OPERATING INSTRUCTIONS

FOR

HICKOK

RADIO TEST EQUIPMENT

MODEL_______________

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
CLEVELAND, OHIO U. S. A.

OPERATING INSTRUCTIONS FOR MODEL 17 & 18 SIGNAL GENERATORS.

GUARANTEE:

Hickok Test Equipment is guaranteed against inaccuracies or defects in workmanship or material for a period of 90 days after date of shipment from factory. Adjustments under terms of this guarantee will be made by the factory or authorized repair stations without charge.

This guarantee does not cover transportation charges to or from our factory or repair station.

Any vacuum tubes used in this equipment are guaranteed by the manufacturers and therefore any claims for adjustment must be made against the manufacturer.

- REGISTRATION CARD -

The above guarantee is contingent upon the attached registration card being returned immediately upon receipt of the equipment.

THE HICKOK ELECTRICAL INSTRUMENT CO. 10514 Dupont Avenue, Cleveland, Ohio

PRECAUTIONS

TO BE OBSERVED

WHEN USING THE SIGNAL GENERATOR

* *

With the exception of damaging the meter, there is only one likely way in which you can injure your Signal Generator.

This consists in connecting the high output terminal of the output W18B cable to the receiver before connecting the ground or black output terminals to the chassis of the receiver.

Always remember that the ground or black output lead from the W18B cable should be connected to the receiver chassis or ground before any other connection is made between the receiver and the Signal Generator.

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THE HICKOK ELECTRICAL INSTRUMENT COMPANY, 10514 Dupont Ave., Cleveland, Ohio.

OPERATING INSTRUCTIONS FOR HICKOK ALL WAVE RADIO & AUDIO FREQUENCY SIGNAL GENERATOR.

- - - - - - - -MODELS 17 & 18 - - - - - - - -

STANDARD LEAD EQUIPMENT SUPPLIED WITH ALL WAVE SIGNAL GENERATOR

1. 1 - W18B 2 wire output cable (length 3 ft.) having provision for connection to the Signal Generator on one end and 2 output connector clips on the other end. Black - ground. Red - output.

Model 18 only:

1 No. B-2 lead (length 3 ft.) for clipping over plate prong of Audio Tube.
1 No. B-3 lead (length 3 ft.) for connecting low side of D.B. meter to chassis or proper place on output circuit.

TECHNICAL DESCRIPTION AND DETAILS, MODELS 17 & 18

2. TUBES: The tubes used are the type 6J7, type 6C6, type 6K7 and type 1V. All these tubes are the latest 6 volt heater type tubes and are operated at their normal rating to insure long life and uniform service.

3. POWER: The oscillator includes a complete built-in power supply consisting of a transformer, rectifier and filter. It may be operated from any 110 volt A.C. line, 40 to 65 cycles, other voltages and frequencies available at slight additional cost.

4. CIRCUIT: The variable radio frequency circuit utilizes the type 6J7 pentode tube as an electron-coupled high stability, radio frequency oscillator. This oscillator circuit is continuously variable from 100 KC to 30 megacycles in six ranges. Each range is clearly marked on the main tuning dial and extends over more than 15% of scale length. The electron couple circuit is used for its high stability and freedom from frequency variations with line voltage. A type 6C6 is used interchangeably, as a negative resistance oscillator at 400 cycles, as a frequency modulated oscillator at 1,000 KC or at a fixed frequency of 150 KC. When used as the 400 cycle oscillator, its output may be used to modulate the radio frequency carrier at approximately 30%. When used as a radio frequency oscillator operating at 150 KC it is used to beat against the main oscillator to provide a variable audio frequency from 100 to approximately 10,000 cycles. The negative resistance oscillator has the inherent advantage of extreme freedom from harmonics and consequently developes a pure sine wave which is essential for oscillograph operation. A type 6K7 tube is used as a demodulator mixer for mixing the outputs of the two oscillating sections, and providing a decoupling amplifier to isolate the input from the output circuit. It also acts as an amplifier and amplifies the audio frequency to the high level of 1 volt output which is essential for modern visional alignment. The type 1V tube is a half-wave cathode type rectifier and is used to rectify the alternating current supplied by the secondary of the power transformer.

5. RADIO FREQUENCY COILS: The radio frequency coils are wound on ceramic forms and impregnated in a special lacquer making them moisture proof and not subject to inductance change with change of humidity or temperature. The coils are mounted integral with a specially designed switch so that the proper coil is selected and all other coils are grounded when not in use. This results in the elimination of interaction between coils which cause frequency absorption

at certain frequencies. This also results in maximum stability and freedom from frequency variation. The coil and switch assemblies are completely shielded in a metal container, and this together with the complete radio frequency section is housed in a second shield. This provides freedom from stray fields which result in poor attenuation. This also concentrates the radio frequency energy in its proper channel in the signal generator.

6. METER: A precision decibel meter, model 18 only, calibrated direct in decibels from minus 10 to plus 38. When this meter is connected across a 500 ohm line the accuracy may be depended upon to within 1%. The output meter has two ranges, the first range from minus 10 to plus 6 DB, the second range plus 3 to plus 22, and the third range plus 22 to plus 38 DB. Provisions are made for a capacity connection to the output meter so that the output may be taken directly from the plate of a tube.

7. OUTPUT RATIO CONTROL is used to provide step attenuation of the radio frequency and audio frequency outputs so that the output potentiometer, which is labeled "Output Control" may be used with maximum effectiveness.

8. OUTPUT SELECTOR: A control which enables the operator to select any desired output. When this is turned to the 400 cycle position the radio frequency carrier is modulated at 400 cycles and may be, as previously explained, used as a 400 cycle fixed frequency audio signal generator. When the switch is turned to the Pure radio frequency position, this 400 cycle modulation is disconnected and the output of the oscillator becomes a pure radio frequency which may be used where modulation is not desired. In the frequency modulation position the output is frequency modulated 50 KC at a rate synchronized by the power supply frequency. When the switch is turned to the 0-10,000 cycle audio frequency position the control in the lower right hand corner of the signal generator panel becomes the control for the variable 100-10,000 cycle audio frequency signal. The output of the audio frequency oscillator within these frequency ranges is constant within about two DB over the entire range.

9. 100-10,000 CYCLE AUDIO: Continuously variable from 100 to 10 KC with output level approximately 1.0 volts. Accuracy 5%.

10. SYNCHRONIZED SWEEP VOLTAGE: This voltage output may be used to supply the horizontal sweep for Cathode Ray Oscillographs when using frequency modulated output for visual alignment.

- OPERATION OF THE SIGNAL GENERATOR -

11. As it is impossible to obtain a ground at zero potential due to the fact that an appreciable amount of resistance always exists between the shield and ground, the shield will assume an R.F. potential above ground which is the produce of this resistance and the R.F. current flow. When the attenuator is set at zero, the above mentioned potential is 180 degrees out of phase from the normal output potential. Zero output will be obtained when the attenuator is not on zero position, but advanced to such a position that the in-phase output potential equals the out of phase ground potential. This zero output position will vary with frequency and value of resistance to ground and usually increases with an increase in frequency, therefore, adjust the attenuator to some advanced position above zero of attenmuator scale for zero output. On lower frequencies which includes scales "A, B & C" zero output will be obtained at or near zero in antennuation scale.

12. TRIMMERS & PADDERS: Since one primary function of the signal generator is to align the trimming and padding condensers in a radio receiver, it is very essential that the operator understand thoroughly what is meant by a trimming and padding condenser and how they are used in the receiver. A trimmercondenser is a small capacity variable condenser which is always connected in parallel with the tuned circuits. The tuned circuits may be simply an inductance or it may be inductance paralleled by a main tuning condenser, but in either case the trimmer condenser is connected across this. The value of the trimmer condenser seldom exceeds 40 micro-micro-farads. An analysis of a trimmer condenser action across a tuned circuit comprising an inductance and a variable condenser may be best made by assuming values for each. The variable condenser may be assumed to vary from 15 micro-micro-farads to 300 micro-micro-farads.

The trimmer condenser of 40 micro-micro-farads maximum is connected across this main tuning condenser. The ffectiveness of this trimmer will be at its maximum when the main tuning condenser capacity is at a minimum as the percentage of capacity supplied by the trimmer is then 40 divided by (40 plus 15) or nearly 70%.

13. PADDING CONDENSER: The padding condenser is a small variable condenser always connected in series with a tuning inductance or condenser. In this case the padding condenser is as a rule of fairly high value, generally over two or three hundred micro-micro-farads. If we assume the case of a padder connected in series with a main tuning condenser of 15 to 300 micro-micro-farads, it will be quite evident that the padding condenser will have its maximum effect when the main tuning condenser is all the way in, or in other words, at its maximum. Capacity of the two series condensers is still 15 and the slight change in the 300 padding condenser would have very little effect in the total overall capacity.

In view of this, it should be remembered that whenever adjusting trimmer condensers these adjustments should be made with the main tuning condenser all the way out, or at its minimum capacity and whenever adjusting a padding condenser it should be tuned with the main tuning condenser all the way in. The common place in a Radio Frequency circuit where a padding condenser is used is in the Oscillator circuit of the superheterodyne receiver. In all other cases, almost universally, trimmers are used and condenser should be aligned at minimum capacity. It should be pointed out that the above notes on trimmer and padding condensers do not apply to trimmer condensers in intermediate frequency transformers as these are not paralleled by other tuning condensers.

14. PRINCIPLE OF OPERATION.

In order to obtain the maximum possible service from the model 17 and 18 signal generators it is well to understand the fundamental principle of its operation. Referring to Fig. 9 it will be noted that the five output selections which are available in these signal generators are obtained by the use of four tubes. A type 1V rectifier tube is used for rectifying the alternating current and supplying D.C. to the other circuits.

