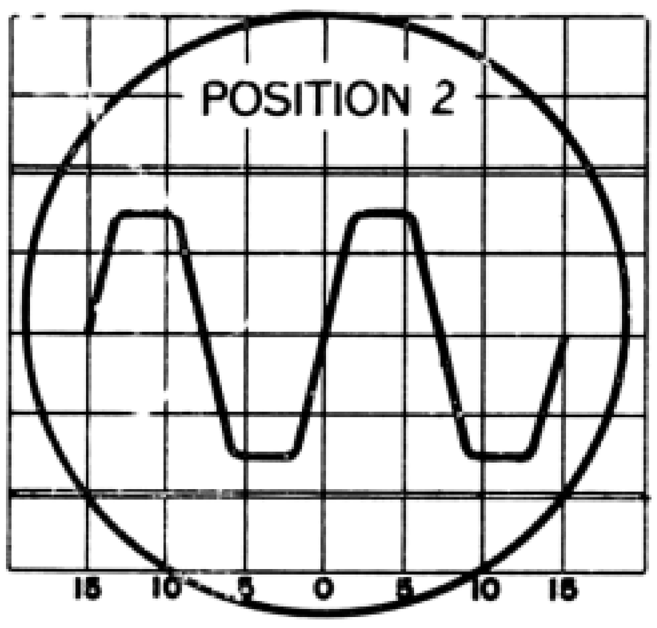


FIG 78

Condition — Normal Operation and Overload. First Audio Amplifier Tube.
Signal Supplied — 400 Cycle A.F.
Signal Connections D-G.
Oscillograph Connections E-G, J-G.
Oscillograph — Position 2.

With the sine wave of any frequency fed into the control grid of the first audio amplifier the trace as observed at the plate of the tube should represent a pure sine wave, The voltage should be from 20 to 50 times greater at the plate connection J-G than the voltage measured at the control grid connection E-G. In case of high gain pentodes used as first audio amplifiers the amplification might be as high as 150 or 200.

In a case of overload of this stage Fig. 78 (Position 2) would be observed at the plate of the tube connection J-G.

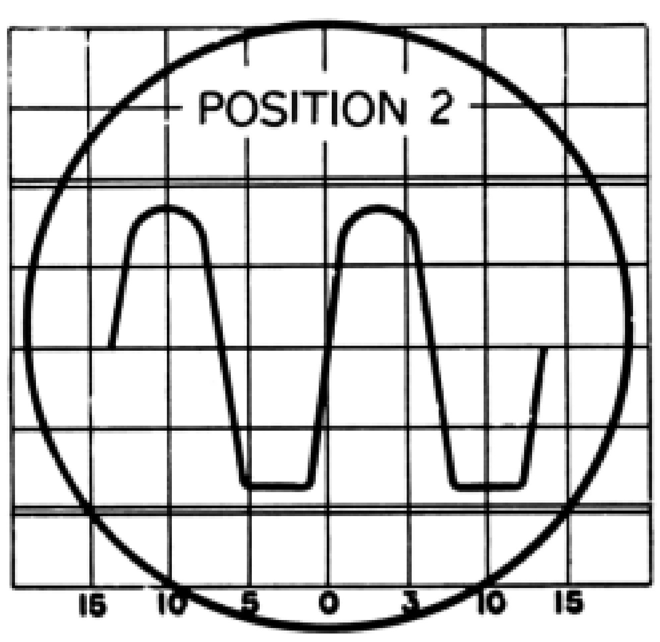
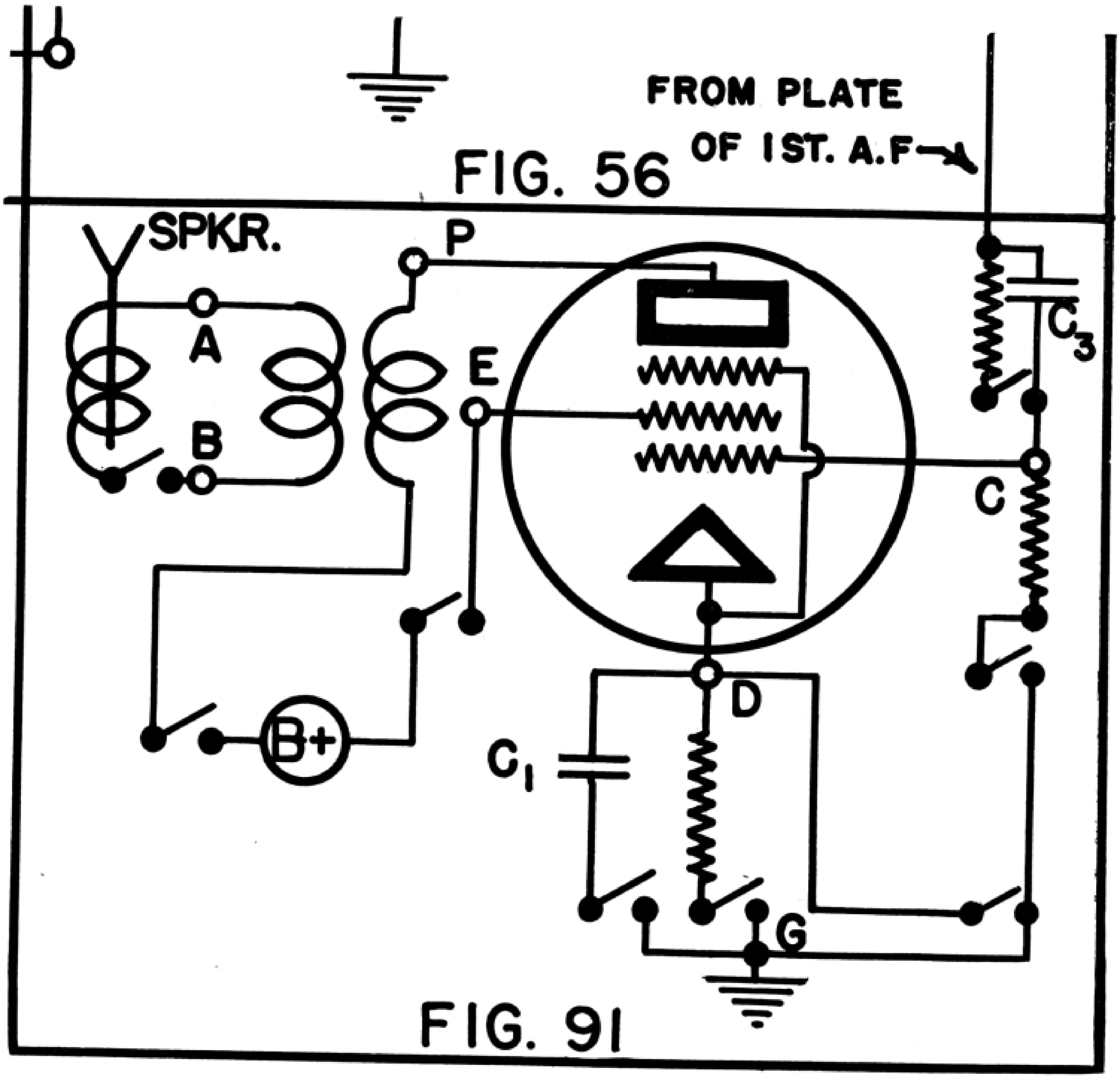


FIG. 79

Condition — Shorted By-Pass Condenser C5.
Signal Supplied — 400 Cycle A.F.
Signal Connections D-G.
Oscillograph Connections J-G.
Oscillograph — Position 2.

Fig. 79 (Position 2) is an illustration of the distortion caused by swinging the control grid positive with respect to cathode. Normally the cathode is operating at a positive potential above ground which puts the grid at negative potential with respect to the cathode. In the condition illustrated, however, the by-pass condenser was shorted out thereby putting both the grid and the cathode at ground potential. Any A. C. voltage applied to the grid would swing it positive with respect to the cathode giving the distortion as illustrated in the above figure.



