Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

MODEL 340
SIGNAL GENERATOR

SIMPSON ELECTRIC COMPANY

5200 W. Kinzie St., Chicago 44, Illinois, Col. 1-1221

In Canada, Bach-Simpson, Ltd., London, Ontario

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MEMORANDA

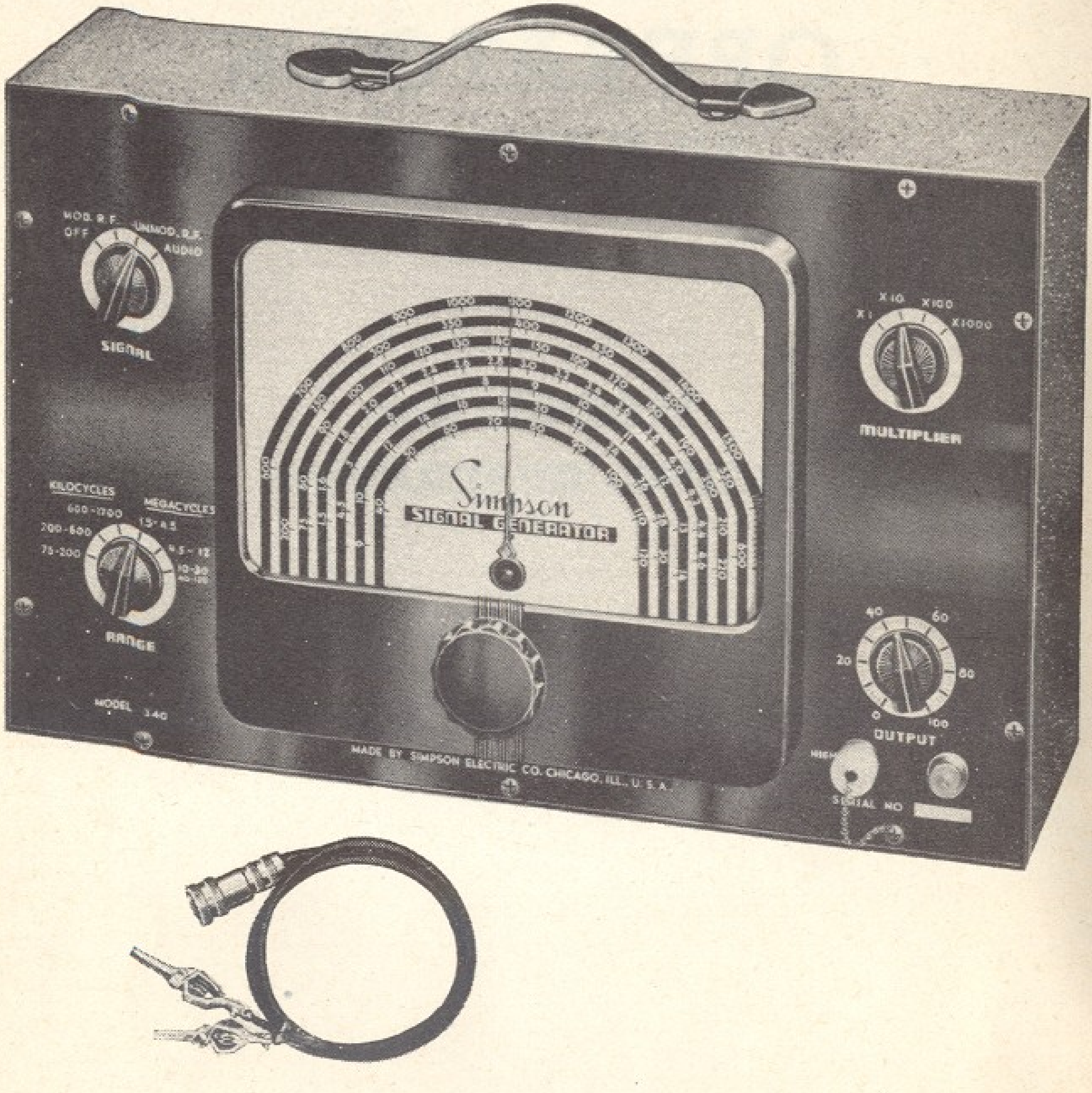

Figure 1 Simpson Model 340 Signal Generator
Size: 16" x 10" x 6". Weight: 20 lbs.

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Foreword

A signal generator is one of the radio serviceman's basic test instruments. In the Simpson 340 Signal Generator we have provided at a moderate price an instrument of highest accuracy, greatest stability, minimum leakage and good wave form. It gives a test signal source that will maintain its accuracy under constant use. It enables you to "trouble-shoot" fast and accurately every time. The big nine-inch meter type dial, with hair-line pointer, gives high readability. Smooth vernier control permits close settings.

Your pride in your Model 340 will grow as you learn of its many hidden virtues—the unusual quality of materials from which it is made, the advanced electronic engineering it embodies. Take the shielding as an example. The coils, the attenuator and the signal selector are individually shielded. Oscillator and modulator assemblies are sealed in a rigidly welded, entirely enclosed chassis. An effective line filter is used. Even the line cord is shielded. The result is to cut leakage to a minimum. These are but a few of the refinements of Model 340.

When you purchase Simpson test equipment you get equipment made almost entirely within the various plants of our Company. We are by far more self-contained than any other manufacturer of test equipment. This is your assurance that testers we offer will not quickly become obsolete. Our tremendous investment in expensive production tools is your safeguard against obsolescence and further assurance of unvarying quality.

Here at Simpson we do not regard our job finished when we have sold an instrument. Our interest in your Model 340 never ceases. We want your satisfaction with it to be continuing. That is the reason for this Operator's Manual. We want you to know how to get the most from your 340.

We have made this instrument as rugged as we know how. Give it the care and careful handling it deserves and it will give you a lifetime of accurate, dependable service.

OPERATOR'S MANUAL

SIMPSON MODEL 340 SIGNAL GENERATOR

SECTION I

GENERAL DESCRIPTION

1. The Model 340 Signal Generator is designed to give the service dealer a practical, easy to use, test signal source that will maintain its accuracy in every-day use. Its big 9-inch meter type dial with its long scale makes accurate settings an easy matter. The entire instrument, with its beautifully finished panel, gives a professional appearance that is an asset to any shop.

The instrument is supplied with a shielded output lead and operator's manual. The standard model is for use on 115 volt, 50 or 60 cycle current supply.

2. FREQUENCY BANDS AVAILABLE

75-200 kilocycles
200-600 kilocycles
600-1700 kilocycles
1.5-4.5 megacycles
4.5-12 megacycles
10-30 megacycles
40-120 megacycles
400 cycle 30% modulation of above radio frequency bands
400 cycle audio frequency signal

3. CIRCUIT

The electron coupled circuit assures extreme stability. Three tubes are used in the circuit, one 6X5GT as a full wave rectifier, one 6J5GT as a 400 cycle audio oscillator and modulator and one 6K6GT as the electron coupled RF oscillator.

4. OUTPUT

The signal is controlled through a step attenuator of the ladder type, each step being regulated by a smooth non-inductive control. The RF output can be varied from a few microvolts to approximately .15 volts while the 400 cycle audio signal can be varied from 0 to about 3.5 volts.

A "HIGH OUTPUT" jack is provided to obtain the full output of the generator before going through the "OUTPUT" control and "MULTIPLIER". The use of this jack is desirable when using the 40-120 megacycle band for FM alignment.