15. MAIN OSCILLATOR:

The main variable oscillator is a type 6J7 tube which has continuously variable radio frequency range from 100 KC to 30 megacycles. This tube is so arranged that its output may be supplied to the attenuator directly when it is being used as a pure radio frequency oscillator from 100 KC to 30 megacycles or when it is used

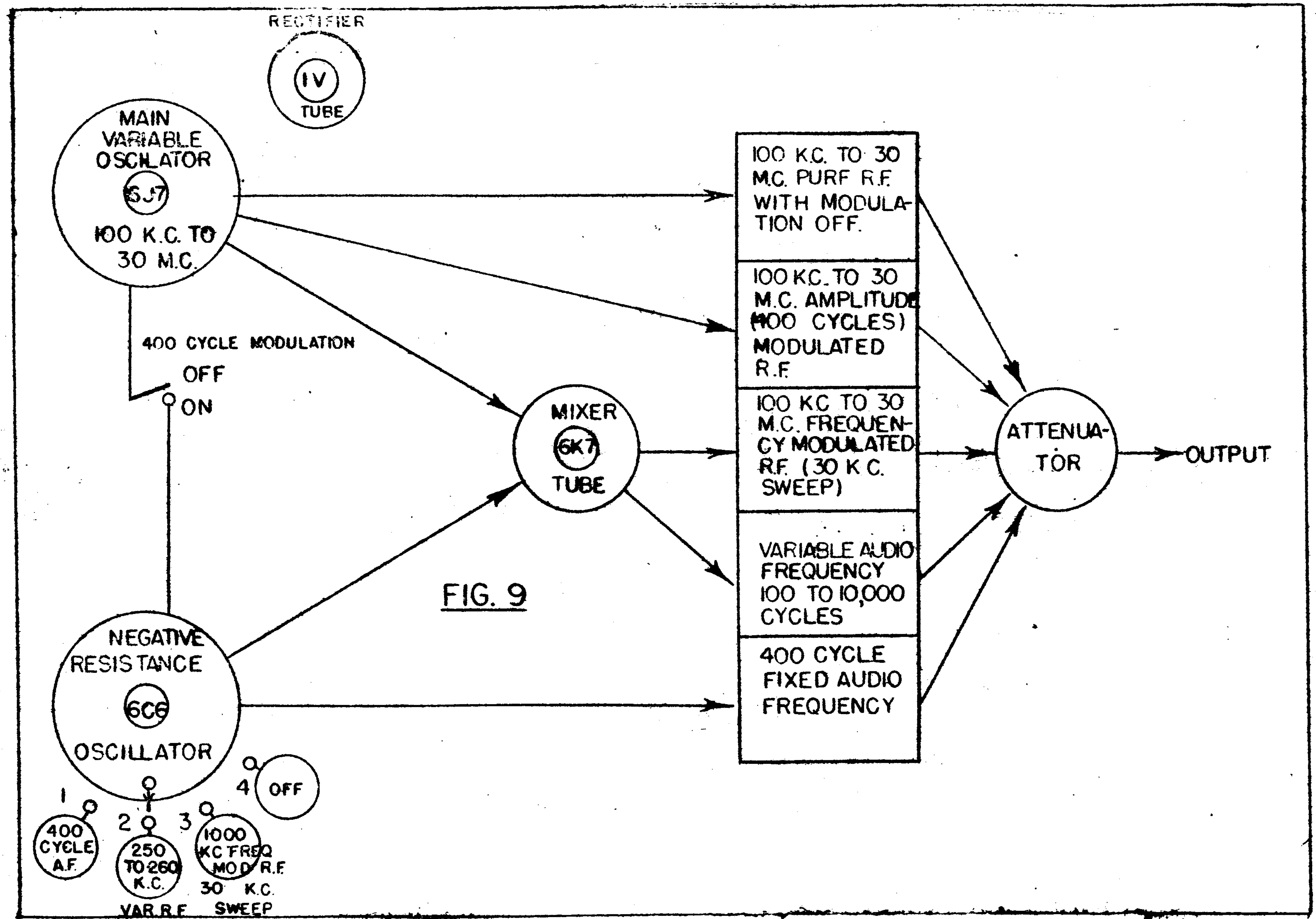

RECTIFIER
IV
TUBE
MAIN VARIABLE OSCILATOR
6SJ7
100 K.C. TO 30 M.C.
400 CYCLE MODULATION
OFF
ON
MIXER
6K7
TUBE
NEGATIVE RESISTANCE
6C6
OSCILLATOR
1
400 CYCLE A.F.
2
250 TO 260 K.C.
VAR. R.F.
3
1000 KC FREQ MOD R.F. 30 K.C. SWEEP
4
OFF
100 K.C. TO 30 M.C. PURF R.F. WITH MODULATION OFF.
100 K.C. TO 30 M.C. AMPLITUDE (400 CYCLES) MODULATED R.F.
100 K.C. TO 30 M.C. FREQUENCY MODULATED R.F. (30 K.C. SWEEP)
VARIABLE AUDIO FREQUENCY 100 TO 10,000 CYCLES
400 CYCLE FIXED AUDIO FREQUENCY
ATTENUATOR
OUTPUT

FIG. 9

as an amplitude modulated oscillator covering the same range. The R.F. output of this tube is also fed into the mixer tube, type 6K7, to obtain the frequency modulated output or the variable audio frequency output from 100 to 10,000 cycles.

16. NEGATIVE RESISTANCE OSCILLATOR:

A type 6C6 tube is used as a negative resistance oscillator, interchangeably as a 400 cycle audio frequency oscillator, as a 250 to 260 KC variable radio frequency oscillator, as a 1000 KC frequency modulated radio frequency oscillator with 30 KC sweep or in the fourth position of the selector switch this negative resistance oscillator is disconnected. When used as a 400 cycle audio frequency oscillator it may be used to amplitude modulate the main variable oscillator, type 6J7, or can be fed directly to the output attenuator network to provide a 400 cycle fixed audio frequency output. When used as a variable radio frequency oscillator operating from 250 to 260 KC the output from this oscillator is heterodyned against the output from the main variable oscillator and the two outputs mixed in the type 6K7 tube to produce a variable audio frequency output from 100 to 10,000 cycles. When being used this way the main oscillator is tuned to approximately 250 KC and the negative resistance oscillator varied from 250 at which the output frequency would be zero to 260 KC at which the output frequency would be the difference between the two, or 10,000 cycles.

17. When the negative resistance oscillator is used as a 1000 KC frequency modulated radio frequency oscillator with 30 KC sweep its output is mixed in the type 6K7 tube against the variable oscillator to produce any frequency modulated output within the limits of the main variable oscillator, or in other words from 100 KC to 30 megacycles. In this connection it might be noted that the main variable oscillator must be set to 1000 KC above or below the desired frequency in order to have a frequency modulated output as required. For example, if alignment at 175 KC frequency modulated output were desired the negative resistance oscillator would be turned to the frequency modulated position and the main variable oscillator adjusted to 1175 KC on the main tuning dial which would result in an output of 175 KC frequency modulated.

18. All of these outputs are fed to the attenuator network so that they can be controlled from zero to the limits of their output voltage.

19. Since it is essential that the operator thoroughly understands the difference between frequency modulated and amplitude modulated output, Fig. 13 & 15 are used by way of explanation of these two principles.

20. FREQUENCY MODULATION:

Referring to Fig. 13 which illustrates frequency modulation it will be noted that the Triode T1 is used as a conventional oscillator of the plate feed-back type. The plate supply voltage E1 is held constant at 100 volts. The frequency of this oscillation is determined by the constants of L1 which is the inductance in the grid circuit and the variable condenser C1 which is connected across L1. Since frequency of the tuning circuit is inversely proportional to the inductance L1 and the capacity C1, it will be obvious that if either the inductance or the capacity were increased the frequency would decrease. Since the inductance L1 is fixed the frequency output is therefore determined by the value of the variable condenser C1 which is connected across this inductance.