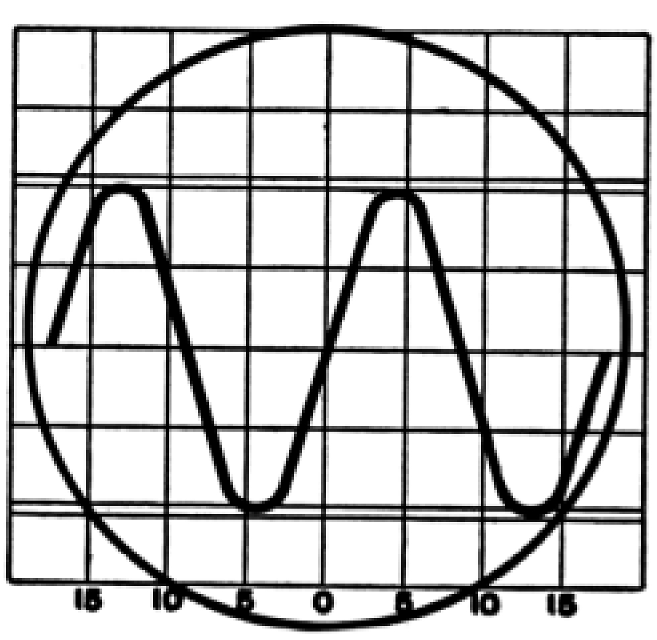


FIG. 4

Condition — Normal Operation.

Signal Supplied — 100 to 10,000 Cycle A.F.

Signal Connection To Grid of First Audio Amplifier.

Oscillograph Connections See Text Below.

Under a condition of normal operation the trace as observed at either the control grid (C-G) plate (D-G) or voice coil (A-B) of the final amplifier should represent a sine wave (Fig. 4). In normal operation of class A amplifiers the audio 'requency voltage as measured at the control grid (C-G) should never exceed approximately .7 of the D.C. bias voltage measured from cathode to ground (D-G). If the voltage applied at the control grid (C-G) were in excess of this amount it would result in the grid swinging positive with respect to the cathode thereby inducing distortion. In the case of class AB or B amplifiers this relation would no longer hold true since in this type of amplifier it is necessary to swing the grid positive with respect to the cathode.

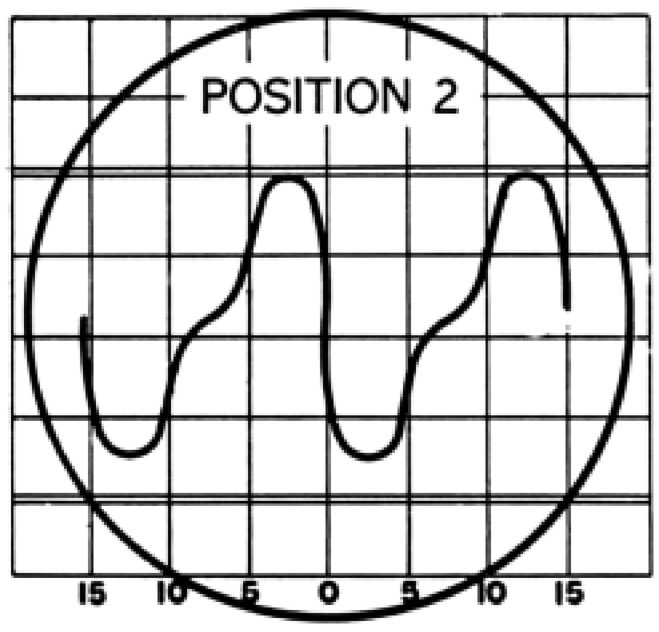


FIG. 80

Condition — Leaky Coupling Condenser C3.
Signal Supplied — 400 Cycles A.F.
Signal Connection Grid of First Audio Frequency Amplifier Tube.
Oscillograph Connections C-G.
Oscillograph — Position 2.

Should the coupling condenser C3 become leaky or shorted out a trace similar to Fig. 80 (Position 2) would be obtained with the oscillograph connection C-G, rather than a pure sine wave.

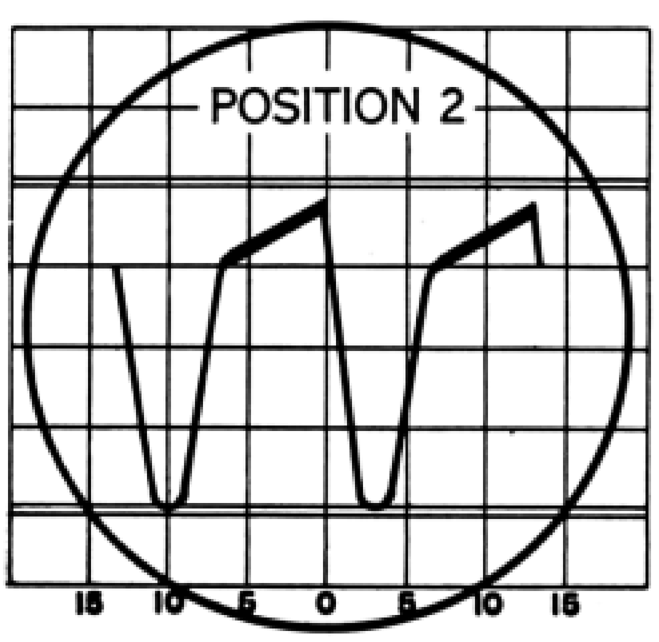


FIG. 81

Condition — Leaky Coupling Condenser C3.
Signal Generator as previously Connected.
Oscillograph Connections P-G.
Oscillograph — Position 2.

The same condition as previously outlined of a leaky coupling condenser would show up as illustrated in Fig. 81 (Position 2) when the oscillograph is connected at the plate of the output tube.

If the oscillograph has been connected across the voice coil from A to B rather than from the plate of the tube back to ground a curve exactly the same as Fig. 81 Position 2) should be obtained with the exception that the voltage would naturally be lower due to the step-down voltage effect of the output transformer.

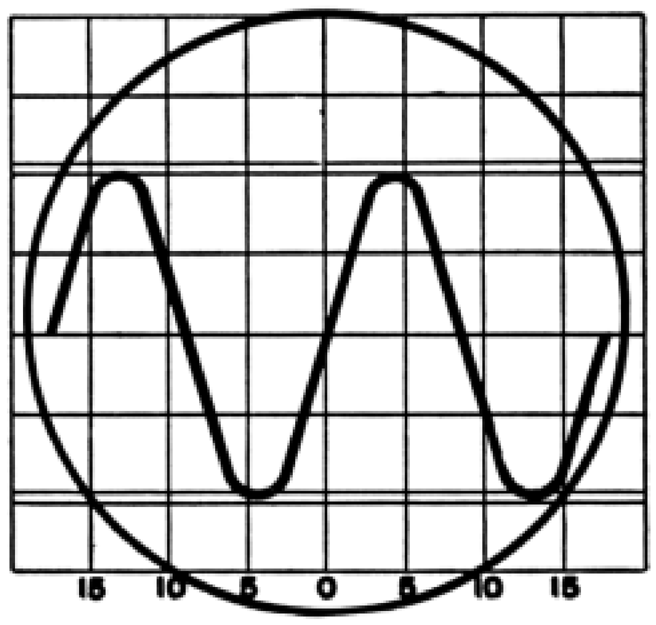


FIG. 4

Condition — Open Cathode By-Pass Condenser C1.
Signal Supplied — 100 to 10,000 Cycles. Variable Audio Frequency Output.
Signal Connection At Grid of First Audio Amplifier Tube.
Oscillograph Connections D-G.
Oscillograph — Position 2.

A pure sine wave (Fig. 4) should be obtained with this connection. The amplitude of this sine wave should increase rapidly as the frequency from the signal generator were decreased due to the increased reactance of by-pass condencer C1 at lower frequencies. If, however, C1 were open it will be found that the amplitude of the trace on the screen would remain almost constant as the signals were varied from approximately 100 cycles up to 10,000 cycles.