5. SHIELDING

The coils, attenuator and signal selector are individually shielded. The oscillator and modulator assemblies are sealed in a rigidly welded, entirely enclosed chassis, the entire assembly being then completely enclosed in a metal case and panel. A shielded line filter and cord are used. Careful shielding in this manner results in negligible leakage.

6. CALIBRATION

Each coil is individually calibrated to close tolerances against crystal standards by means of variable inductance and variable minimum capacitance. Tests show negligible changes over long periods of time with extreme temperature and humidity variations.

SECTION II

OPERATING INSTRUCTIONS

1. OPERATION OF CONTROLS

A front view of the Model 340 Signal Generator, with the position of the controls indicated, is shown in Figure 1. An explanation of their functions is contained in the following paragraphs.

a. SIGNAL SWITCH

When the switch at the upper left corner of the front panel marked "SIGNAL" is in the "OFF" position, the 115 volt, 60 cycle power input to the signal generator is turned off. Turning this switch to any one of the three positions marked "MOD. R.F.", "UNMOD. R.F." or "AUDIO", turns on the power and also selects the type of signal desired.

b. RANGE SELECTOR SWITCH

The switch at the lower left corner of the front panel marked "RANGE" selects the frequency band desired. When it is placed in any one of the six positions, any frequency within that band is obtained by rotating the dial knob until the pointer indicates the desired frequency on the dial scale. Read the frequency on the arc, the calibration of which corresponds to the setting of the "RANGE" switch.

For the 40-120 megacycle band, the range switch should be set in the same position as for 10-30 megacycles as marked on the panel, although the frequency is read on a different arc of the dial. When using the 40-120 megacycle band it will usually be found desirable to connect the output lead to the "HIGH OUTPUT" jack. The metal shield cap should be placed over whichever output jack is not in use.

c. MULTIPLIER SWITCH

The switch at the upper right corner of the front panel marked "MULTIPLIER" has four positions marked "X1", "X10", "X100" and "X1000". When set in the "X1000" position, the entire output of the signal generator is available, amounting to approximately .15 volts RF or 3.5 volts audio. When set in the "X100", "X10" and "X1" positions, the output is reduced in proportion. This control is not in use when connection is made to the "HIGH OUTPUT" jack.

d. OUTPUT CONTROL

The control at the lower right corner of the front panel marked "OUTPUT" gives smooth, complete control of the output of the generator up to the point of the multiplier switch setting. This control is not in use when connection is made to the "HIGH OUTPUT" jack.

2. RECEIVER ALIGNMENT

a. DUMMY ANTENNA

In normal operation the antenna has a loading effect on a radio receiver and the circuits should be aligned with this taken into account. For this reason, it is advisable to connect a dummy antenna between the signal generator output and the antenna terminal of the radio receiver when proceeding with alignment unless manufacturer's specifications state otherwise. It is common practice to use a 200 micromicrofarad condenser for the broadcast band and a 400 ohm resistor for the short wave bands as shown in Figures 2a and 2b. How-

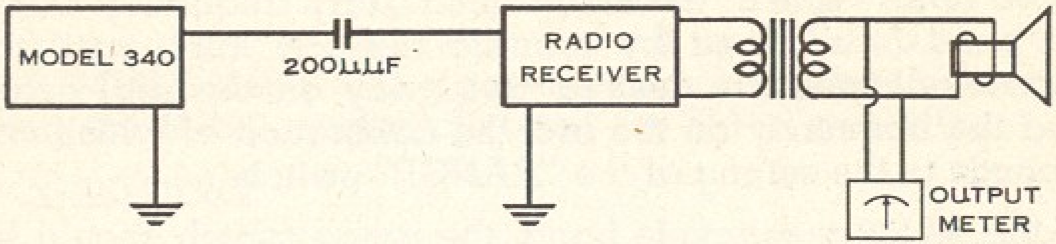


Figure 2a Dummy Antenna for Broadcast Band Consisting of 200 MMF Condenser

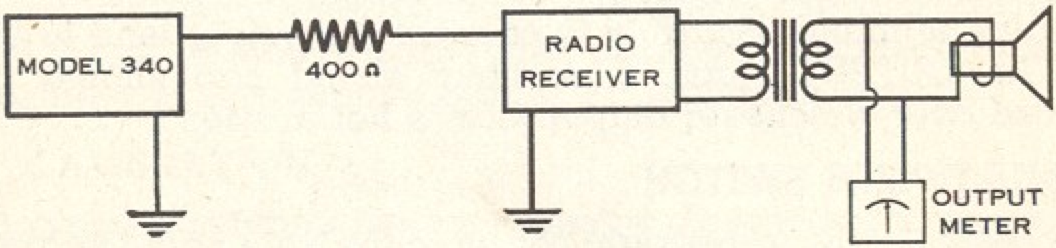


Figure 2b Dummy Antenna for Short Wave Bands Consisting of 400 Ohm Resistor

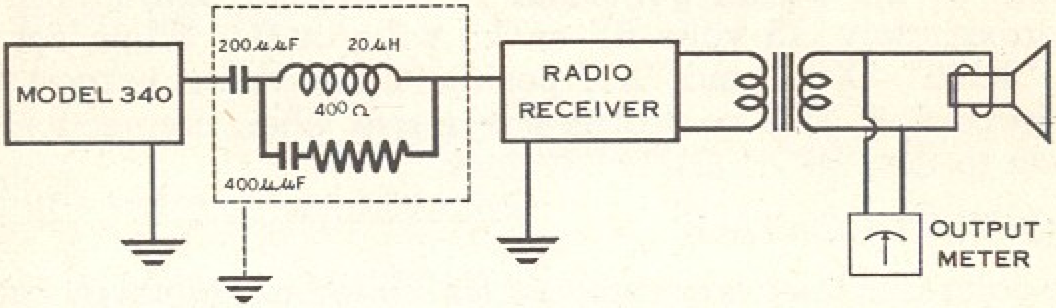


Figure 2c Dummy Antenna Suitable for all Wave Bands

ever, it is very simple to construct a dummy antenna according to IRE specifications which is suitable for all wave bands. This is shown in Figure 2c and is self-explanatory. In cases where a loop antenna is used, the dummy antenna can be omitted and a short piece of wire connected to the output of the signal generator placed near the loop antenna.

b. OUTPUT METER

An output indicating device is necessary for comparative readings as alignment progresses. This is connected across the voice coil leads as shown in Figure 2 or across the plate circuit of the output tube and may be a copper oxide rectifier AC meter such as the Simpson Model 260 or a vacuum tube voltmeter such as the Simpson Model 266.

c. ALIGNMENT OF TRF RECEIVERS

Before attempting the alignment of a receiver, it should be put in good operating condition with defective tubes and parts replaced. Thus, the alignment procedure is the last step in the reconditioning process. If the manufacturer's alignment instructions are available, they should be followed, but in the absence of such instructions, the general procedure is as follows:

1. Connect the output lead from the Model 340 Signal Generator to the antenna terminal of the radio receiver through a dummy antenna as shown in Figure 2.

2. Connect an output meter as shown in Figure 2.

3. Turn on both the signal generator and radio receiver and allow them to warm up for at least 10 minutes so that the frequency drift will be reduced to a minimum.

4. Set the "SIGNAL" switch on the Model 340 to the "MOD. R.F." position.

5. Set the "RANGE" switch on the Model 340 to the 600-1700 kilocycle position and set the dial pointer to 1400, using the outside arc of the scale.