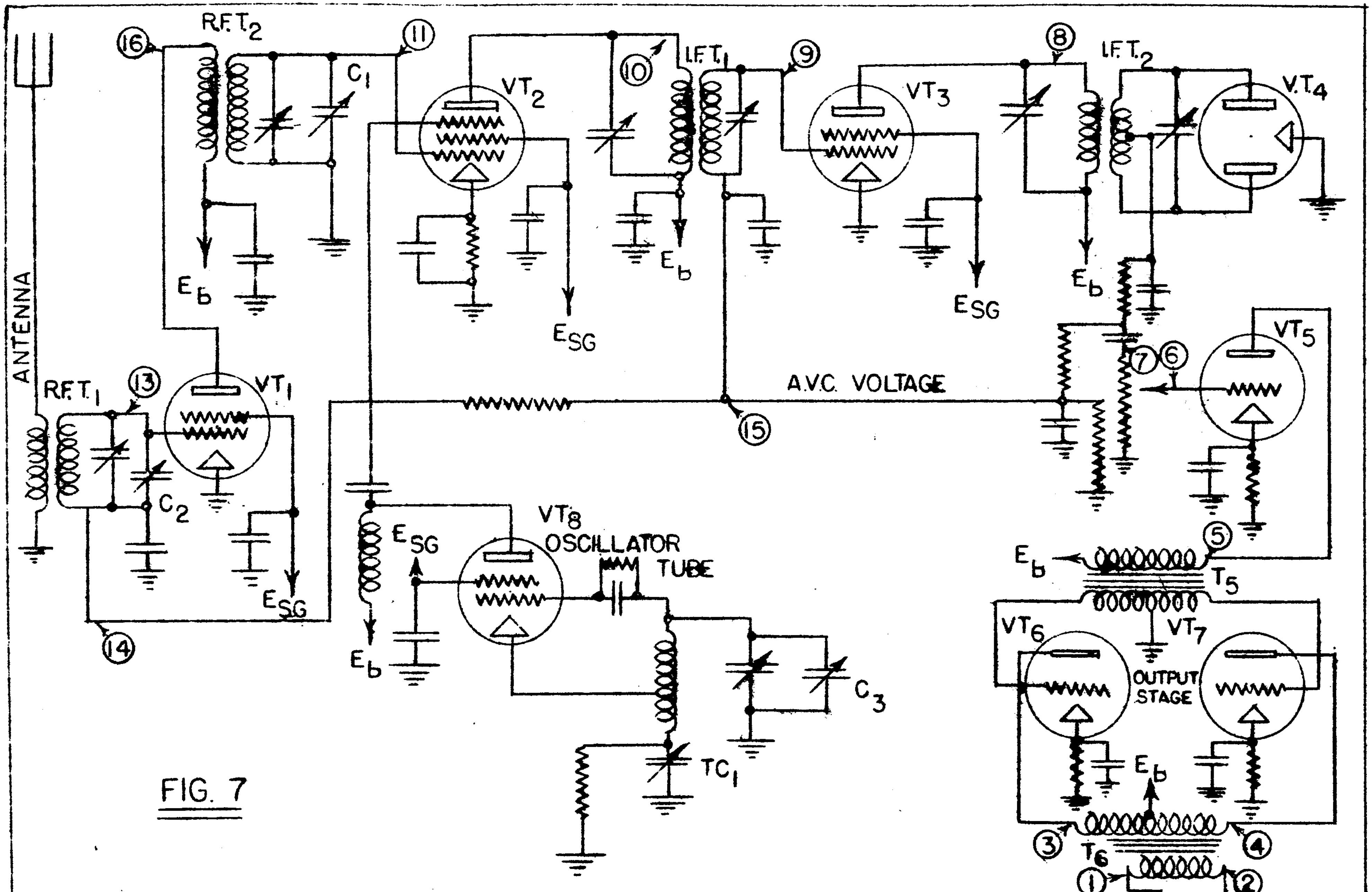


FIG. 7

BASIC SUPERHETRODYNE RECEIVER CIRCUIT

21. Assume that when variable condenser C1 is 1/2 in mesh, or when the capacity is 1/2 of its maximum capacity that the constants of L1 and C1 are such that the frequency of the oscillating circuit is established at 1000 KC, we then have a starting point. Position 1 of the frequency modulation illustration. If we illustrate the sine wave output voltage from the oscillator directly above the condenser C1 in position 1 we will note that the sine wave has a certain amount of spread which represents a frequency of 1000 KC. In position 2, in which the condenser has been rotated until it has a minimum of capacity, it will be noted that the sine waves are very much closer together indicating a higher frequency which in this case is 1015 KC. As the condenser rotates on to position 3 where it is again one-half in mesh the frequency has decreased again to 1000 KC. In position 4 the condenser is entirely in mesh decreasing the frequency to 985 KC and resulting in the sine waves being spread out considerably more than they were in any of the previous positions. As the condenser rotates on to position 5 the frequency would again be 1000 KC and the sine waves again contract to the same width that they were in position 1, or at the starting. In this connection, it is well to note that the amplitude of the oscillations are constant regardless of frequency and therefore we have what is known as constant amplitude output with the frequency modulated or changing frequency.

22. The method of obtaining frequency modulation by means of a rotating condenser has for some time been discarded in favor of an electronic method of accomplishing the same results. In a model 17 and 18, frequency modulation is accomplished by varying the voltage applied to the suppressor grid of the type 6C6 tube which is used as negative resistance oscillator. The voltage appearing on the suppressor grid causes the frequency of the oscillating circuit to increase or decrease in accordance with the applied voltage. This system is considerably more stable than the mechanical means of obtaining frequency modulation and is inherently more trouble free than the older method. This system also has the advantage that the voltage which is being used to provide frequency modulation is taken directly from the 60 cycle supply line therefore making it possible to use this same voltage from the supply line to sweep the horizontal plates on the oscillograph, this automatically locks the response curve in the center of the screen and eliminates the necessity of using sweep circuit oscillator for the horizontal deflection.

23. If such a signal were fed into the antenna post of a receiver which was tuned for 1000 KC and the voltage developed at the second detector analyzed by an oscillograph we would see on the oscillograph screen a curve similar to Fig. 14 which illustrates the response of a receiver to signals varying from 985 KC or 15 KC below the frequency for which the receiver was tuned up to the frequency at which the receiver is tuned and on to 15 KC above this value. It is this type of signal, that is,frequency modulated signal, which is used for the visual alignment and trouble shooting of receivers.

24. AMPLITUDE MODULATION:

Fig. 15 illustrates what is known as amplitude modulation in which the amplitude of the output voltage varies while the frequency is remaining constant. In this case we assume the same triode T1 connected as an oscillator similar to that illustrated in Fig. 13 with the exception that the capacity C1 which is across the inductance L1 instead of being variable is fixed, thereby establishing the frequency of oscillation of this circuit to a given value. In this case, however, the plate voltage E1 is connected into opposite sides of a potentiometer P1 in which the rotating arm can travel 360 degrees. Actually, this system of modulation is never used commercially but serves only as an illustration of a principle. If we assume that the rotating pointer R at the beginning of the test is at position A, or so that the full 100 volts of battery is being supplied to the oscillator tube, then the amplitude of the output frequency will be at a maximum as illustrated in position A of the curve. As this potentiometer arm rotates to position B, at which the voltage applied to the plate is only 75 volts, the amplitude of the output frequency will decrease, as indicated in the curve, and so on until the potentiometer arm has reached point E at which the voltage applied to the plate will be zero, therefore, the amplitude or output voltage from the oscillator will then also be zero. As the arm progresses around positions F, G and H, the voltage increases from 25 to 50 and 75 volts gradually increasing the amplitude of the output voltage until this voltage has reached 100 where again the amplitude is at a maximum.

25. PERCENT MODULATION:

In the case illustrated, the percent modulation is 100%, that is, at the minimum swing of output the output voltage has dropped to zero. The formula for percent modulation is given as percent modulation is equal to "E" maximum minus "E" minimum divided by "E" maximum plus "E" minimum and the equation times 100. In this particular case we assume "E" maximum to be 100 volts and "E" minimum to be zero volts, and in accordance with the equation outlined the resultant percent modulation will be 100%. Actually in practice in commercial signal generators this percent modulation is held to approximately 30% as illustrated in the dotted line superimposed on the curve illustrating 100%.

26. If an oscillograph is connected at the second detector of a receiver under test and an amplitude modulated signal applied to the antenna and ground post with the receiver tuned to the proper frequency the curve appearing on the oscillograph screen should be as illustrated in Fig. 16. In other words, a perfect reproduction of the modulating voltage. In actual practice the method of obtaining modulation of an RF carrier, of course, is not accomplished as illustrated in Fig. 15. In this case it is accomplished by supplying the voltage to the plate of the R.F. oscillator tube through a transformer winding which is connected to an oscillating circuit operating at 400 cycles. In this case the voltage being delivered to the R.F. oscillator tube alternately decreases and increases at the rated frequency of the modulating oscillator, which causes the amplitude modulation.

27. CONNECTIONS OF THE SIGNAL GENERATOR TO THE RECEIVER:

Referring to Fig. 7 which is the basic circuit employed in modern superheterodyne receivers and Fig. 8 which shows the panel lay-out and connections to model 18 signal generator. Common procedure for locating trouble and aligning super heterodyne receivers, when using a signal generator and output meter, is to start at the end of the audio frequency channel at the speaker and work towards the antenna post.

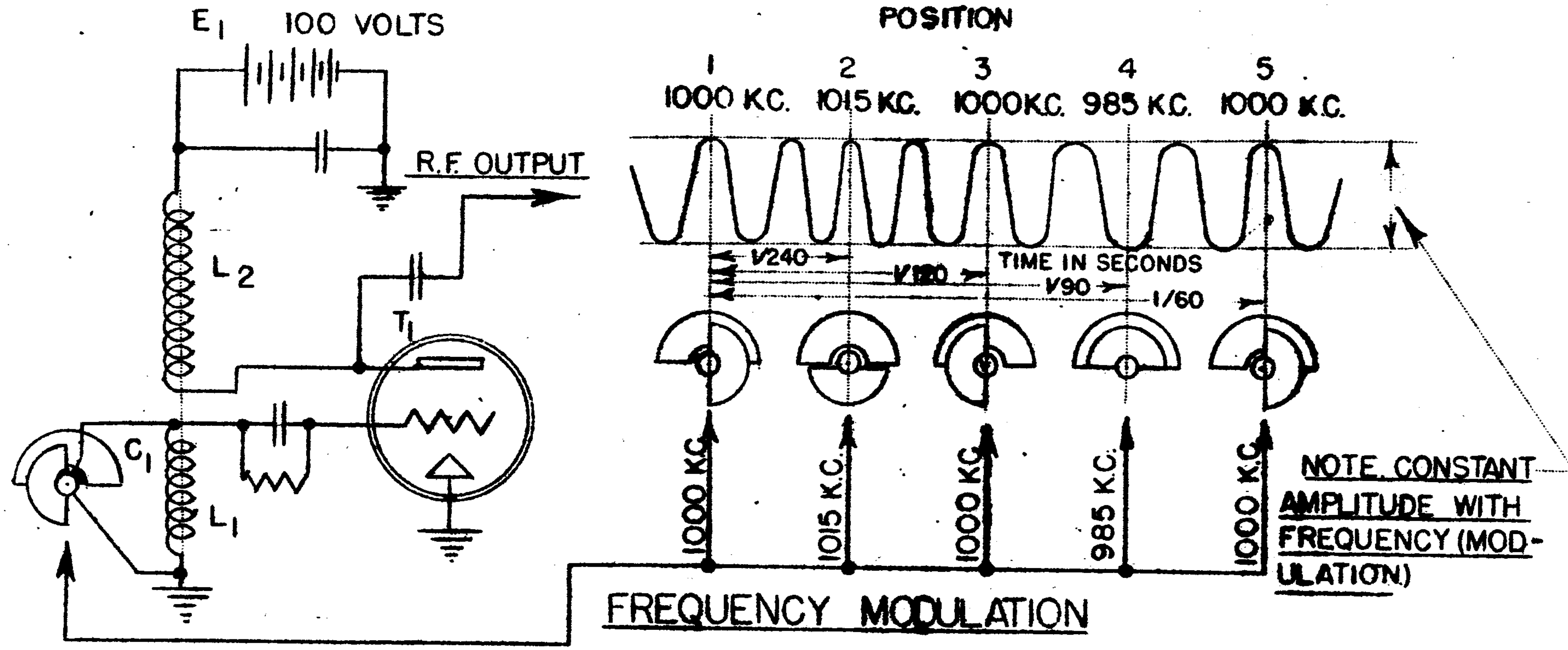
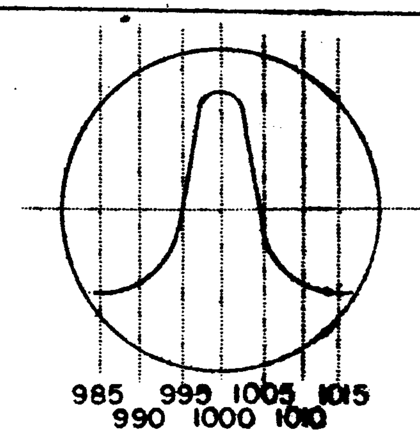
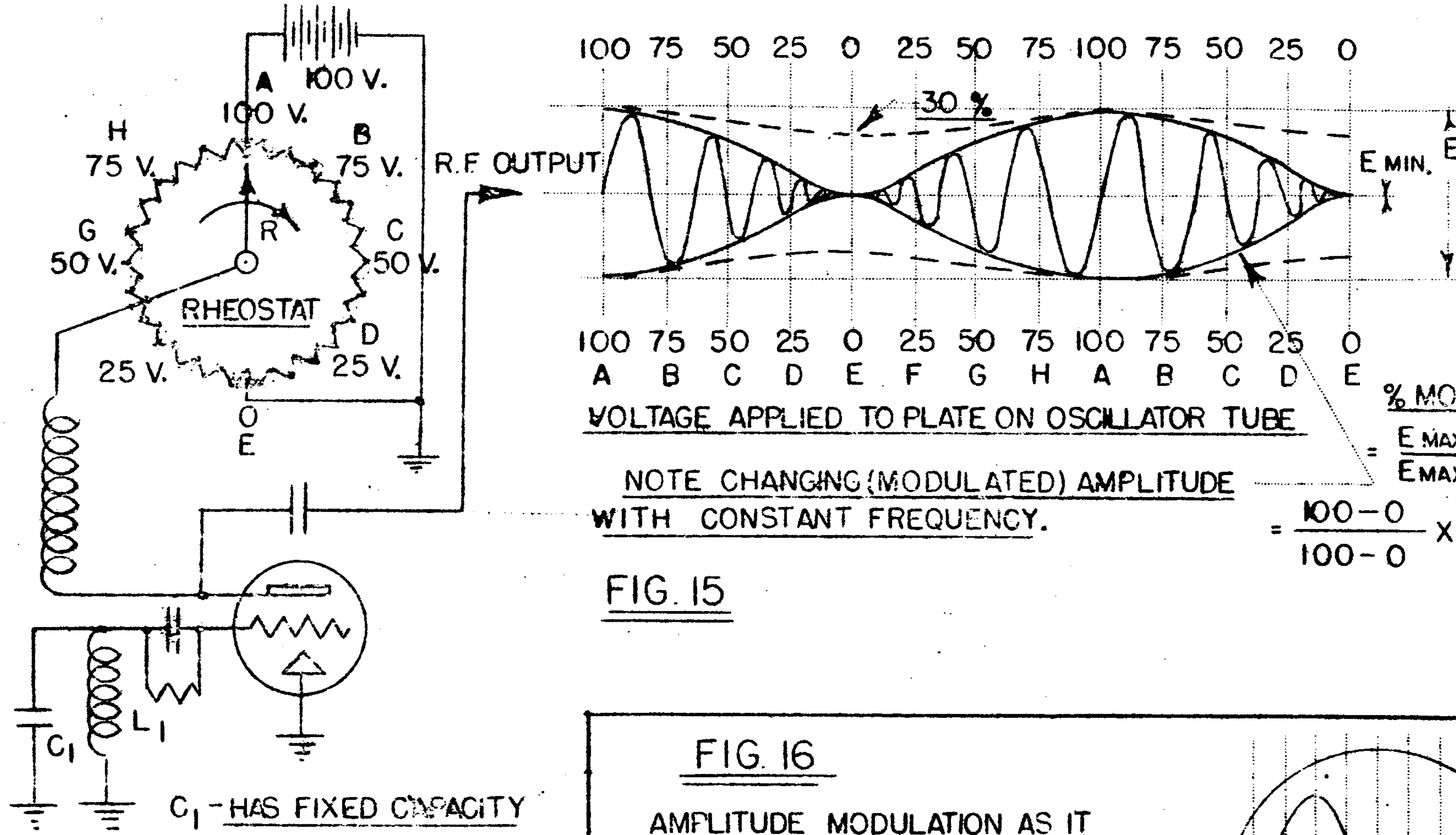