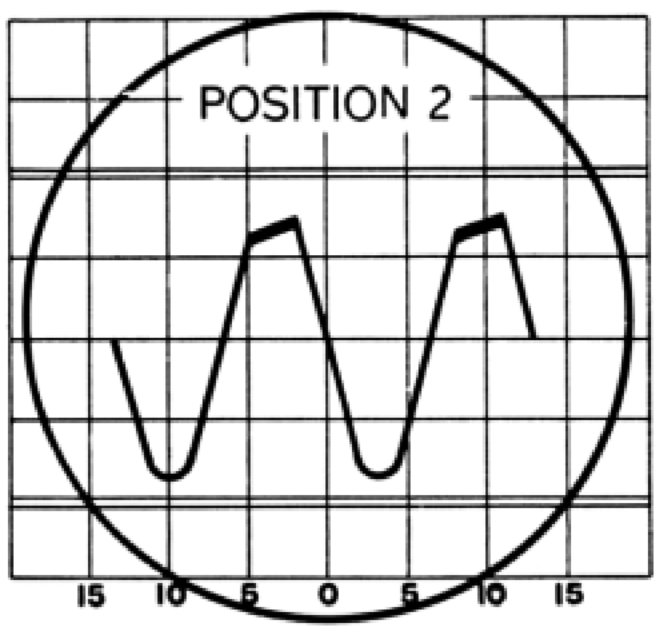


FIG 82

Condition — Cathode By-Pass Condenser C1 Shorted Out.
Signal Supplied — 400 Cycle A. F.
Signal Connection At Grid of First Audio Amplifier Tube.
Oscillograph Connections P-G.
Oscillograph — Position 2.

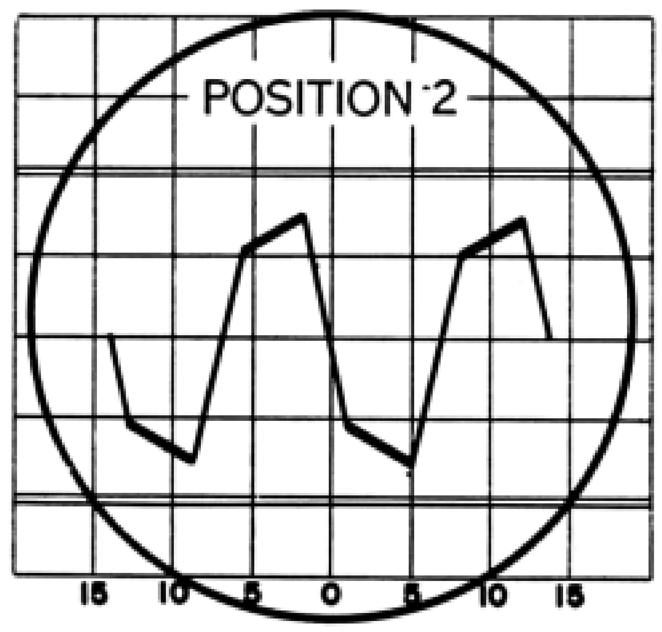


FIG 83

If the cathode by-pass condenser has become shorted out a trace as illustrated in Fig. 82 (Position 2) would be obtained.

If the output stage were push pull a trace as illustrated in Fig. 83 (Position 2) would be obtained.

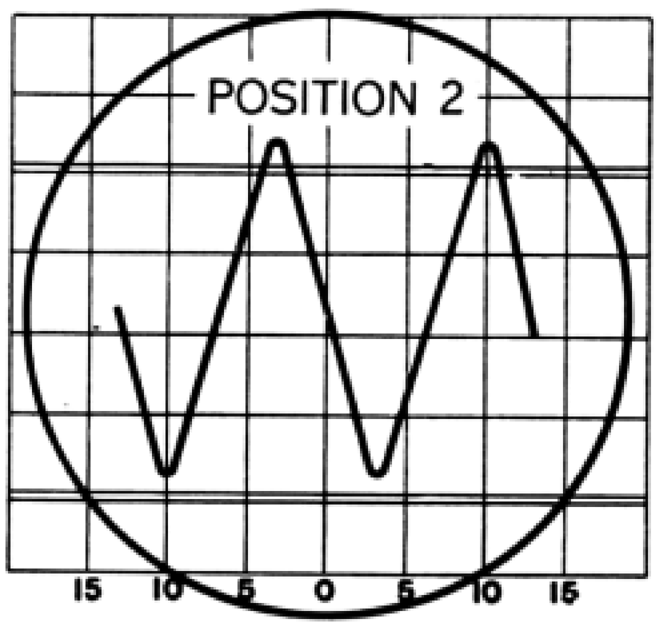


FIG 84

Condition — Mismatching of Plate Load.
Signal Supplied — 400 Cycle A.F.
Signal Connection To Grid of First Audio Amplifier Tube.
Oscillograph Connections P-G.
Oscillograph — Position 2.

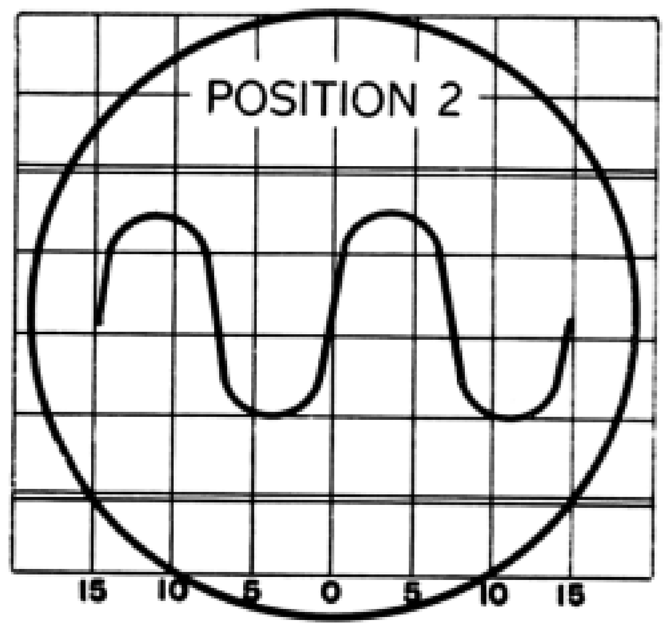


FIG 85

Fig. 84 (Position 2) is an illustration of the effect on the output wave trace of too light loading on the plate circuit of the tube. This might be caused by an open voice coil or high resistance in the voice coil connection.

Fig. 85 (Position 3) is illustrative of a condition of excessively heavy loading which could be caused by shorted voice coil or shorted turns in the output transformer.

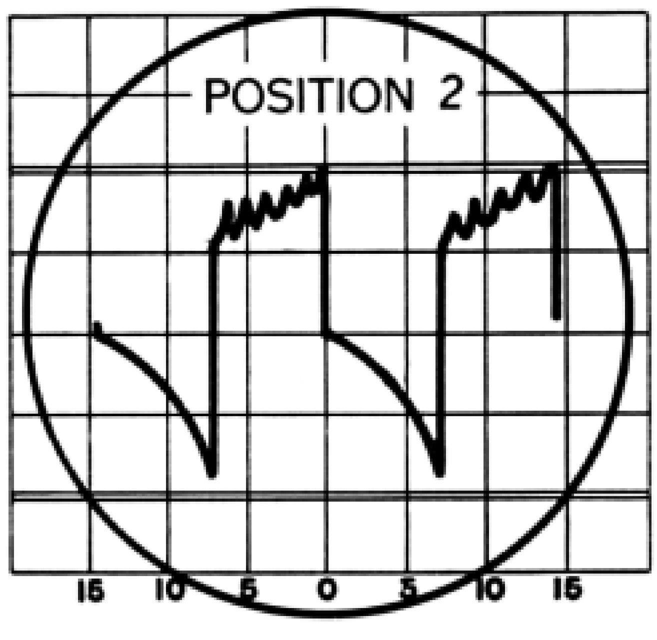


FIG 86

Condition — No Voltage at Screen of Output Tube.
Signal Supplied — 400 Cycle A.F.
Signal Connection To Grid of First Audio Amplifier Tube.
Oscillograph Connections P-G.
Oscillograph — Position 2.

Should the wiring to the screen of the output tube become defective thereby delivering no voltage to the screen, or should the screen of the tube become defective causing it to be inoperative a trace similar to Fig. 86 (Position 2) will be obtained.

Very strong signal will have to be delivered from the signal generator to show up this defect.