6. Set the radio receiver dial to the same frequency.

7. Turn the "OUTPUT" control on the Model 340 to the "100" position. Set the "MULTIPLIER" switch in one of the four positions "X1", "X10", "X100" or "X1000" so that the 400 cycle audio signal from the generator is heard in the loudspeaker with the radio volume control turned all the way up. A reading can now be observed on the output meter. Select a position of the "MULTIPLIER" switch and "OUTPUT" control so that a signal with just enough output to be usable is obtained. This is to prevent broad tuning and to keep the signal below the point where the radio AVC will start to operate.

8. Proceed to adjust the tuning condenser trimmers by starting with the detector circuit. Observe the reading on the output meter and adjust the trimmer until a maximum reading

is obtained. Continue with the next trimmer, working toward the antenna section of the radio. As the alignment progresses, the signal generator output should be reduced to prevent AVC action and broad tuning. After the first adjustment, go back over the trimmers as there may be some interaction between them. It is usually best to keep the signal level just above the noise level during the final adjustment. This will result in a sharply tuned job.

After the alignment at 1400 kilocycles is completed, set both the signal generator and radio receiver to a frequency near the low end of the broadcast band, about 600 kilocycles. There is usually no provision in a TRF circuit for alignment at this frequency and so the usual procedure is to bend the outside plates of the condensers slightly until the correct adjustment is obtained. After completing, return to the 1400 kilocycles position and recheck.

d. ALIGNMENT OF SUPERHETERODYNE RECEIVERS

The following alignment procedure is a method commonly used but may differ from that recommended by some manufacturers of radio receivers. In such a case, follow the instructions supplied by the manufacturer of the receiver under test. Before starting, find the location of all trimmer and padder adjustments. In most cases these will be condensers but in other cases may be adjustable iron cores.

1. IF ALIGNMENT

a. Connect the output lead from the Model 340 Signal Generator to the grid of the mixer tube in the radio receiver through a condenser. This condenser may be approximately .05 MF in size but may be larger or smaller but not smaller than .001 MF. Leave the grid cap on the tube and the wave band switch in the broadcast band position.

b. Tune the signal generator to the intermediate frequency used in the radio. This can be determined from the manufacturer's specifications or other manuals giving such information. Most broadcast receivers have an intermediate frequency between 450 KC and 470 KC although some of the older receivers may have an IF of 175 KC or 260 KC.

c. Connect an output meter as shown in Figure 2.

d. Observe the reading on the output meter and set the output of the signal generator at a level just high enough to obtain a usable reading with the radio volume control all the way up.

e. Adjust the trimmers of the IF transformers for a maximum indication on the output meter, starting at the 2nd detector and working toward the mixer. Reduce the output of the signal generator, if necessary, as alignment progresses. Go over the adjustments a second time as there may be interaction between them.

f. In some cases the IF transformers are designed to pass a 10 kilocycle band of frequencies. In some cases this is accomplished by "stagger tuning" the transformer; that is, by adjusting one trimmer 5 KC below the IF and the other trimmer 5 KC above the IF. Other receivers are provided with a third or "tertiary" adjustment for obtaining the necessary band spread. In these cases the proper precedure is to screw the tertiary trimmer either to its minimum or maximum capacity, then adjust the primary and secondary trimmers to a maximum reading of the output meter. After this adjustment the tertiary trimmer is adjusted to a *minimum* reading on the output meter. After the tertiary adjustment, results may be checked by shifting the signal generator frequency 5 KC either side of the IF and observing the output meter for equal output on both sides. If the two sides are not equal a slight adjustment of the primary or secondary will usually equalize the two readings. Still other receivers are equipped with a variable band spread control which usually consists of a means by which the spacing or coupling between the primary and secondary is varied. To adjust such receivers the band spread controls should be set to the "selective" position (maximum spacing between coils) and adjust the IF transformers for maximum output. Then set the control to the "broad" position (minimum spacing between coils) and check for equal output 5 KC either side of the IF. Slight adjustment of the primary or secondary may be made to equalize the readings if necessary. Do not set the IF transformers in such a manner unless specified by the manufacturer.

2. ALIGNMENT OF BROADCAST BAND

a. Connect the output lead from the Model 340 Signal Generator to the antenna terminal of the receiver through a suitable dummy antenna as shown in Figure 2.

b. Tune the signal generator to 1400 kilocycles. Before starting, find the location of all trimmer and padder adjustments. In most cases these will be condensers but in other cases may be adjustable iron cores.

c. Set the receiver dial to 1400 kilocycles.

d. Adjust the output of the signal generator to a level just high enough to produce a usable reading on the output meter with the radio volume control turned all the way up.

e. If the receiver is equipped with automatic frequency control, be sure that it is turned off.

f. Adjust the oscillator and RF trimmers to a maximum reading on the output meter, starting with the oscillator trimmer.

g. Tune both the signal generator and radio receiver to 600 kilocycles.

h. Adjust the oscillator padding condenser for maximum reading on the output meter, at the same time rocking the tuning condenser slightly with the tuning control knob.

i. Reset both the signal generator and radio receiver to 1400 kilocycles and recheck as in (f) above. If all adjustments have been properly made, the dial calibration should be correct.

3. ALIGNMENT OF AUTOMATIC FREQUENCY CONTROL

After completing the IF and RF alignment of the receiver under test, the automatic frequency control should be adjusted

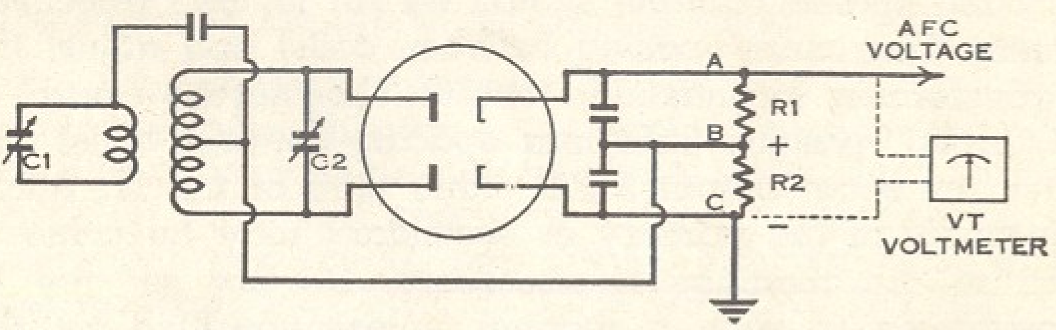


Figure 3 Simplified Circuit of Automatic Frequency Control Discriminator

if the receiver is so equipped. A simplified schematic of a commonly used AFC discriminator stage is shown in Figure 3. If the manufacturer's instructions are available, be sure to follow them. Otherwise the following method may be used.
a. Connect the signal generator to the grid of the mixer tube as described under IF alignment, and set it at the intermediate frequency, being certain that it is peaked at the correct frequency.

b. Connect a high resistance DC meter such as the Simpson Model 266 Vacuum Tube Voltmeter across points (a) and (c) in Figure 3.

c. Turn the AFC on. If the AFC is in proper adjustment, the voltage across the resistors R1 and R2 will be balanced and there will be no reading across (a) and (c). The readings across (a) and (b) and across (b) and (c) should be equal but of opposite polarity.

d. To align the circuits detune condenser C2 across the secondary of the discriminator transformer slightly if necessary to get a reading across (a) and (c). Tune condenser C1 across the primary until a maximum reading is obtained. Then tune condenser C2 until a minimum reading is obtained which should result in a zero reading across (a) and (c).