FIG. 13

FIG. 14



DEMODULATED OUTPUT AS IT APPEARS ON OSCILLOGRAPH AT THE SECOND DETECTOR OF RECEIVER.



% MODULATION

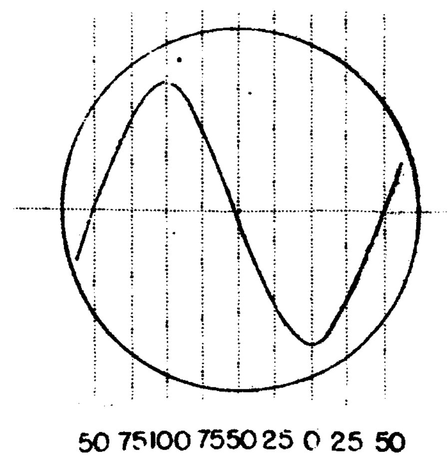
$$= \frac{E_{MAX.} - E_{MIN.}}{E_{MAX.} - E_{MIN.}} \times 100$$

$$= \frac{100-0}{100-0} \times 100 = 100\%$$

FIG. 15

FIG. 16

AMPLITUDE MODULATION AS IT APPEARS ON OSCILLOGRAPH AT SECOND DETECTOR OF RECIEVER



1. TESTING THE OUTPUT TRANSFORMER T6:

Connect the ground from the signal generator to the ground or chassis of the receiver under test. Connect the output connector through a blocking condenser of approximately 1/2 microfarad to point 3 of output transformer T6. Connect low output connector B3 to one side of voice coil winding on transformer at point 1. Connect high output lead B2 to point 2 on output transformer. Turn range selector on decibel meter to high range, that is, +22 to +38 decibels. Turn band selector to "OFF" position, line switch "ON", multipliers to 400 cycles A.F., output control advanced to maximum. Selector switch to 400 cycle modulation. With this connection a 400 cycle audio frequency signal is being fed in through 1/2 of the primary of transformer T6 and if this half of the transformer is operating properly the voltage appearing on the secondary of voice coil winding should indicate on the decibel meter. It is quite probable that the meter selector switch will have to be turned down to the lowest or -10 to +6 D.B. range due to the low impedance of voice coils being used in modern receivers. To check the other side of primary of T6 the only change in the connection would be to connect the output from the blocking condenser at point 4 rather than point 3 and this will give a check on the other half of the primary of this transformer.

29. CHECKING THE OUTPUT TUBES:

Connections as previously outlined with the exception of the output connection. Disconnect this from the primary of the transformer T6 and remove the blocking condenser from the output lead, then connect the output lead directly to the grid of audio output tube VT6. A noticeable increase in the output meter should be obtained due to the amplifying action of VT6. Disconnect the output lead from VT6 and connect to the grid of VT7. This should give the same output indication on the decibel meter but in this case the amplifying action of VT7 is being checked in place of VT6.

30. CHECKING THE INPUT TRANSFORMER T5:

Again leave all connections as previously outlined with the exception of the output connection and in this case connect the 1/2 microfarad blocking condenser in series with the output lead. The output of the condeuser connection should then go to the high side of the input transformer labelled T5. Again an increase in the output meter reading should be obtained due to the step-up ratio of transformer T5. This gives a check on the operation of the transformer.

31. CHECKING THE FIRST AUDIO FREQUENCY STAGE:

All of the connections as previously outlined, but with the exception that the output control should be connected either to the grid of VT5, as indicated by position 6, or at the high end of the audio volume control P1, as indicated in position 7. In the case where connection is made to point 6 of the grid of the first audio amplifier tube a noted increase should be obtained in the decibel meter due to the amplyfying action of VT5. If the connection is made at point 7 at the high end of the volume control the same amplification should be apparent if the volume control is advanced to a maximum position whereas if the control is retarded towards the ground end or towards the low output position the signal should gradually be reduced as indicated by the output meter.

32. The foregoing procedure illustrates the method of checking the audio frequency section of a receiver when using a fixed frequency of 400 cycles. This is generally suitable for ordinary checking, however, cases may come up where the output of the receiver sounds distorted or fuzzy which could be caused by frequency discrimination in the amplifying stages or a defective speaker.

33. VARIABLE AUDIO FREQUENCY OUTPUT:

When it is necessary to check the audio frequency response from a low frequency of approximately 100 cycles up to 8000 or 9000 cycles, this can be done by merely re-arranging the controls on the signal generator to give a variable audio frequency output.

34. Turn the frequency band selector switch to the "A" position. Multiplier to 0-10 KC audio frequency. Output control advanced to a maximum. Selector switch to the 0-10 KC AF position. Audio frequency calibrated dial to the zero position. Leave the output connection connected to either point 6 or point 7 and adjust the main tuning dial on the receiver to approximately 240 to 250 KC on the "A" band. At some frequency in this range it will be found that the audio frequency output reaches a zero beat. That is, a position at which tuning the dial either side will cause an increase in audio frequency. The signal generator is then properly set up to produce a calibrated variable audio frequency in accordance with the 0-10 KC dial in the lower right hand corner of the signal generator. By varying this dial between 100 and 10,000 cycles some point will probably be found where considerable distortion appears in the speaker output, or, perhaps where there is a decided peak or falling off in the set at this point where the difficulty occurs and look for trouble in the transformers, by-pass condensers, resistors, etc.

35. I.F. - R.F. ALIGNMENT (AMPLITUDE MODULATED SIGNAL)

After having completely checked over the audio system and having put it in normal operating condition it is then advisable to proceed back to the intermediate and radio frequency stages and properly align these stages. One is to use the amplitude modulated radio frequency and the other is to use frequency modulated output. In the case amplitude modulated radio frequency is to be used the output meter may be left connected across the secondary winding of T6 or in lieu of this connector B5 may be removed from one side of the secondary winding and connected to the ground or chassis of the receiver under test and plate connector clip B2 may be inserted over the plate pin of one of the output tubes, VT6 or VT7. In this case be sure and start with the decibel meter range switch on the high position +22 to +38 decibels. The proper setting on the signal generator to produce amplitude modulated audio frequency output is as follows: Assume the intermediate frequency of the receiver under test to be 175 KC, set the band selector switch to the "A" position, adjust the frequency control to 175 KC as indicated on the calibrated dial, set the multiplier to the RF X100 position, advance the output control to a maximum. Set the selector switch to 400 cycle modulation position. The setting of the audio frequency dial is not necessary in this connection.

36. Connect the output of the signal generator to a blocking condenser of approximately 1/2 microfarad or less to point 8 on the high end of the second intermediate frequency transformer IFT2. If this transformer is operating properly and the second detector VT4 and associated circuits are operating properly an audible signal of 400 cycles should be heard in the speaker and the decibel meter should indicate that voltage was being delivered to the plates of one of the audio frequency tubes into which the meter was connected. It is not well to attempt to make an alignment of IF transformer T2 with the output connected

into this transformer as the loading of the output circuit of the signal generator will tend to disturb the proper alignment of this transformer, however, this connection will give an indication as to whether or not this transformer and associated circuits between this transformer and output tubes are operating.