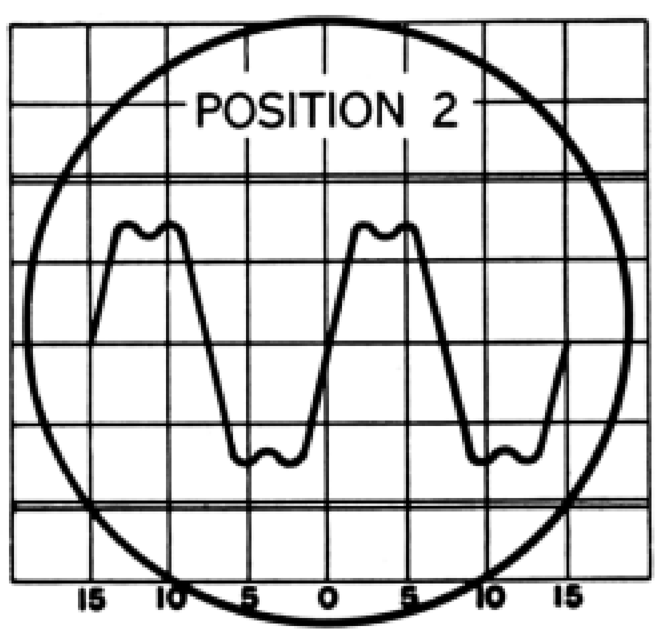


FIG 87

Condition — Overload In Final Amplifier.
Signal Supplied — 400 Cycle A.F.
Signal Connection To Grid of First Audio Amplifier Tube.
Oscillograph Connections P-G.
Oscillograph — Position 2.

Fig. 87 (Position 2) illustrates condition of overload in the final audio amplifier. The constants of the amplifier circuit are normal.

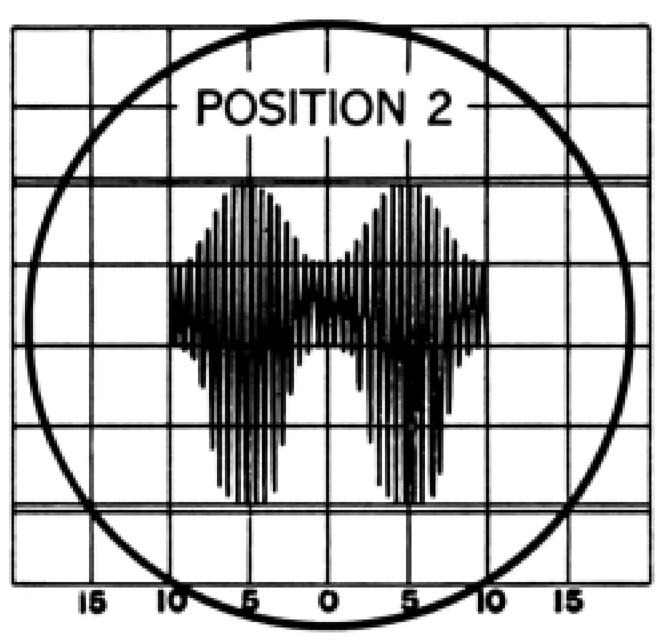


FIG. 88

Condition — Regeneration in Audio Frequency System.
Signal Supplied — 400 Cycle A.F.
Signal Connection To Grid of First Audio Amplifier Tube.
Oscillograph Connections P-G.
Oscillograph — Position 2.

Should defective wiring or placement of parts in the audio frequency amplifiers result in feed-back sufficient to cause oscillation a trace similar to that illustrated in Fig. 88 (Position 2) would probably be obtained. This figure actually represents a high frequency oscillation being amplitude modulated at the signal frequency of 400 cycles.

DYNAMIC VISUAL AUDIO FREQUENCY RESPONSE CURVES

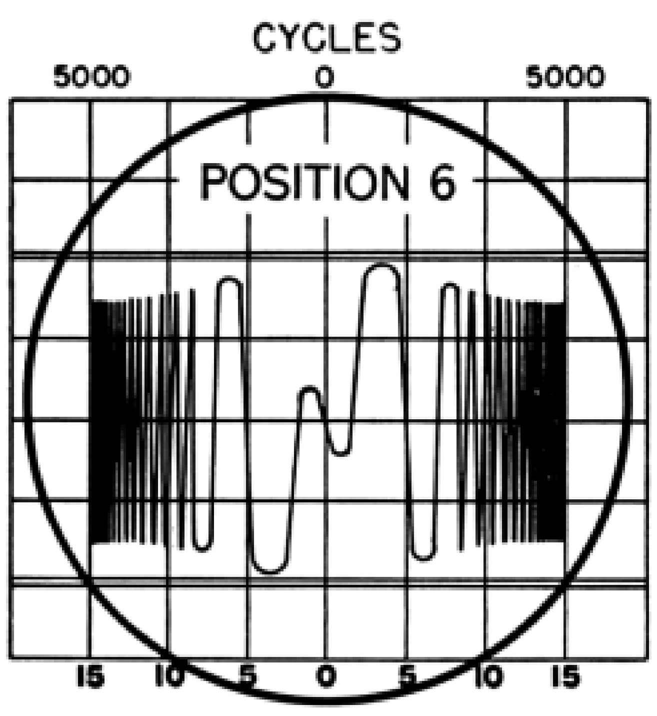


FIG 89

Condition — Normal Operation

Signal Supplied — Frequency Modulated Audio Frequency.

Signal Connection To Grid of First Audio Amplifier Tube.

Oscillograph Connections P-G.

Oscillograph — Position 6.

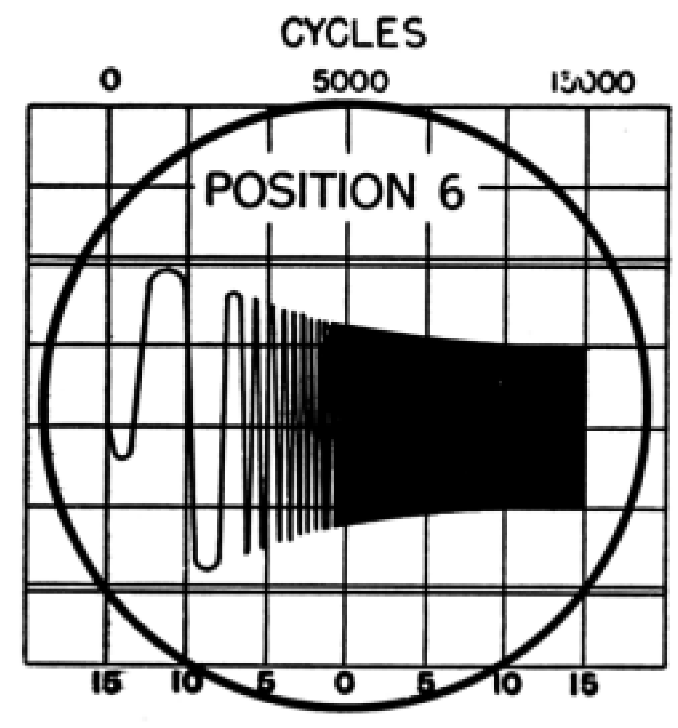


FIG. 90

To produce a frequency modulated audio frequency output. Connect the output from the signal generator to the external oscillator binding post on the oscillograph as illustrated in Fig. 1. Adjust the output from the signal generator to 665 KC. Pure R.F. (unmodulated). The signal generator frequency of 665 KC will then beat against the internal frequency modulated oscillator (665 KC frequency modulated 10 KC) to produce a frequency modulated audio frequency output which is continuously varying from 5000 cycles to zero cycle and to 5000 cycles completing the cycle.

Fig. 89 (Position 6) is illustrative of the trace as it would appear at the plate of the final audio frequency tube. By re-adjusting the signal generator to 600 KC the zero cycle position can be moved over to the left side of the screen giving Fig. 90 (Position 6) which shows the dynamic response characteristics of the amplifier from zero to 10,000 cycles.

If the KC sweep control were turned to the 15 KC position the characteristics of the amplifier from 0 to 15,000 cycles could be studied.

If the amplifier had flat response characteristics from 0 to 10,000 cycles the trace would not narrow up as it approached the side of the screen.