4. ALIGNMENT OF SHORT WAVE BANDS

a. Connect the output lead from the signal generator to the antenna terminal of the radio receiver through a suitable dummy antenna as shown in Figure 2.

b. Tune both the signal generator and radio receiver to a frequency near the high frequency end of the band.

c. Adjust the oscillator and RF trimmers for the short wave band for maximum indication on the output meter.

d. Tune both the signal generator and radio receiver to a frequency near the low frequency end of the band.

e. Adjust the short wave oscillator padding condenser for maximum indication on the output meter, at the same time rocking the tuning condenser slightly.

f. Return to the high frequency setting and recheck.

g. Other frequency bands may be checked in the same manner, selecting a frequency near the high end of the band for adjusting the trimmers and a frequency near the low end of the band for adusting the oscillator padder. Usually these frequencies are specified in the manufacturer's instructions.

5. IMAGE FREQUENCIES

The oscillator in the majority of superheterodyne receivers operates at a frequency above that of the signal being received, differing by the amount of the intermediate frequency. In beating against the signal frequency, a signal at the intermediate frequency is produced. Likewise, if a signal is present, at a frequency above that of the oscillator, differing by the amount of the intermediate frequency, the oscillator will also beat against this signal and produce another signal at the intermediate frequency, thus causing interference. This latter is called the image frequency and is an undesired response. For example, if the signal being received is 1000 KC and the IF is 455 KC, the oscillator would be operating at 1455 KC. Another response would be found at 1455 KC plus 455 KC or 1910 KC, the image frequency. Thus it can be seen that the image frequency always differs from the fundamental by twice that of the IF.

In some receivers, particularly on short waves, the oscillator operates at a point lower than the received signal and in this case the image frequency would be lower than the received signal by an amount equal to twice the IF.

Good design of a receiver resulting in sharper tuning of the RF circuits helps to reject image frequencies.

Image frequencies are seldom encountered in the lower frequency bands but become more troublesome at the higher frequencies as the IF becomes proportionately smaller as compared to the frequency of the signal being received. Care must be used in alignment to adjust the oscillator to the fundamental frequency and not the image frequency.

This can be checked by observing the calibration of the dial through the various wave bands. The Model 340 can be used for this purpose by setting it at 2 MC and checking the dial calibration of the radio receiver at higher harmonics (every 2 MC). Harmonics up to the 10th (20 MC), and in some cases higher, will be found usable, depending on the gain of the receiver under test.

If the oscillator has been set to the fundamental frequency, the dial should track properly and the harmonics should be heard at each 2 MC point (8 MC, 10 MC, 12 MC, 14 MC, etc.).

3. ALIGNMENT OF FM RECEIVERS

a. GENERAL DESCRIPTION

Frequency modulated transmission differs from AM transmission in that the modulation causes a shift in the carrier frequency instead of a variation in amplitude of a fixed frequency carrier. For 100% modulation, the variation in frequency of the carrier amounts to 75 KC above and below the center point.

The FM frequency band is 88-108 megacycles and the IF frequency is usually 10.7 megacycles. Receivers designed for use on the old FM band of 42-50 megacycles commonly used on IF frequency of 4.3 megacycles.

An FM receiver contains the customary RF, oscillator and IF stages. In some receivers, however, these are broadly tuned in order to pass the band of ± 75 KC. This is usually accomplished by overcoupling, resistance loading, or a combination of both. In other cases RF and IF transformers with normal characteristics are used. In addition, an FM receiver contains a limiter and discriminator. The purpose of the limiter is to cut off any amplitude modulated signals above the level of the carrier that may find their way into the circuit. Included in these are man-made electrical interference and static. The discriminator stage converts the frequency variation of the carrier into audio signals. A typical limiter and discriminator circuit is shown in Figure 4. If the manufacturer's alignment instructions are available, they should be followed, but in the absence of such instructions, the general procedure is as follows:

b. ALIGNMENT PROCEDURE

1. DISCRIMINATOR ALIGNMENT

a. Connect the output lead from the "LOW OUTPUT" jack on the 340 to the grid of the limiter tube through a mica condenser of approximately .01 MF, connecting the ground lead to the metal chassis. In cases where two limiter tubes are used, connection should be made to the second one.

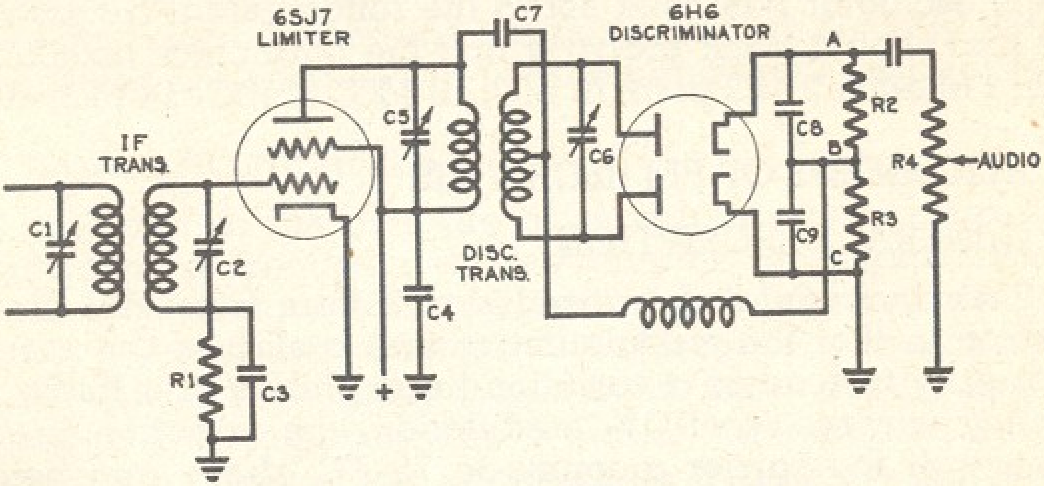


Figure 4 Simplified Circuit of FM Limiter and Discriminator

b. Set the "SIGNAL SELECTOR" on the 340 to the "UNMOD" position and the frequency to the IF frequency specified by the manufacturer of the receiver, usually 10.7 megacycles.
c. Connect a high resistance DC voltmeter such as the Simpson 260 or preferably a vacuum tube voltmeter such as the Simpson 266 across the load resistors of the discriminator, points A and C in Figure 4.

d. Adjust the primary condenser of the discriminator transformer shown at C5 for maximum indication on the meter. If the meter reads in reverse, the connections may be changed. If a Model 266 is used, the zero center scale permits either a positive or negative indication. It may be necessary to detune the secondary condenser C6 slightly in order to obtain a reading.

e. Adjust the secondary condenser shown at C6 in Figure 4 for minimum indicaiion on the meter. This should result in zero reading across A and C. If more than one position is found for C6, use the one which causes an increase in the reading when the condenser is detuned slightly in either direction.

2. IF ALIGNMENT

a. Connect a micro-ammeter in series with the limiter grid resistor shown as R1 in Figure 4. A Model 260 can be used or if a vacuum tube voltmeter is available, it can be connected directly across R1, making it unnecessary to open the circuit. In the first case, maximum current is shown and in the second case, maximum voltage is indicated.

b. Leave the setting of the 340 the same as for the discriminator alignment and connect it to the input grid of the mixer tube, through a mica condenser, the same as in any conventional superheterodyne. Be sure that the dial setting has not been disturbed.

c. Adjust the trimmers for maximum indication on the meter, starting with the last IF stage. In case of overcoupled transformers, two positions of a trimmer may be found to give maximum voltage. In such a case it should be set at the dip between the two peaks.

d. Recheck all adjustments, starting with the discriminator.

e. To check the band width of the tuned circuits, vary the dial setting of the 340 approximately 100 KC above and below the IF frequency. In case of an IF of 10.7 megacycles, this would be a variation from 10.6 to 10.8 megacycles. As the frequency is varied over this range, an approximately uniform indication on the meter indicates symmetrical alignment.