37. To align IF transformer IFT2 and check VT3 which is the first intermediate frequency amplifier tube, the output connetion should be removed from position 8 and reconnected at the grid of VT3 as indicated by position 9. Then alignment of IFT2 may be effected for maximum reading of the output meter.

38. The first IF transformer as indicated by IFT1 could readily be checked by removing the output connection from position 9 and connecting it into position 10 through a blocking condenser, however, again it would be impractical to attempt to align this transformer with this connection due to the loading of the signal generator on this transformer, therefore, proper alignment of this transformer should be effected by connecting the output of the signal generator to point 11 which is the grid of the first detector tube and then adjusting the trimmers on the first intermediate frequency transformer for maximum indication of the output meter.

39. CHECKING THE OSCILLATOR SECTION OF THE RECEIVER:

The tests made so far have indicated that the intermediate frequency and audio frequency sections have been operating normally. The next step is to check the oscillator section of the receiver to determine whether or not this is operating across the entire band. The procedure in this case would be to leave the output of the signal generator connected to point 11 which is the first detector grid and tune the receiver dial to the low end of a frequency range for example at 550 KC on the broadcast band. If the signal generator frequency is then adjusted to 550 KC the local oscillator in the receiver should then be operating at the intermediate frequency of 175 KC above the frequency at which the main tuning dial is tuned, or at 725 KC. If, with this connection the signal is obtained at the speaker or in the output meter it will be an indication that the oscillator section is operating properly at the low end of the dial. The same check should be again made at the center of the dial at approximately 1000 KC readjusting the oscillator to correspond to the reading on the receiver dial and again at the high end or 1500 KC.

39. ALIGNMENT OF THE RADIO FREQUENCY SECTION:

In order to align the radio frequency section it is advisable to consult the manufacturers specifications on the particular receiver under test and determine at which frequency the radio frequency section should be aligned. In most cases the alignment of the trimmer condensers is made at 1500 or 1600 KC on the broadcast band and the alignment of the tracking condenser approximately

550 or 600 KC. A check on the RF transformer RFT2 could be made by tuning the main dial on the receiver to approximately 1500 KC and by adjusting the output from this signal generator to this same frequency, connect its output to a blocking condenser at point 16 or the high end of the primary of the second radio frequency transformer. Alignment, however, should not be effected with this connection as the loading of the signal generator might result in improper alignment at this frequency. The alignment of this section should be made with the output of the signal generator connected at the antenna post of the receiver or at point 13 which is the grid of the first radio frequency tube. The proper alignment procedure with the signal generator connected at the antenna post would be to adjust RF trimmer C1, C2 and oscillator trimmer C3 for maximum response in the output meter. Then, retune the receiver to the low end of the dial at 550 or 600 KC and after readjusting the signal generator to correspond to this frequency, adjust tracking condenser TC1 for maximum output response. Sometimes it is advisable to rock the tuning section back and forth when making an alignment of TC1. Follow manufacturers recommendations in this regard.

41. USE OF FREQUENCY MODULATION FOR RF AND IF ALIGNMENT:

The use of frequency modulation necessitates the use of cathode ray oscillograph as an output and resonance indicator. If the oscillograph being used does not contain a demodulator it must be connected at the second detector load. If the oscillograph has a demodulator it will be connected any place from the antenna post on to the second detector load resistance.

42. NEVER USE AN OUTPUT METER FOR ALIGNMENT WHEN USING FREQUENCY MODULATED SIGNAL.

43. It is recommended that frequency modulation not be used above the broadcast band for the reason that little is to be gained by the alignment of the trimmers on the short wave band above a gain in amplitude which is readily indicated by a conventional output meter.

44. PERCENT ERROR IN FREQUENCY MODULATED OUTPUT:

It is also well to note that the possibility of error in frequency output when using frequency modulation is considerably greater than the error when using straight amplitude modulated or single signal output. The reason for this being, first that there is accummulated error as a result of the error in the main RF oscillator added to the error of the fixed or frequency modulated oscillator. Secondly, that a 1/2% error in the main oscillator might easily lead to a 3% or 4% error when using frequency modulation. A good example of this would be to assume that there was a 1/2% error in the main oscillator at 1100 KC. This 1/2% error would result in an error of 5.5 KC.. If we were using the signal generator for frequency modulated output at, for example, 100 KC the main oscillator would be set to 1100 KC to heterodyne against the fixed frequency modulated oscillator to produce a 100 KC frequency modulated output. This error of 5.5 KC which was evident at 1100 KC would show up not as a 1/2% error but as an error of 5.5 KC in 100, or a 5.5% error. It is advisable, therefore, to take this fact into consideration when making alignment using frequency modulated output at the lower frequencies. In case a question does come up as to whether or not the frequency modulated output is correct it would be well to use the standard amplitude modulated output at the lower frequencies to check the circuit under test for possible frequency error.

CONNECTIONS FOR VISUAL ALIGNMENT

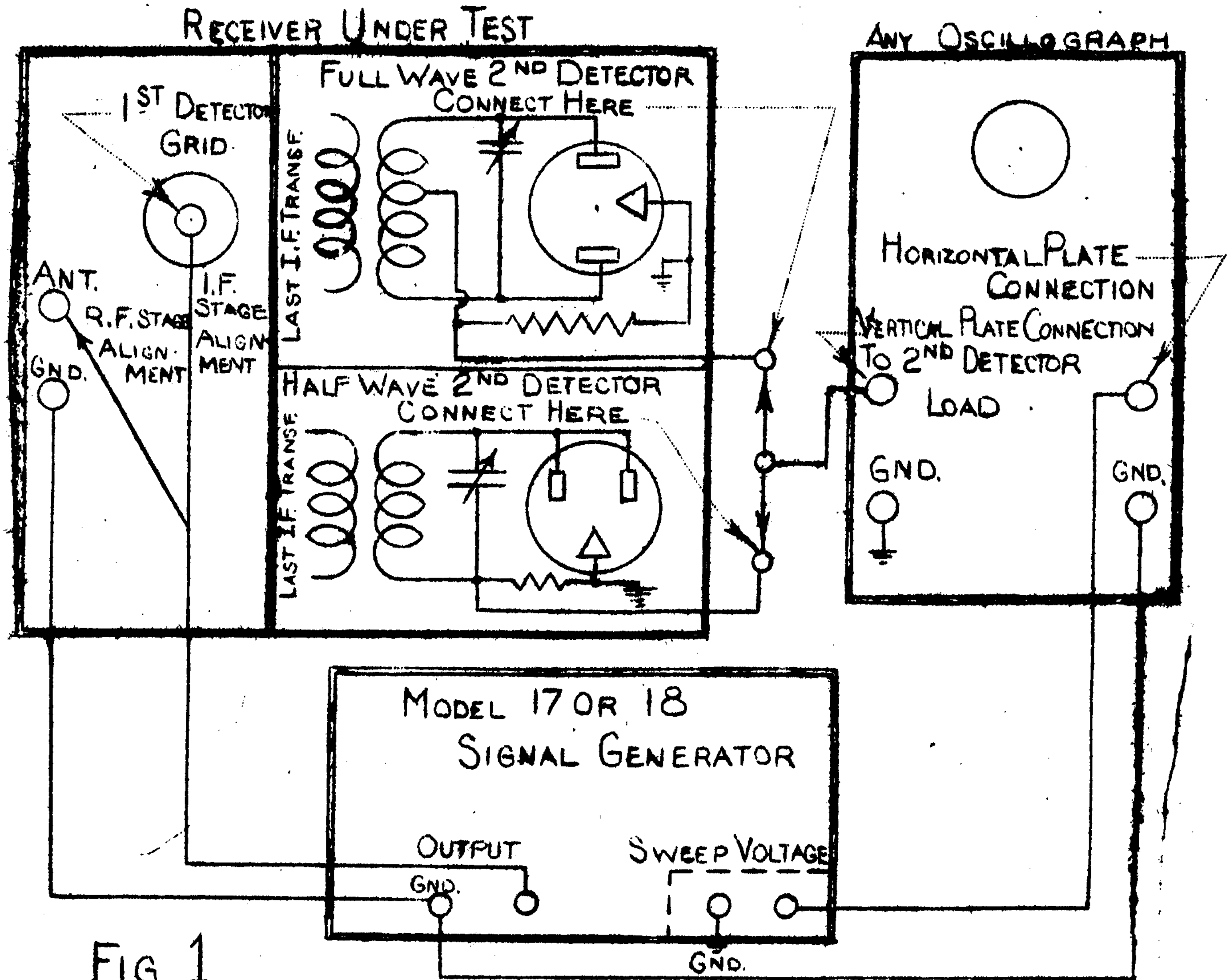


FIG 1

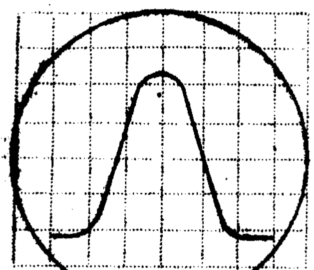


FIG 2 PROPERLY ALIGNED AND TUNED

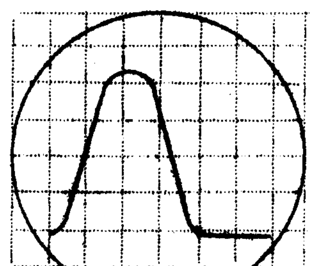


FIG 3 PROPERLY ALIGNED TUNED BELOW PROPER FREQ.

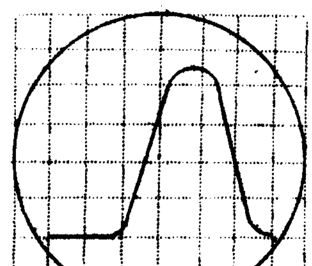


FIG. 4 PROPERLY ALIGNED TUNED ABOVE PROPER FREQ.