VIBRATOR TESTING

An oscillograph makes an excellent tool for locating trouble in power supplies employing the vibrator for changing the low voltage D.C. to high voltage D.C. The oscillograph could be used as a medium through which a proper adjustment of vibrator contact points could be made. It is generally recommended by the manufacturers that defective vibrators be replaced rather than repaired by the serviceman. We are illustrating the curves which will be obtained under normal conditions and also under conditions of defective vibrators or associated equipment.

OSCILLOGRAPH POSITION

The oscillograph should be used at Position 2 for all tests. The sweep circuit oscillator step and vernier control should be adjusted so as to give 1 or 2 waves on the screen. The locking control should be advanced sufficiently to lock the image stationary on the screen.

OSCILLOGRAPH CONNECTIONS

Under no condition connect the ground of the oscillograph to the ground or chassis of the receiver under test. The vertical input connection to the oscillograph that is, the vertical input binding post and ground binding post should be connected across the primary of the vibrator transformer.

The foregoing connections are for measuring the voltage waves. In the illustrations given of the current wave the oscillograph should be connected across the supply line from the 6 volt battery to the receiver under test. That is, the ground of the oscillograph should be connected to the 6 volt connection of the receiverand the vertical input binding post connected to the battery terminal. The oscillograph will then indicate the voltage being built up across the supply line from the battery to the receiver which will be, of course, directly proportional to the current flowing in this line. The vertical amplifier in the model RFO-4 oscillograph has sufficient sensitivity to obtain a suitable vertical deflection as a result of the voltage drop across this lead.

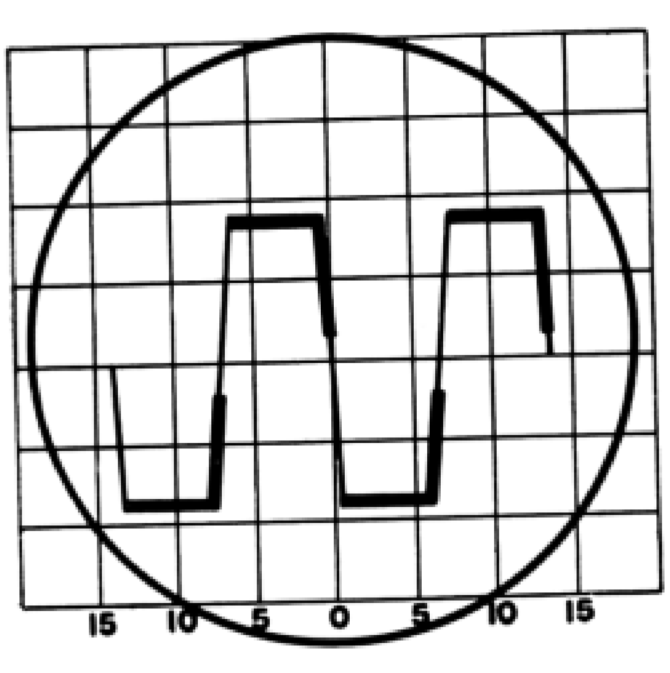


FIG. 92

Fig. 92. Non Synchronous Vibrator. Normal Operation. Voltage Wave.

Fig. 93. Non Synchronous Vibrator. Open Buffer Condenser. Voltage Wave.

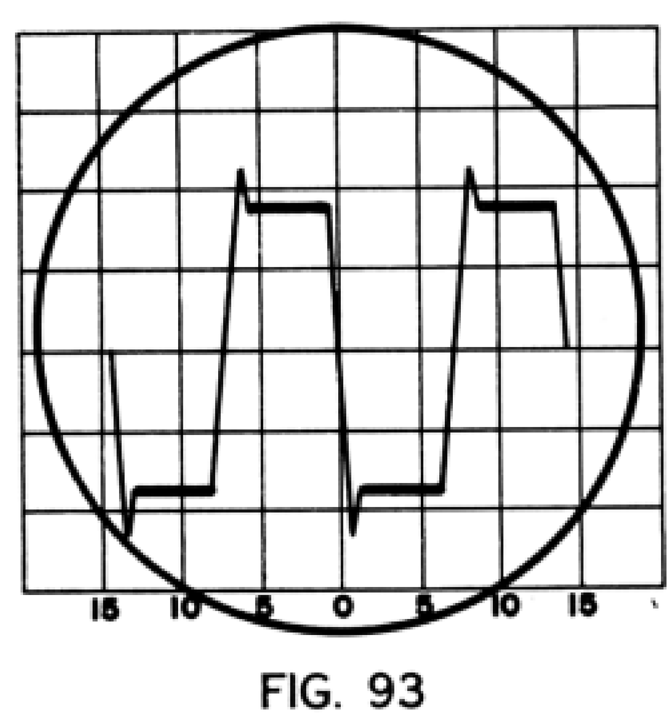


FIG. 93

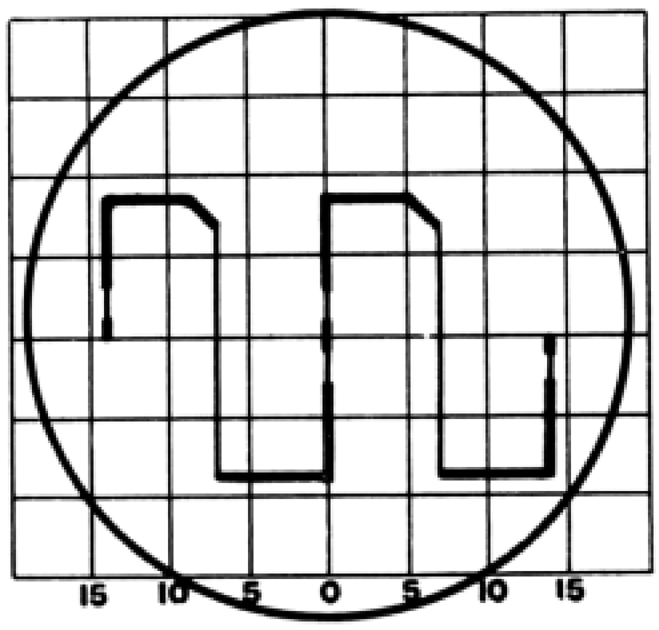


FIG. 94

Fig. 94. Non Synchronous Vibrator. Excessive Buffer Condenser. Voltage Wave.

Fig. 95. Non Synchronous Vibrator. Contact Chatter. Voltage Wave.

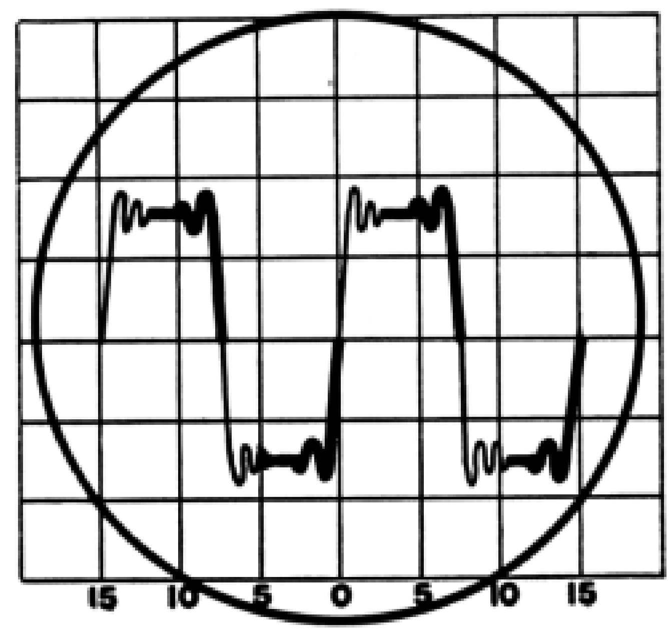


FIG 95

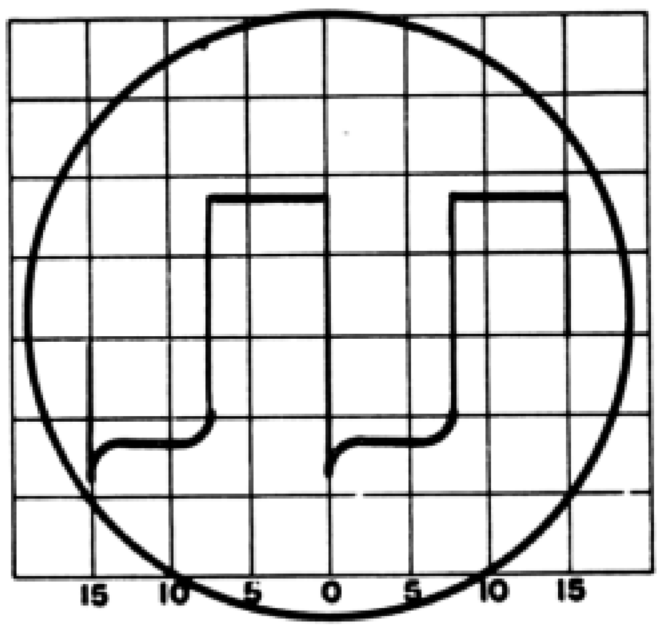


FIG. 96

Fig. 96. Non Synchronous Vibrator. Single Footing. Voltage Wave.