3. OSCILLATOR AND RF ALIGNMENT

a. Connect the RF output lead from the "HIGH OUTPUT" jack of the 340 to the antenna terminal of the receiver through a dummy antenna as shown in Figure 2. If the receiver uses a built-in dipole, it is best to connect a short piece of wire to the RF output of the 340 and place this near the dipole rather than to use a dummy antenna.

When connections are made from the "HIGH OUTPUT" jack of the 340, the "OUTPUT" control and "MULTIPLIER" switch are not in use.

b. Set the Model 340 to 105 megacycles and tune the receiver to the same frequency. Leave the "SIGNAL SELECTOR" in the "UNMOD" position and the meter connected to the limiter grid resistor.

c. Adjust the oscillator trimmer and then the RF trimmer for maximum indication on the meter.

This completes the alignment of a typical FM receiver.

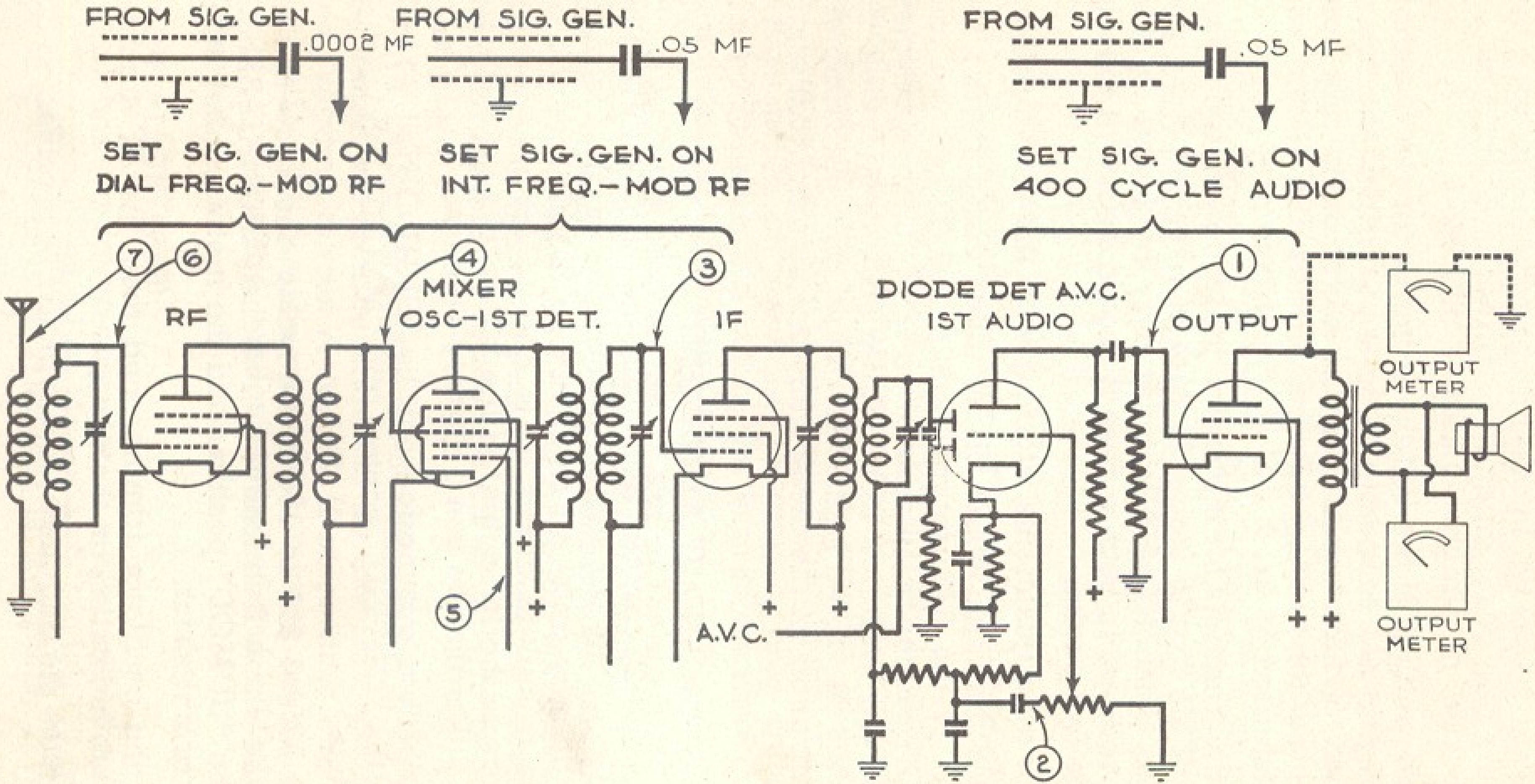


Figure 5 Simplified Circuit of a Superheterodyne Radio Receiver Showing Location of Test Points

4. SIGNAL TRACING METHODS

Since the functioning of a radio receiver depends on a signal being received at the antenna terminal and passed through the various circuits to the output, the best way to examine it is with a signal present. If signal tracing equipment is available, the Model 340 Signal Generator can be connected to the antenna terminal as the signal source and the signal tracer used to examine the signal at various points in the circuit. Instructions supplied with the signal tracing equipment should be followed.

An alternate method is to use the Model 340 with an output meter such as the Simpson Model 260 or a vacuum tube voltmeter such as the Model 266. In this case, the output meter is connected to the output of the radio receiver and the signal generator connected to the input of the output stage first. It is then moved along stage by stage toward the antenna section and a fault in any stage will be indicated by the failure of the signal to come through. This method will be described in the following paragraphs as applied to a superherterodyne receiver consisting of one RF stage, mixer, one IF stage, diode detector and first audio, and output stage, the simplified schematic of which is shown in Figure 5. Before starting, test all tubes and make the usual voltage measurements.