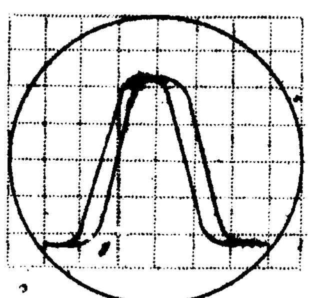


FIG. 4 PHASE DISTORTION

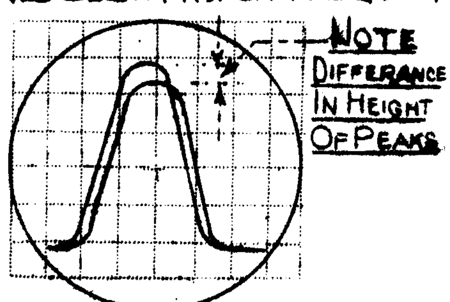


FIG. 5 - HUM DUE TO IMPROPER FILTERING

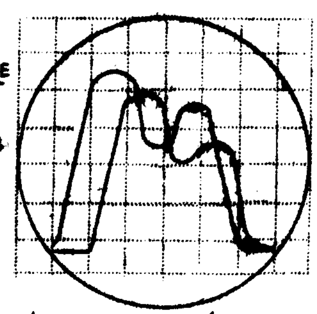


FIG. 6 - IMPROPER ALIGNMENT AND REGENERATION

45.
CONNECTION OF THE SIGNAL GENERATOR TO THE RECEIVER FOR FREQUENCY MODULATED ALIGNMENT.

Fig. 1 illustrates the proper connections from model 17 or 18 signal generator to any oscillograph and receiver under test.

46. First ground the signal generator to the chassis or ground of the receiver and also to the ground of the oscillograph being used.

47. The connections for the sweep circuit voltage should be made from the right hand binding post to the horizontal plate connection of the oscillograph being used. The other side of the sweep circuit voltage is grounded and consequently circuit will be obtained from this to the oscillograph through the regular ground. The switch for the horizontal plate connection of the oscillograph should be turned to the external position and the horizontal gain control adjusted until the horizontal sweep is approximately 2/3 screen width. The connection from the signal generator to the receiver under test should be ground-to-ground as previously mentioned, and the R.F. output connection to the antenna post if alignment of radio frequency stage is desired, or to the first detector grid in the case of alignment of intermediate frequency stages only.

48. The connections from the receiver under test to the vertical plates of the oscillograph are illustrated under two headings. First, full wave second detector and second, the half-wave second detector. The proper connection to the vertical plate is always at the high end of the load resistor on the second detector and in the case of full wave detection this will be found at the center tap of the last intermediate frequency transformer whereas in the case of half wave detection it will be found at the low end of the last intermediate frequency transformer.

49. ADJUSTMENT OF SIGNAL GENERATOR TO PRODUCE FREQUENCY MODULATED OUTPUT.

The proper setting of either model 17 or 18 signal generator to produce frequency modulated output is as follows: Multiplier switch to RF X1, 10 or 100 as desired, output control advanced to give suitable output, selector switch on frequency modulation position. The frequency set on the main tuning dial should be 1000 KC above or below the desired frequency. For example, if 175 KC frequency modulated output is required it would be necessary to set the frequency band selector switch on the "C" band and adjust the frequency control to 1175 KC. The other alternative would be to set the main tuning dial at 175 KC below 1000 KC which in this case would be 825 KC.

50. With the connections as previously outlined and the receiver properly tuned and aligned the response curve should appear on the oscillograph screen as illustrated in Fig. 2. That is, with symmetrical sides consistent with maximum amplitude and the two traces, that is, the forward and reverse trace completely coinciding. If the receiver is tuned to a lower frequency both curves should shift together to the left side of the screen, (fig. 2), and as the receiver is tuned to a higher frequency both curves should shift together to the right hand side of the screen, (Fig. 5).

It is quite possible to use the linear internal sweep on the oscillograph in lieu of the sweep circuit voltage as supplied by the model 17 or 18 signal generator. However, in this case it is generally necessary to set several extra controls before alignment can proceed. The controls are the horizontal gain control; the sweep circuit oscillator step control; the sweep circuit oscillator vernier control; the synchronization switch and the horizontal locking control. By the use of the suggested circuit in which the sweep circuit voltage is supplied from a signal generator all of these controls may be eliminated with the exception of the horizontal gain control thereby greatly simplifying the connection. The actual response curve as viewed on the screen when using the internal sweep circuit oscillator, however, would be similar to those illustrated with the exception that the return trace should be eliminated and only the forward trace appearing on the screen.

51. ALIGNMENT OF RF STAGES:

Disconnect the output from the signal generator from the first detector grid and connect to the antenna of the receiver under test.

52. The output frequency of the signal generator should be changed to correspond to manufacturers specifications on radio frequency alignment and the trimmers on the RF and oscillator sections should be adjusted to give the maximum amplitude consistent with symmetrical sides on the response curve.

53. As the oscillator trimmer T3 is adjusted it will probably be noticed that the response curve will travel horizontally back and forth across the screen. Proper adjustment in this case would be to have the curve exactly centered in the screen when the dial setting on the receiver corresponded to the correct output frequency from the signal generator.

54. LOCATING TROUBLE WITH FREQUENCY MODULATED SIGNAL AND OSCILLOGRAPH:

MISALIGNMENT: When connecting up the oscillograph to a receiver it may be found in some cases that two humps or peaks appear in the response curve similar to Fig. 6 rather than a single symmetrical curve as in Fig. 2. This would probably be caused by a misalignment of one of the intermediate frequency stages and the alignment of these stages should be checked and adjusted in an attempt to clear this condition up.

55. SHORTED TURN: If realignment will not correct this double peak as illustrated in Fig. 6 it is possible that there is a shorted turn in one of the intermediate frequency transformers. The effects of this shorted turn would be to decrease the inductance of the coil thereby increasing its resonance frequency considerably above the proper value. In this case, of course, the remedy is to replace the defective transformer or correct the defective condition.

56. REGENERATION: In some cases where there is excess regeneration there will be a tendency for a double peak or hump similar to that illustrated in Fig. 6. This is usually traceable to defective or open by-pass condensers especially on the screen circuit.

57. OSCILLATION: If regeneration is excessive it is quite possible that oscillation might occur. This is illustrated in Fig. 10. Corrective measures would be similar to those used for correcting regeneration.

58. PHASE DISTORTION: It is quite probable in the alignment of most receivers a certain amount of opening up of the two traces as illustrated in Fig. 4 will be present. A normal amount of this phase distortion should not be considered detrimental to the proper operation of the receiver, however, if the opening up of these traces gets as much as 1/4 or 3/8 of an inch it would be well to check the coupling capacitors and by-pass condensers for possibilities of open.

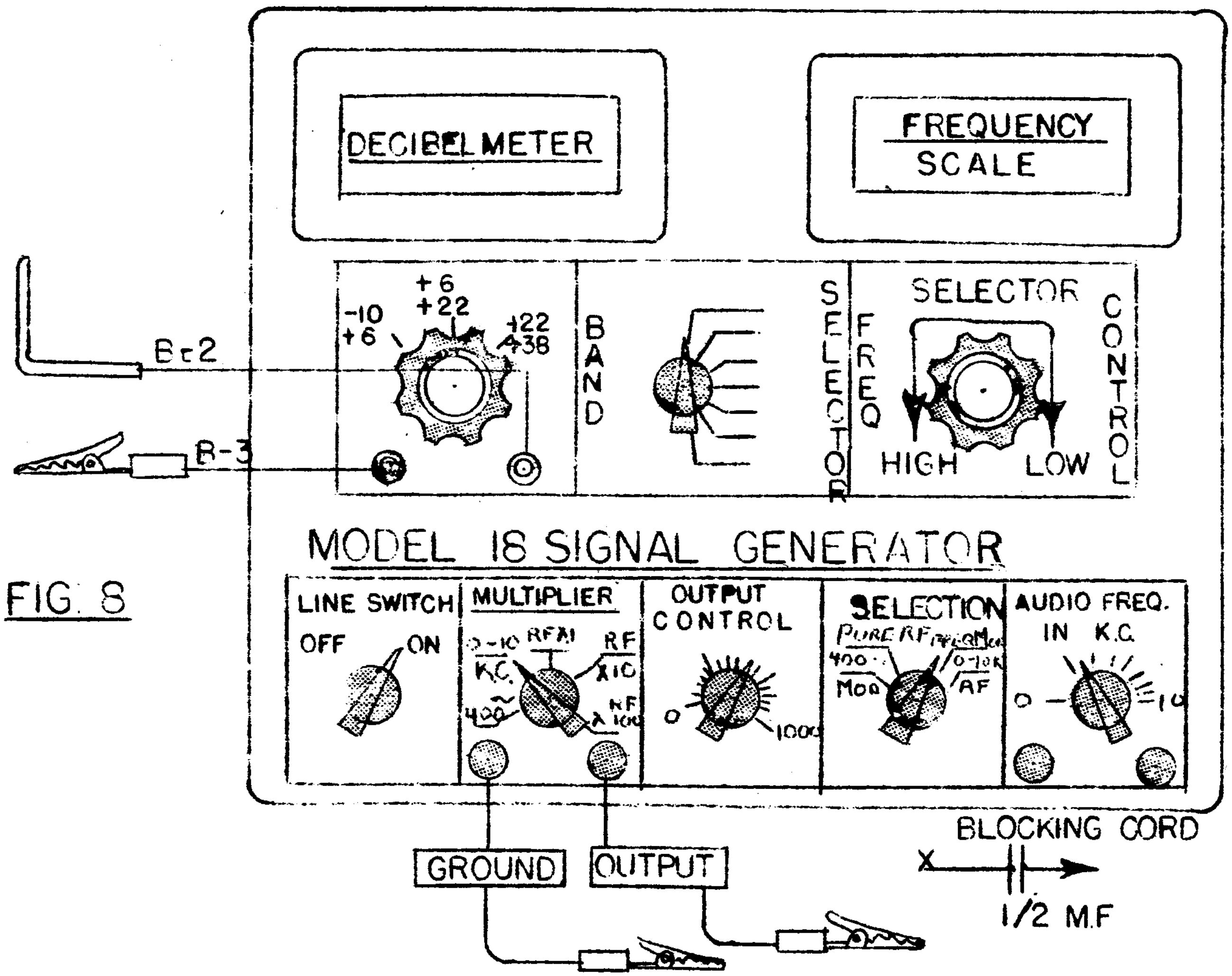


FIG. 8

FIG. 10

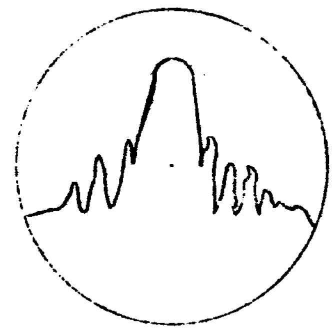


FIG. 11

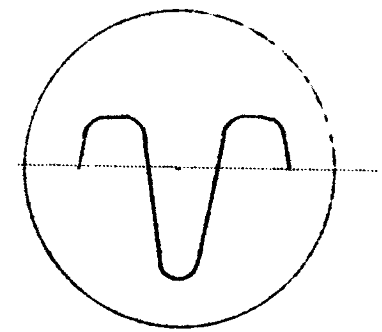
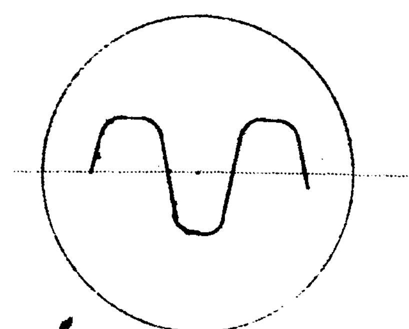


FIG. 12



59. HUM: If in aligning receivers a difference in the heighth of the two curves is noted as illustrated in Fig. 5 this will undoubtedly be caused by defective filtering in the power supply of the receiver and the correction in this case would be to replace filter condensers or chokes in order to eliminate this hum.