Fig. 97. Non Synchronous or Synchronous Normal Operation. Current Wave.

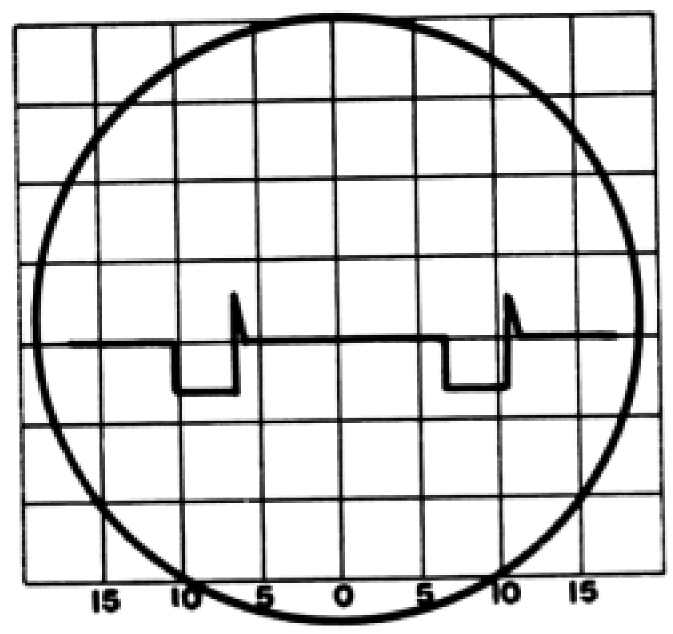


FIG. 97

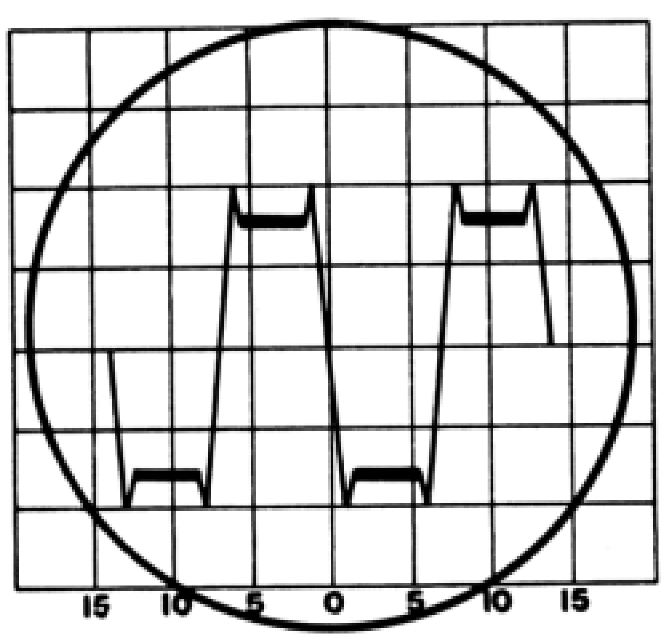


FIG 98

Fig. 98. Synchronous Vibrator. Normal Operation. Voltage Wave.

Fig. 99. Synchronous Vibrator. Single Footing. Voltage Wave.

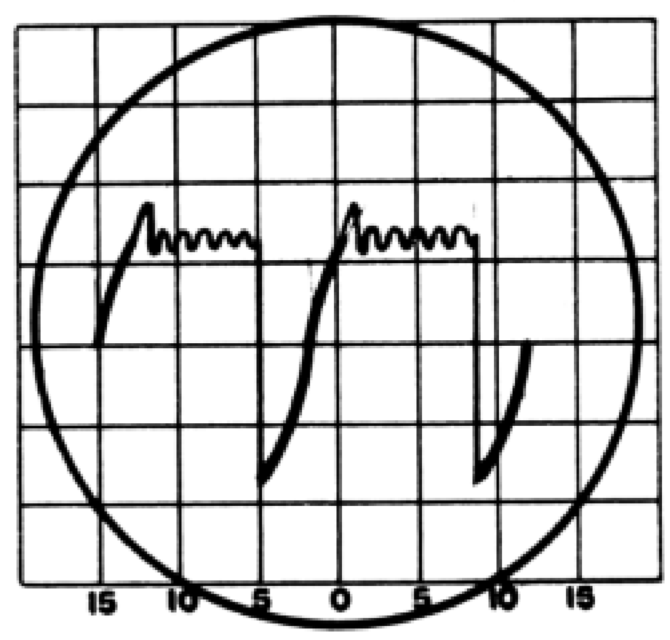


FIG. 99

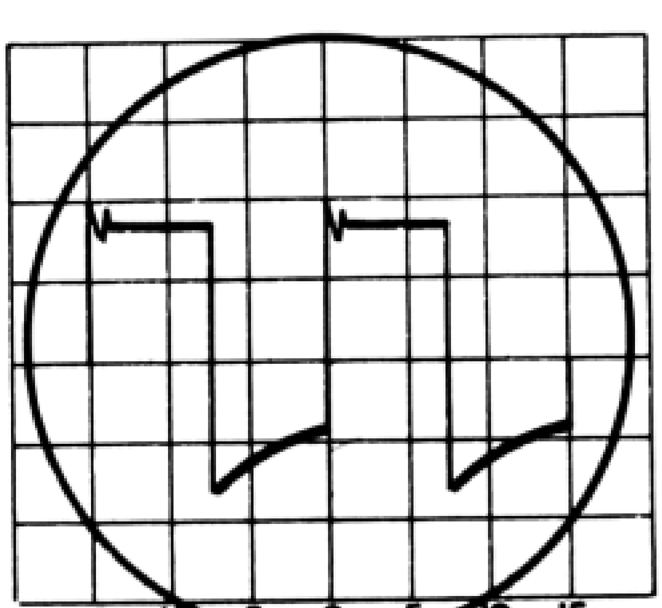


FIG 100

Fig. 101. Synchronous Vibrator. No Load. Voltage Wave.

Fig. 100. Synchronous Vibrator. One Plate of Rectifier Tube Open. Voltage Wave.