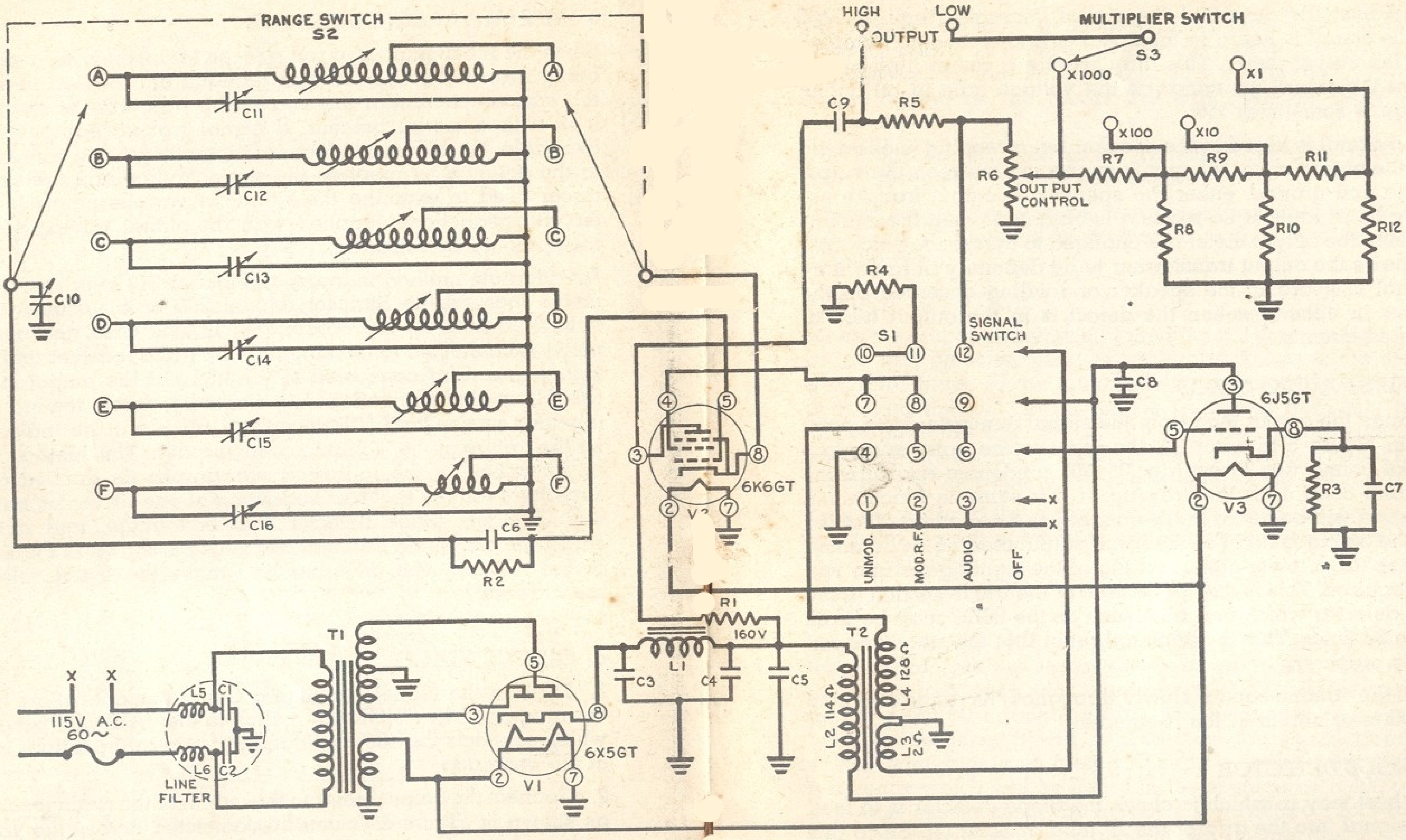
a. OUTPUT STAGE

1. Turn on the Model 340 Signal Generator and allow it to warm up. Set the "SIGNAL" switch to the "AUDIO" position which connects the 400 cycle audio signal to the output lead of the generator.

2. Connect the output meter to the output of the radio receiver as shown in Figure 5. It can be connected across the voice coil as shown by the solid lines and set on the 2.5 volt AC range or connected between the output plate and ground as shown by the dotted lines and set on a higher range.

3. Connect the output lead from the signal generator to the grid of the output stage through a condenser of approximately .05 MF capacity at point (1) in Figure 5.

4. Turn on the radio and allow it to warm up.



R1—500 ohms
R2—20 K ohms
R3—750 ohms
R4—45 ohms
R5—10 K ohms
R6—200 ohm Pot.
R7, 9, 11—970 ohms
R8, 10, 12—120 ohms

C1, 2, 9—.05 MF
C3, 4—10 MF
C5—.25 MF
C6—.0002 MF
C7, 8—.5 MF
C10—440 MMF
C11, 12, 13—Trimmers
C14, 15, 16—Trimmers

T1—Power Transformer
T2—Modulation Transformer
L1—Filter Choke
L5, 6—RF Choke
S1—Signal Switch
S2—Range Switch
S3—Multiplier Switch

RANGES
75-200 KC
200-600 KC
600-1700 KC
1.5-4.5 MC
4.5-12 MC
10-30 MC
40-120 MC

Figure 6 Model 340 Schematic Diagram

5. Adjust the output of the signal generator until the 400 cycle signal is heard in the speaker and a reading obtained on the output meter. This may require a rather high output from the signal generator as the voltage gain in an output stage is sometimes low.

If no signal is heard in the speaker but a reading is observed on the output meter when it is connected between the output plate and ground, either the speaker or output transformer may be at fault. If no reading is obtained when the connections of the output meter are changed to across the voice coil, it shows the output transformer to be definitely at fault. If no signal is heard in the speaker or reading observed on the meter in either position the defect is in the output tube or related circuits.

b. FIRST AUDIO STAGE

Change the output lead from the signal generator from point (1) in Figure 5 to point (2), the input to the volume control. Make connection through a .05 MF condenser and turn the volume control all the way up. If this stage is functioning, a signal will be heard in the speaker and a reading obtained on the output meter. For the same output reading as obtained in step (a), a lower output setting of the signal generator will be required. This is due to the gain of the triode section of the 2nd detector which in a tube such as the 6SQ7 may be from 20 to 50 times. This is additional proof that the stage is operating properly.

Turn the volume control slowly throughout its range and note whether or not its action is smooth.

c. DIODE DETECTOR

The best way in which to check the diode detector is to feed the signal into the grid of the IF tube at point (3). Since this circuit is tuned to the intermediate frequency, set the "SIGNAL" switch on the Model 340 to the "MOD. R. F." position and set the "RANGE" switch and dial pointer to the intermediate frequency used in the radio receiver. Make the connection to point (3) through a .05 MF condenser. Turn the volume control all the way up.

If the speaker responds to the 400 cycle signal and a reading is obtained on the output meter, it is clear that the diode detector and IF stage are functioning. Due to a lower output voltage on RF than on audio and 30% modulation, a higher output setting on the Model 340 than at point (2) will be required.

The diode detector will introduce some loss (5 to 15%) but the IF stage will provide some gain.

Before proceeding, note the settings of the output controls on the Model 340 needed to produce a usable reading on the output meter.

d. FIRST DETECTOR

Move the output connection of the Model 340 to the input grid of the first detector, point (4) in Figure 5. Leave the signal generator tuned to the intermediate frequency and connect it through the .05 MF condenser. A signal from this point shows that the first detector is functioning but does not eliminate the oscillator as the cause of trouble. The receiver dial should be tuned to the low frequency end of the band.

Less output from the signal generator should be required at this point than at point (3) to produce the same indication on the output meter.

e. OSCILLATOR

Leave the Model 340 set in the "MOD. R.F." position and set the dials of both the signal generator and radio receiver to the same frequency—for example, 1000 KC. Make connection to point (4) through a .0002 MF condenser. If the oscillator is operating, it will beat against the signal from the signal generator and create a signal at the intermediate frequency which will be heard in the speaker as a 400 cycle note and observed on the output meter. Before proceeding, note the setting of the output controls on the Model 340 to produce the desired reading on the output meter.