60. AUDIO DISTORTION: If the signal generator were used as an audio frequency oscillator and fed through one of the audio frequency stages and a curve similar to Fig. 11 was obtained, it would be a definite indication of improper bias which would cause the voltage swing in one direction to be reduced whereas the swing in the lower direction would be normal. If a curve similar to Fig. 12 were obtained it would be a definite indication of an overload in the audio system.

61. USE OF PURE RADIO FREQUENCY OUTPUT:

In general, there are two practical applications of the use of a pure radio frequency output. One of these is to check the calibration of your oscillator against known frequencies such as broadcast stations, etc.

62. The other use of the pure radio frequency output might be to check the automatic volume control voltage. In this test it is only necessary to feed the output of the signal generator to the antenna and ground post of the receiver and adjust the dial on the receiver to correspond to frequency being generated by the signal generator. For example, tune the receiver to 1000 KC and adjust the output of the signal generator for 1000 KC. By the use of an infinite resistance zero current voltmeter or vacuum tube voltmeter it is possible to measure the automatic control bias which is being supplied to the control grids of the first RF tube VT1 or the first intermediate amplifier tube VT3. In this test connect the indicating voltmeter through a fairly high resistance of 150,000 ohms or more to the control grid of VT1 or VT3. As the receiver dial is tuned to resonance of the output frequency of the signal generator, this control bias should increase appreciably and fall off again as the receiver is tuned beyond the resonance frequency. The voltmeter could also be connected to the low side of the secondary of the RF and IF transformers at point 14 or point 15. If connections are made to these points it is not necessary to put an isolating resistor between the circuit under test and the vacuum tube or zero current voltmeter. In this connection, it is well to point out that a voltmeter drawing any current at all cannot be used to accurately measure the voltage appearing at these points. These voltages are fed through high resistance networks R5 and R1 which are usually from 2 to 5 megohms and the receiver circuit is so designed that there is no current being drawn through this circuit, therefore, the IR or voltage drop across the resistor R1 or R5 is zero. If the voltmeter which does draw current is connected at either point 14 or 15, then the resistors R1 or R5 will be carrying current and a voltage drop will be produced in those resistors giving an incorrect reading on the voltmeter. At the present time, there is commercially available only two types of voltmeters with which the measurement can be made, one being the zero current voltmeter and the other the vacuum tube voltmeter.

63. PRECAUTIONS TO BE OBSERVED WHEN USING THE OSCILLOGRAPH:

64. First, be sure that the voltage and frequency being used correspond to the rating of the signal generator.

65. Second, start with the decibel meter on the high range +22 to +38 as high voltage applied to the low range scale could damage the meter.

66. Never connect the AF or RF output lead to any place in a receiver where DC might be applied between this connection and the ground of the signal generator. Whenever connecting on to the plate of a tube or other DC voltage point with the output lead be sure to insert a blocking condenser to protect the output attenuator network from possibility of damage.

67. Never attempt to use output meter for alignment when using frequency modulated signal.

68. D.B. METER CORRECTIONS FOR OTHER THAN 500 OHM LINES. When line impedance is less than 500 ohms:

FORMULA - $\text{True D.B.} = \text{Indicated D.B.} + 10 \log. \frac{500}{R_e}$

Where R_e = Line Impedance

EXAMPLE: - Assume -

Line Impedance = R_e = 50 Ohms.
Indicated D.B. = 0 D.B.

Substituting in Formula

$$\text{True D.B.} = (\text{Indicated D.B.} = 0) + (10 \log. \frac{500}{R_e = 50})$$

$$= 0 + 10 \log \frac{500}{50} = 0 + 10 \log 10$$

$$= 0 + (10)\ (1)$$

True D.B. = + 10 D.B.

69. WHEN THE LINE IMPEDANCE IS GREATER THAN 500 OHMS: The following will be a close approximation if the impedance of the line is less than 5000 ohms, & the DB meter is being used on the low range (-10 to +15) or if the line impedance is less than 50,000 ohms & the D.B. meter is used on the high (+15 to +40) range. When used beyond these limits, the error becomes appreciable due to the relative power consumed by meter:

FORMULA: $\text{True D.B.} = \text{Indicated D.B.} - 10 \left(1 - \log \frac{500}{R_e}\right)$

EXAMPLE: Assume Line Impedance = 2500 ohms
Indicated D.B. + 5 D.B.
Substituting in formula.

$$\text{True D.B.} = \text{Indicated D.B.} - 10 \left(1 - \log \frac{500}{2500}\right)$$

$$= (5) - 10\ (1 - \log 0.2)$$
$$= (5) - 10\ (1 - .3)$$
$$= (5) - 10.\ (.7)$$
$$= 5 - 7.0$$

True D.B. = - 2.0 D.B.

USEFUL TECHNICAL DB DATA

POWER LEVEL DB	POWER 6 MW AT 0 DB WATTS	VOLTS-BASED ON 6 MW AT 0 DB IN 500 OHMS
- 10	0.0006	0.547
- 9	0.0007	0.614
- 8	0.0009	0.689
- 7	0.0011	0.773
- 6	0.0015	0.868
- 5	0.0018	0.974
- 4	0.0023	1.092
- 3	0.0030	1.226
- 2	0.0037	1.375
- 1	0.0047	1.543
0	0.006	1.732
1	0.007	1.943
2	0.009	2.180
3	0.011	2.446
4	0.015	2.745
5	0.018	3.080
6	0.023	3.455
7	0.030	3.877
8	0.037	4.350
9	0.047	4.881
10	0.060	5.477
11	0.075	6.145
12	0.095	6.895
13.	0.119	7.736
14.	0.150	8.680
15	0.189	9.740
16	0.238	10.92
17	0.300	12.26
18	0.378	13.75
19	0.476	15.43

POWER LEVEL DB	POWER 6 MW AT 0 DB WATTS	VOLTS BASED ON 6 MW AT 0 DB IN 500 OHMS
20	0.600	17.32
21	0.755	19.43
22	0.950	21.80
23	1.197	24.46
24	1.507	27.45
25	1.897	30.80
26	2.388	34.55
27	3.007	38.77
28	3.785	43.50
29	4.766	48.81
30	6.000	54.77
31	7.555	61.45
32	9.509	68.95
33	11.97	77.36
34	15.07	86.80
35	18.97	97.40
36	23.88	109.2
37	30.07	122.6
38	37.85	137.5
39	47.66	154.3
40	60.00	173.2
41	75.53	194.3
42	95.09	218.0
43	119.71	244.6
44	150.71	274.5
45	189.74	308.0
46	238.86	345.5
47	300.7	387.7
48	378.5	435.0
49	476.6	488.1
50	600.0	547.7

Observation of the foregoing table will disclose that for every 10 DB increase or decrease that the power is increased or decreased 10 times. Also, that for every 3 DB increase or decrease the voltage is approximately doubled or halved. With this in mind values of D.B. Power or voltage not given in the table could be estimated.

Any values of D.B. Power or voltage can be calculated from the following formula from which the above table was derived:

$$DB = 10 \log \frac{P_1}{P_2} \qquad \frac{E^2}{R} = P \text{ watts}$$

$$0 \text{ DB} = .006 \text{ watts} \qquad R = 500 \text{ ohms}$$

EXAMPLE:

Calculate power level corresponding to 6.0 watts. Also voltage developed c across 500 ohm line.

$$DB = 10 \log \frac{6.0}{.006} \quad \begin{array}{l}(\text{watts}) = P_1 \\ (= 0 \text{ DB}) = P_2\end{array}$$

$$= 10 \log 1000$$

$$10^x = 1000$$

$$x = 3$$

$$DB = 10 \times 3 = 30 \text{ DB}$$

CALCULATING CORRESPONDING VOLTAGE:

$$\frac{E^2}{R} = 6.0 \text{ watts}$$

$$E^2 = (6.0)\ (500)$$

$$E^2 = 3000$$

$$E = \sqrt{3000}$$

$$= 54.70 \text{ volts}$$

GIVEN 30 DB CALCULATE POWER:

$$DB = 10 \log \frac{P_2}{P_1}$$

$$30 = 10 \log \frac{P_2}{.006}$$

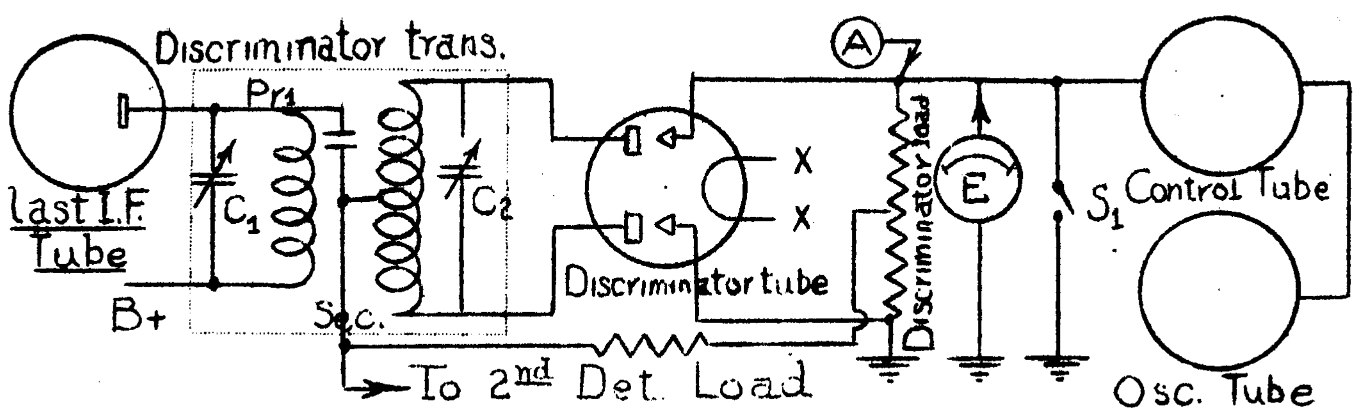
$$3.0 = \log \frac{P_2}{.006}$$

$$10^3 = \frac{P_2}{.006}$$

$$P2 = 10^3 \times .006 = 6.0 \text{ watts}$$

The voltage figures given in the third column are corrected only when measuring across a matched line terminated by a 500 ohm load.