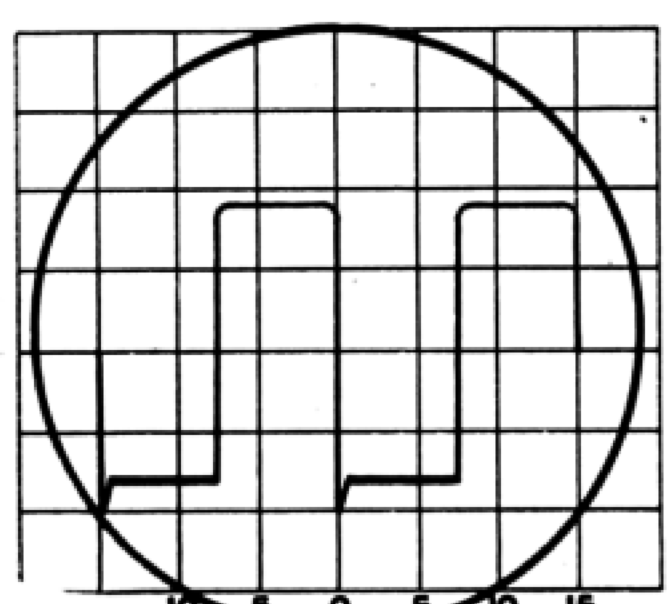
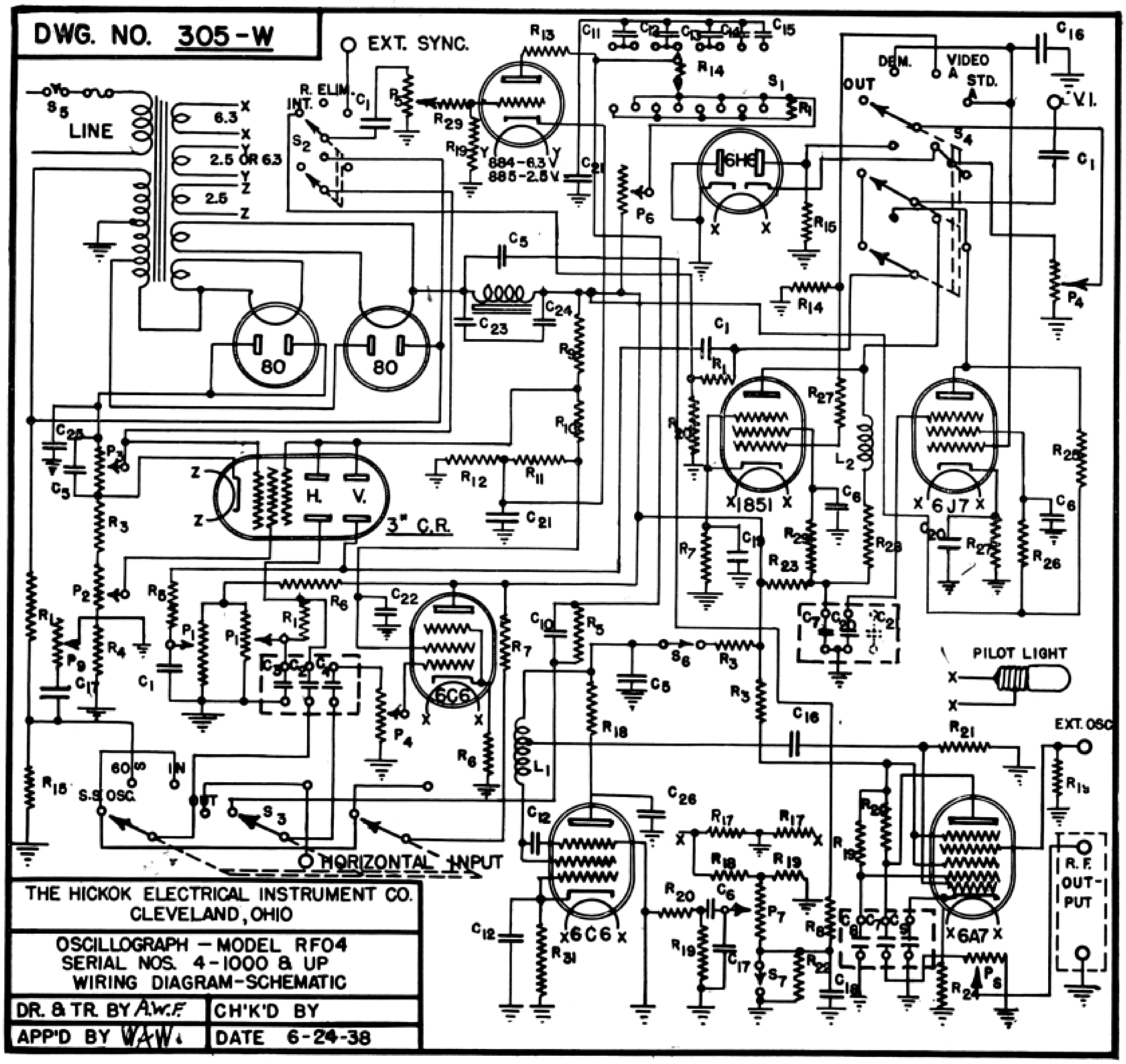


FIG 101



TECHNICAL SPECIFICATIONS

POWER SUPPLY

VOLTAGE	110-120 Volts
WATTAGE	60 Watts
FREQUENCY	50-60 Cycles
FUSE PROTECTION	1.0 Amp.

TUBE COMPLIMENT

906	Cathode Ray Tube
5Z3	High Voltage Rectifier
80	Low Voltage Rectifier
1852	Video Amplifier (vertical)
6J7	Standard Amplifier (vertical)
6C6	Standard Amplifier (Horizontal)
885	Sweep Circuit Oscillator
6H6	Demodulator
6A7	R.F. Mixer
6C6	Frequency Modulated Oscillator
Mazda 41	Pilot Lamp

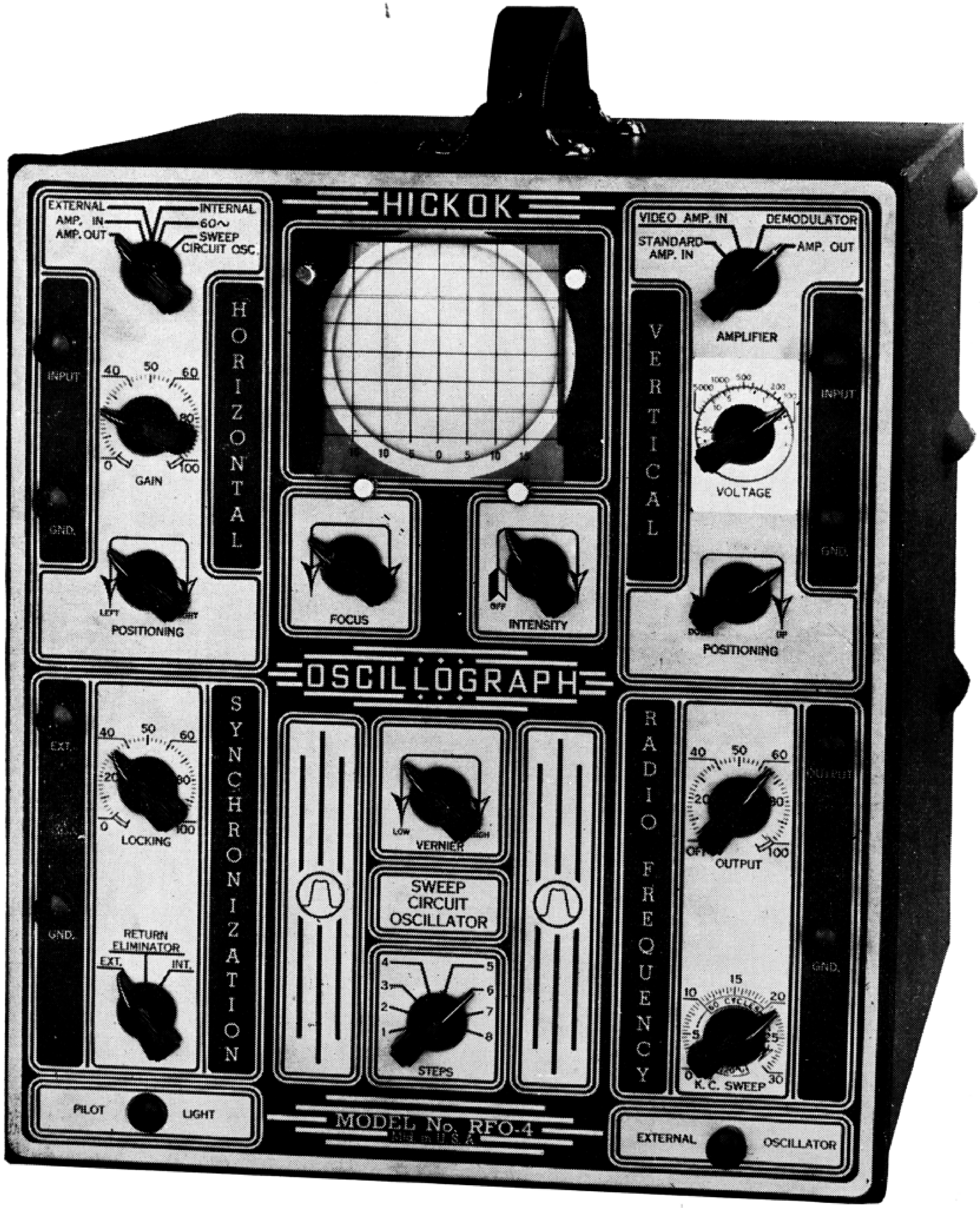
DEFLECTION SENSITIVITY

VERTICAL 0.20 Volts per inch.
HORIZONTAL 0.25 Volts per inch.
Input Impedance
Vertical and Horizontal 1.0 megohm—Amp. IN
3.0 megohms—Amp. OUT

FOR COMPLETE VISUAL ANALYSIS

A COMPLETE

OSCILLOGRAPH



MODEL RFO-4

SELECTING A SIGNAL GENERATOR

With the countless number of signal generators that are available on the market to the radio service industry today it sometimes becomes a problem to accurately determine just which one of these signal generators is really the best investment. We will try to outline the various factors which are generally considered by the serviceman before final decision is reached.