If no signal is obtained, the oscillator may be checked further by setting the receiver dial to a local broadcast station and connecting the signal generator to the oscillator plate, point (5) in Figure 5, tuning it to a frequency higher than that of the broadcast station by the amount of the intermediate frequency. For example, if the broadcast station is at 1000 KC, the signal generator should be tuned to 1460 KC if the intermediate frequency is 460 KC. The signal generator will act as the local oscillator and the station will be heard.

f. RF STAGE

To check the RF stage, connect the output of the Model 340, tuned to the frequency of the radio dial and set on "MOD. R.F.", to the input grid of the RF tube, point (6) in Figure 5, through a .0002 MF condenser. If this stage is operating, a signal will be heard and a reading observed on the output meter. The gain of the stage will be indicated by lower settings of the Model 340 output controls needed to produce the same reading on the output meter as obtained from point (4).

g. ANTENNA COIL

The last step is to check the antenna coil. Move the Model 340 output connection from point (6) to point (7) in Figure 5, leaving all settings the same. Make connection through a .0002 MF condenser or a dummy antenna as shown in figure 2 c. Little, if any, gain will be observed at this point. Automobile receivers, however, will show more gain.

This has been a simple test for the purpose of isolating the particular section of the receiver which is inoperative, without regard for the exact amount of gain. For more detailed instructions on stage gain, refer to the following paragraphs on that subject.

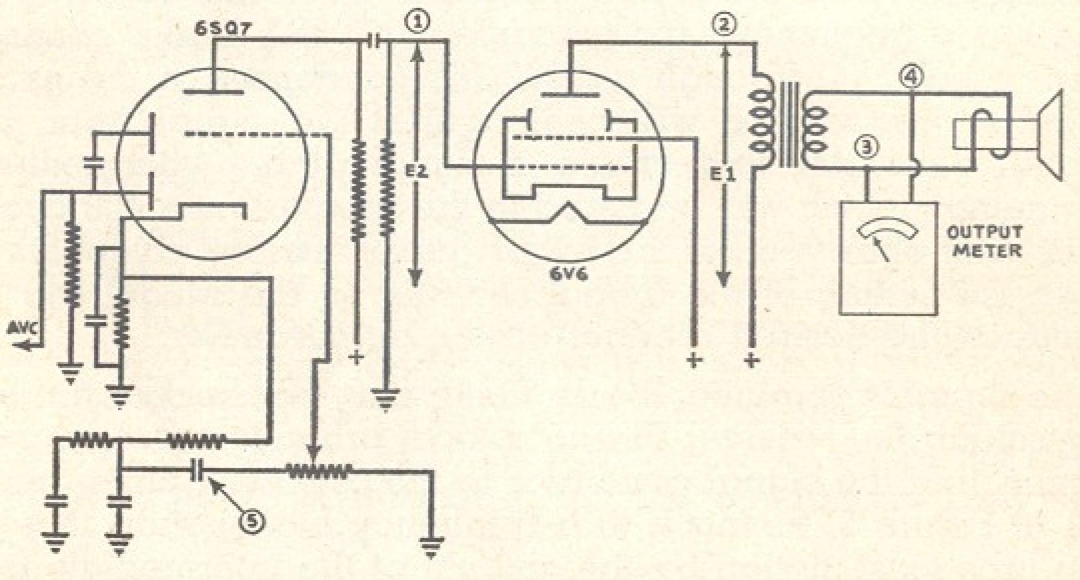


Figure 7 Simplified Circuit of Audio Amplifier Section of Radio Receiver

5. MEASUREMENT OF STAGE GAIN

a. GENERAL INFORMATION

The previous stage by stage check of a radio receiver under "SIGNAL TRACING METHODS" has been concerned only with finding a stage which is inoperative, thereby isolating the fault in a relatively small section of the circuit. There are many cases, however, where a stage may be operating, but not at full efficency, making more accurate measurements necessary.

Since the purpose of a tube and its associated circuits, in most cases, is to amplify the signal, a measurement of its ability to amplify is the best indication of its condition. This is called stage gain and is illustrated in Figure 7 which represents a 6V6-6L6 tube in the output stage of a radio receiver. Here the input voltage is represented by E2 and the output voltage by E1. The stage gain is expressed by the ratio of E1 to E2 or E1/E2. If E2 is 3 volts and E1 is 30 volts, then the gain is 30/3 or 10. If E2 were 1 volt and E1 were 10 volts, the gain would be the same, 10/1=10. Therefore it can be seen that it is the ratio between the input and output voltages that indicates the stage gain and that the actual voltage applied to the input is not important, provided it is high enough to give a usable signal and not high enough to overload the tube. An output pentode can be expected to have a gain of from 10 to 20, a beam power tube a gain of from 20 to 30 while a triode will have a gain of only from 2 to 5.

Output readings usually are taken across the voice coil as shown by points (3) and (4) in Figure 7. Due to the step down ratio of the output transformer, which is often higher than 30 to 1, the voltage appearing across points (3) and (4) will be in the same ratio. Hence, if E2 is 3 volts and E1 is 30 volts, then the voltage across points (3) and (4) will be 30/30 or 1 volt if the step down ratio is 30/1. In measuring stage gain, the general procedure is to select some value of voltage appearing across the voice coil circuit and determine the voltages necessary to apply to different stages to produce the same voltage across the voice coil. The ratio between these voltages indicates the stage gain. In laboratory measurements this is usually stated in terms of the number of microvolts necessary to produce an output of .5 watts (.05 for battery receivers) across a resistive load corresponding to the voice coil. The standard signal used is 30% modulated at 400 cycles. The voltage corresponding to any wattage may be found if the impedance of the voice coil at 400 cycles is known, by the formula $E=\sqrt{RW}$ where E is the voltage, R the impedance of the voice coil at 400 cycles and W the number of watts.

Many manufacturers of radio receivers are now supplying information on stage gain in their instruction manuals and if such information is available, it should be helpful. However, in the absence of such instructions or if they are not applicable, the following methods may be used.

b. NECESSARY EQUIPMENT

Other than the Model 340 Signal Generator, an output meter is needed. This, preferably, should be a vacuum tube type voltmeter such as the Simpson Model 266 but may be a copper oxide rectifier type of meter such as the Simpson Model 260. The Model 340 has been designed as a service instrument and as such does not require the output calibrated in microvolts. However, the attenuator is linear in action and can be used to establish ratios between settings, thus indicating gain without the necessity of knowing the output voltage. The following instructions are based upon this method.

c. OUTPUT STAGE

1. Turn on the Model 340 and allow it to warm up. Set the "SIGNAL" switch in the "AUDIO" position.

2. Connect the Model 340 output lead to the input grid of the output tube of the radio receiver as shown at point (1) in Figure 7.

3. Connect an output meter across the voice coil as shown at points (3) and (4) in Figure 7. Set it on the 2.5 AC range.

4. Turn on the radio and adjust the multiplier switch and output control on the signal generator until a reading is obtained on the output meter. It is not important what this reading is, provided the same value is used throughout the test and is within usable limits. It may be convenient to select 1 volt or whatever may be specified in the radio manufacturer's instructions.

5. Measure the output of the Model 340 being fed into the grid at point (1). Use either a V.T.V.M. or a copper oxide type of meter for this purpose. This reading may, for example, be about 2 volts and is represented by E2.

6. If a V.T.V.M. is available, measure the signal voltage at the plate of the 6V6 tube, point (2) in Figure 7. A Copper oxide meter can be used for this purpose with a series condenser if correction is made for the condenser. The reading at this point may be about 60 volts which is represented by E1. The gain of the stage is therefore E1/E2 or 60/2=30. The low reading of 1 volt appearing at points (3) and (4) across the voice coil is due to the step down ratio of the output transformer. This voltage will usually be less than the input voltage applied at Point (1).

d. FIRST AUDIO STAGE

1. Make a record of the positions of the multiplier switch and output control as set for the output stage. These may be, for example, X1000 for the MULTIPLIER and 50 for the OUTPUT control.