ALIGNMENT OF A.F.C. CIRCUIT WITH HICKOK MODEL RFO-1 OR RFO-4 OSCILLOGRAPH



The operation of automatic frequency control circuit may be briefly explained by a reference to the above A.F.C. circuit schematic. Automatic frequency control system may be broken down into four fundamental parts. Namely, discriminator transformer which replaces the last intermediate frequency transformer in the conventional superheterodyne receiver, the discriminator tube which is usually the type 6H6

The operation of automatic frequency control circuit may be briefly explained by a reference to the above A.F.C. circuit schematic. Automatic frequency control system may be broken down into four fundamental parts. Namely, discriminator transformer which replaces the last intermediate frequency transformer in the conventional superheterodyne receiver, the discriminator tube which is usually the type 6H6 or equivalent, the control tube and the oscillator tube which is the regular oscillator tube in the receiver.

The discriminator transformer and the discriminator tube operate in the following manner. It is assumed that the intermediate frequency of this transformer is designed to be 450 kilocycles, then with a 450 KC signal being fed from the last intermediate frequency tube to the primary of the discriminator transformer and C1 properly tuned, this frequency will be transferred to the secondary of the discriminator transformer and when C2 is properly adjusted to resonate the secondary at 450 KC the discriminator tube will act to produce a voltage E from point A to ground which will be exactly zero across the discriminator load resistance.

If the frequency being supplied from the last I.F. tube changes either above or below the designed frequency, that is, the frequency for which the discriminator transformer is tuned the voltage "E" from point A to ground will vary either positive or negative in accordance with the increase or decrease above or below 450 KC of the applied frequency. This change in voltage is then applied to the grid of the control tube which in turn varys the frequency of the oscillator section.

It is quite obvious that if a given frequency is fed in at the antenna post of a receiver and the receiver properly tuned to this frequency, that the frequency supplied to the intermediate frequency stages will be a frequency equal to the difference between the oscillator tube frequency and the incoming frequency, and this frequency should be exactly equal to the intermediate frequency of the receiver under test. If we take the case of a received signal of 1000 KC and assume that the dial on the receiver is tuned to exactly 1000 KC then the oscillator tube would be operating in this case, at 1450 KC giving us a difference of 450 KC which would be fed thru the intermediate frequency stages. Since the discriminator transformer is tuned to exactly 450 KC the voltage appearing across E will be zero and the control tube will have no effect on the oscillator tube frequency. However, if the receiver were mistuned, say 5 KC high, or in other words, while the oncoming signal was still 1000 KC the actual tuning of the receiver were at 1005 KC the oscillator tube frequency would then be 1455 KC rather than 1450 and the frequency appearing thru the intermediate frequency stage would then no longer be 450 KC but would be 455 KC. This would result in a voltage "E" being applied across the discriminator load resistance which would react on the control tube causing it to shift the oscillator frequency down towards 1450 KC which would result in the intermediate frequency being reduced towards its proper frequency of 450 KC. Conversely, of course, if the receiver were mistuned to 995 KC the same result would be obtained with the exception that the voltage appearing across E would be of opposite polarity thereby causing the control tube to shift the oscillator tube frequency up rather than down tending to bring the intermediate frequency back to its proper value of 450 KC.

In most cases where automatic frequency control is employed there is a method of disconnecting the automatic frequency control feature so that standard tuning may be obtained. This is generally accomplished by a switch on the main panel of the receiver which enables the operator to select automatic frequency control or not at will, and is generally accomplished by a switch in a position similar to that shown at S1 which shorts out the discriminator load resistance back to ground thereby always applying a zero voltage on the control tube which results in this tube having no effect on controlling the oscillator tube frequency.

In many cases the discriminator circuit is also used as a second detector and the audio frequency stages fed directly from this circuit as indicated in the drawing, however, in some cases a tap is taken off the discriminator transformer or a capacity coupling from this over to a separate detector and this used for demodulation and the demodulated signal applied to the audio frequency stages. In all cases, however, the connections of the oscillograph vertical plate to the receiver under test should be made to the second detector load, whether this load is incorporated into the discriminator circuit or whether it is separate as previously mentioned.

The proper alignment procedure should be as follows:

First, connect the frequency modulated signal adjusted to the proper intermediate frequency direct into the first detector tube grid through a blocking condenser. This connection is illustrated in Fig. 5, page 24, of booklet entitled "Cathode Ray Oscillograph Operation and Application."

Second, close S1 back to ground, thereby eliminating any discriminator action.

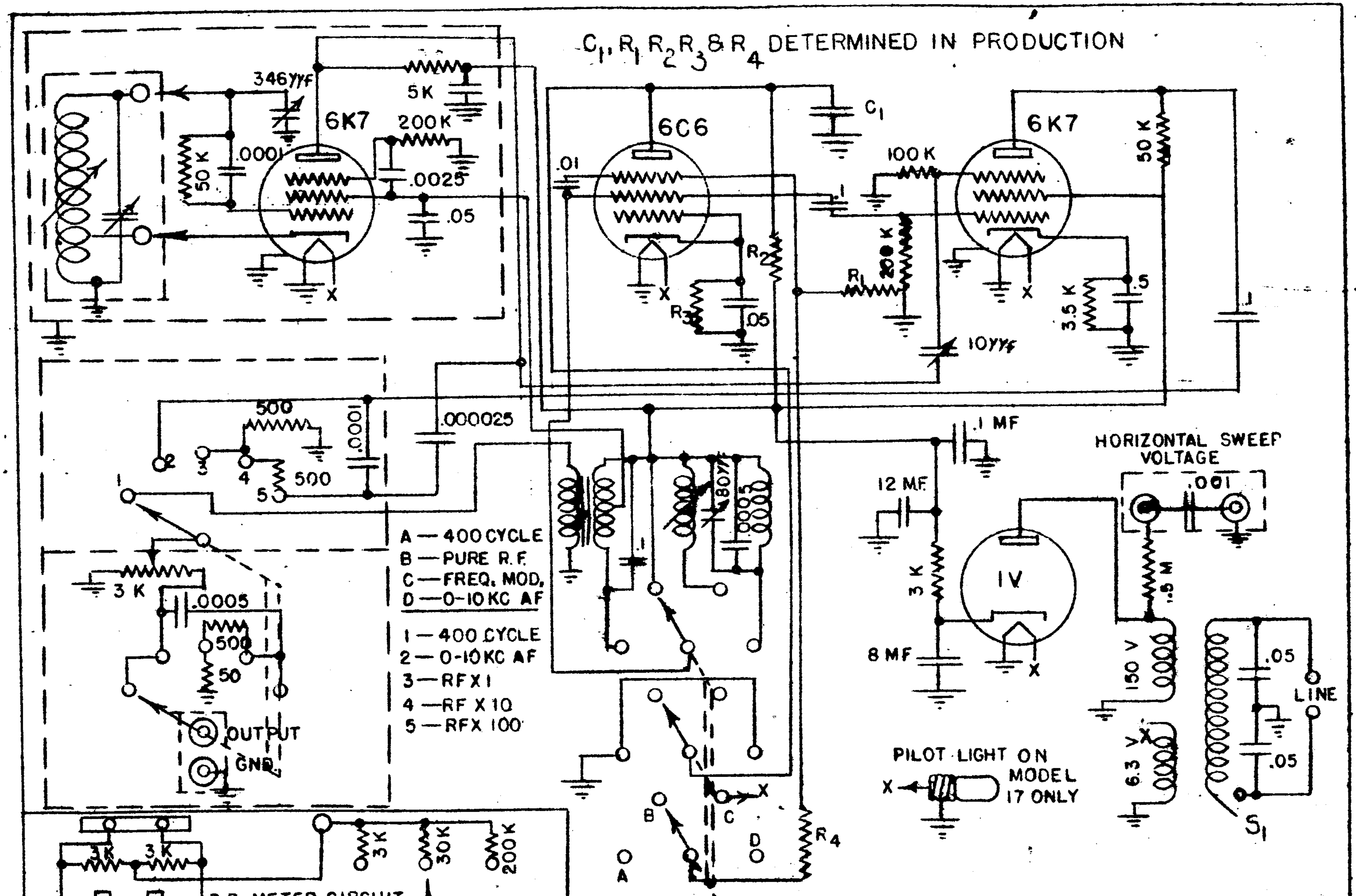
Third, align the intermediate frequency stages in the conventional manner, getting the maximum possible amplitude from the response curve consistent with symmetrical sides as outlined in the operating instruction book previously mentioned. In this alignment it is not necessary that the secondary of the discriminator transformer tuned by C2 be adjusted. However, C1 should always be adjusted in the same manner as the other trimmer condensers on the intermediate frequency transformers.

After this alignment has been completed, disconnect the frequency modulated output which was being fed in at the first detector and connect to the antenna post of the receiver. In this connection, it is suggested that no external oscillator be used, but the radio frequency output of 665 KC be taken from the radio frequency of the oscillograph and connected to the antenna post of the receiver under test. With all other connections the same, tune the receiver at approximately 665 KC until the response curve is centered in the cathode ray tube screen, use the 60 cycle sinusoidal sweep for horizontal voltage.

Fourth, open S1 and when this switch is open it will be found that the response curve will travel rapidly either to the right or left on the screen. Merely readjust C2, the secondary discriminator condenser, until the curve is returned to the center of the screen and the alignment of the discriminator circuit will then be complete. A check on this alignment may be made by opening and closing S1 and making sure that the curve does not move when this switch is either opened or closed.

An alternative method is somewhat faster and can be used if you are reasonably sure that the intermediate frequency stages are tuned quite close to their proper frequency as follows:

Sort out S1 and feed the output of the oscillograph directly to the antenna and ground post of a receiver which is tuned for 665 KC.
Second, adjust all intermediate frequency trimmers together with C1 on the Discriminator transformer for a proper response curve as previously outlined. Open S1 and readjust C2 to re-center the curve on the screen.



WIRING DIAGRAM MODEL 17&18 SIGNAL GENERATOR