COST

A good radio service shop, properly operated figures the cost of their service equipment which is purchased, not in terms of direct cash outlay but as an investment in service tools which is to be written off over a given period of time. Any good signal generator should certainly not be written off over any less period of time than three years, and in most cases, it is considerably longer than this. However ever, if we take the most pessimistic attitude and assume that we are writing a cost off on a period of three years, the difference between a $25.00 signal generator and a $50.00 signal generator is less than 3c a day. This 3c could very easily mean the difference between a satisfied customer and one which was not, which, over a period of three years could easily make up the complete difference between the cost of the $25.00 and the $50.00 signal generator. We can, therefore, come to the conclusion that initial cost is not and should not be a primary consideration for a radio shop that intends to be in business for three years or more.

MANUFACTURER

Quite often a piece of equipment will be bought largely on the reputation of the manufacturer of that equipment under the assumption that anything manufactured by that company would undoubtedly be trustworthy and well worth the price asked. In this connection, we would like to point out that the Hickok Electrical Instrument Company has been manufacturing precision electrical equipment since 1910 and this 28 years of experience should well be an assurance that the product bearing this name would be of the Highest Quality.

APPEARANCE

It has been proven by several large service organizations that customer confidence is a very important factor in successful servicing. It follows, therefore, that unless the appearance of the test equipment which is used by the radio serviceman has the ability of building confidence and assurance on the part of the customer that he is going to sacrifice business and consequently profit.

Some signal generators, especially those in the lower price bracket, have an appearance almost similar in some cases to miniature radio sets. The customer is not going to have the confidence in the serviceman who uses a piece of equipment that appears to him like a $10.00 midget radio set when servicing a $100.00 or $200.00 modern receiver. The professional appearance of the horizontal edgewise

FOR COMPLETE VISUAL ANALYSIS

A COMPLETE

SIGNAL GENERATOR

MODEL 17

Universal Signal Generator Identical in Specifications to Model 18 but does not incorporate self contained power level meter.

SIGNAL GENERATOR—MODEL 18

Universal Signal Generator

5 Output Selections

1. Amplitude Modulated R.F.
2. Frequency Modulated R.F.
3. Unmodulated R.F.
4. 400 Cycle Fixed A.F.
5. 100-10,000 cycle variable A.F.

Self Contained Power Level Meter—
3 Ranges
—10 to +38 D.B.

MODEL 15—MICROVOLTER

Laboratory Signal Generator

R.F. Output calibrated directly in microvolts from 0.5 to 100,000 microvolts on all ranges.

400 cycle A.F. output calibrated directly from 5 microvolts to 1.0 volt. Self contained vacuum tube voltmeter and 3 range power level meter.

dial, and the built-in horizontal edgewise power level meter, together with the panel and control arrangement of the Hickok Signal Generator would play an important factor in building up customer confidence.

Keep in mind that the customer mentally estimates the value of your service by the appearance of your shop and the equipment you use. Cheap equipment, cheap job. Quality equipment, quailty job, and you get paid for the difference.

ACCURACY

It certainly is not good policy to attempt to line up a radio receiver which can be be read to an accuracy of 1% or 2% with a signal generator which has only an equivalent accuracy. The signal generator is really the standard of frequency in a radio laboratory and therefore should be of such a design that its accuracy will be maintained over long period of time in spite of fluctuations in humidity, temperature, etc. The Hickok Signal Generator makes provisions for this accuracy and stability by making use of ceramic coil forms on which all coils are wound, an inductance trimming arrangement so that the inductance of each coil can be laboratory adjusted to a value which corresponds exactly with the direct reading scale and in addition to this each coil is individually air trimmed for capacity. The combination of these three factors together with a precision variable condenser results in a product which can be guaranteed to ½ of 1% accuracy and in all cases the accuracy is held much closer than this before the final hand calibration at the factory is finished and the instrument ready for shipment.

RUGGEDNESS

It is generally impossible to determine the ruggedness or mechanical stability of a signal generator from the outside appearance. Hickok Signal Generators are so constructed that they should be able to withstand not only normal abuse but excessive abuse which is often encountered. The mechanical construction has even gone so far as to provide ball bearings to carry the direct reading dial so that this could not possibly get out of alignment and give inaccuracies in calibration.

OBSOLESCENCE

When a serviceman invests as much as $50.00 in a Signal Generator he has the right to feel that signal generator is not going to become obsolete within the next year or two. Modern service demands are continually becoming more and more strict and requiring more flexibility from this signal generator.

For example, several years ago a signal generator was adequate to service work which had only an amplitude modulated radio frequency output. It soon became necessary to also provide a pure radio frequency output for various tests which were to be made on the receiver. Proper servicing of a modern receiver today and undoubtedly that of tomorrow necessitates at least **five output selections.** The **First** being amplitude modulated radio frequency, the **Second** being pure radio frequency unmodulated, the **Third,** frequency modulated radio frequency, **Fourth,** a fixed audio frequency output and **Fifth,** a variable audio frequency output. In most commercial signal generators not all five of these output selections are available, therefore, it becomes necessary for the serviceman to purchase additional equipment in order to have all the requirements for modern servicing. In the **model 17 and 18 signal generators** all five of these output selections are available, thereby minimizing the possibility of any obsolescence in the test oscillator and also providing the convenience of having all these output selections available from a single unit.

USEFULNESS

Primarily a signal generator must be useful or there is no reason for purchasing it. As previously pointed out, the five output selections greatly increase its usefulness over signal generators which are not equipped with such a flexibility of output selections. In addition to these five output selections several other features should be found in good signal generators which contribute to their usefulness.

Attenuation: Unless a signal generator is capable of attenuating to a minimum of 1 or 2 microvolts the problem of aligning extremely sensitive radio sets becomes somewhat complicated since the output cannot be reduced below the level at which the automatic volume control starts operating. The **model 17 and 18** are triple shielded to insure a minimum of one microvolt or less.

Wave Form of the Audio Frequency Modulating Voltage: Unless this wave form is sine wave the usefulness of the signal generator in connection with an oscillograph is seriously impaired. The reason for this being of course that unless a pure sine wave is available distortion occurring in the amplifying stages could not readily be localized or determined. In the **model 17 and 18** signal generators the negative resistance oscillator is used to supply the 400 cycle voltage for modulating the RF carrier and also for the variable audio 0-10,000 KC output voltage. The negative resistance oscillator is inherently very stable and produces a wave form practically free of harmonic distortion.

Power Level Meter: The incorporation of this output meter in the model 18 signal generator obviates the necessity of having an external output meter available.

Horizontal Sweep Voltage for Oscillograph Use: In many cases the oscillographs are not equipped with sinusoidal horizontal sweep and therefore when using frequency modulation it becomes necessary to hook up some transformer andcondenser combination to provide this proper horizontal sweep in its proper phase relation to the frequency modulated section.

Summing it all up, the **model 17 and 18** signal generators have all of the worth while features found in any signal generator, and in addition have many features not found in any other signal generator.

HICKOK

SINCE 1920

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The only Manufacturer of Dynamic Mutual Conductance Tube Testers.

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NOTE: The Unit of Mutual Conductance is the Micromho. If a Tube Tester does not read in Micromhos it is not a Dynamic Mutual Conductance Tester.

The Hickok Electrical Instrument Co.
Cleveland, Ohio, U. S. A.