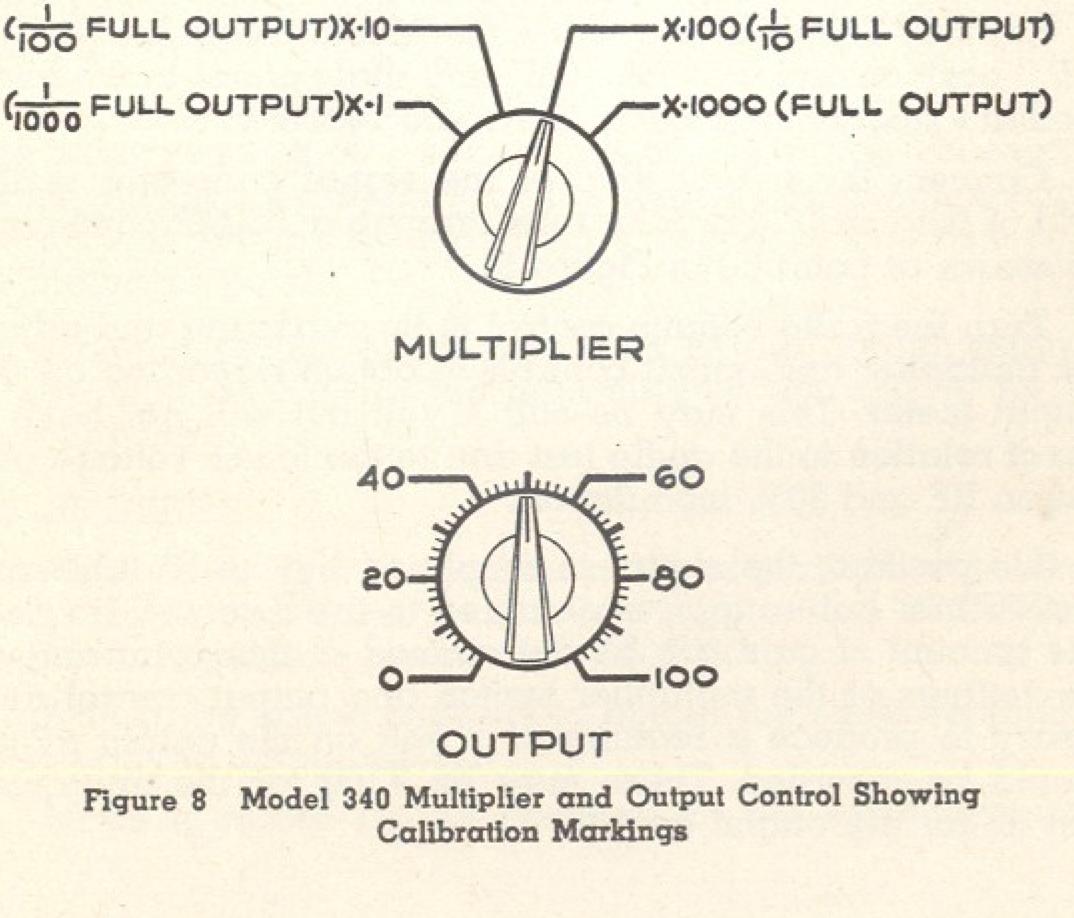


Figure 8 Model 340 Multiplier and Output Control Showing Calibration Markings

2. Connect the output of the Model 340 to the input of the triode section of the 6SQ7 tube, point (5) in Figure 7 (across the volume control). Turn the volume control to its maximum position.

3. Adjust the output controls of the Model 340 to give the same reading of 1 volt on the output meter as before.

4. Make a record of the positions of the controls. These may be X100 for the multiplier and 20 for the OUTPUT control. A study of the two controls as illustrated in Figure 8 will show that each step of the MULTIPLIER is 1/10 of the next higher and that the setting of the OUTPUT control can be regarded as an approximate percentage of the position of the multiplier. Therefore, by determining the ratio between the settings for the first and second audio stages, the approximate gain can be determined. These settings can be expressed as 1000 x .50 when the Model 340 was connected to the grid of the output tube and 100 x .20 for the first audio or $\frac{1000 \times .50}{100 \times .20}=25$, the amount of the stage gain.

e. DIODE DETECTOR AND IF

1. Set the "SIGNAL" switch on the Model 340 to the "MOD. R.F." position and the "RANGE" and dial pointer to the intermediate frequency used in the radio receiver.

2. Connect the output lead of the signal generator to the grid of the last IF amplifier tube through a .05 MF condenser as ssown at point (3) in Figure 5.

3. Turn the radio volume control to its maximum and adjust the multiplier and output controls to obtain a reading on the output meter. This may be still 1 volt but will not have a direct relation to the audio test due to the lower voltage output on RF and 30% modulation.

In this position, the signal is amplified by the IF tube and transformer but no gain is obtained in the detector. No definite amount of gain can be determined at this point and so the settings of the multiplier switch and output control necessary to produce a reading of 1 volt on the output meter should be recorded. These may be X100 for the multiplier and 50 for the output control.

f. FIRST DETECTOR

1. Leave the Model 340 on "MOD. R.F." and tuned to the intermediate frequency and connect the output lead through a .05 MF condenser to the input grid of the first detector, point (4) in Figure 5.

2. Adjust the multiplier switch and output control to the positions necessary to obtain a reading of 1 volt on the output meter.

3. Make a record of the settings. These may be X1 for the multiplier and 100 for the output control. The gain between points (4) and (3) can therefore be expressed as $\frac{100 \times 50}{1 \times 100}=50.$

g. OSCILLATOR

1. Set the "RANGE" switch and dial pointer on the Model 340 to the same frequency as the radio dial, for example, 1000 KC. Leave the "SIGNAL" switch in the "MOD. R.F." position.

2. Connect the output lead of the Model 315 to the input grid of the mixer tube, point (4) in Figure 5 through a .0002 MF condenser.

3. Adjust the multiplier switch and output control to obtain the same reading of 1 volt on the output meter. These positions will be only slightly higher than when the signal generator was set on the intermediate frequency and connected to the same point.

4. Make a record of the positions of the output controls. These may be X10 for the multiplier switch and 10 for the output control.

h. RF STAGE

1. Move the output connection of the signal generator from point (4) to point (6) in Figure 5, leaving it set on "MOD. R.F." and set at the same frequency—1000 KC.

2. Adjust the output controls to obtain the same reading of 1 volt on the output meter.

3. Make a record of the positions of the output controls.

These may be X1 for the multiplier and 10 for the output control. This can be expressed as 1 x 10 and the settings for the previous reading at point (4) as 10 x 10. The gain of the R. F. Stage is therefore $\frac{10 \times 10}{1 \times 10} = 10$.

i. ANTENNA COIL

1. Leave all settings on the Model 340 the same and move the output lead to the antenna terminal of the radio shown as point (7) in Figure 5.

2. Adjust the "MULTIPLIER" and output control to obtain the same reading of 1 volt on the output meter. There will be little gain, if any, at this point except in automobile receivers.

3. If the noise level in the vicinity is high, it may be that a higher level on the output meter will have to be used throughout the RF test so that the signal from the signal generator will be greater than the noise. However, it must be kept below the point where the AVC starts to operate.

SECTION III

FUNCTIONING OF PARTS

1. RADIO FREQUENCY OSCILLATOR

A simplified circuit of the radio frequency oscillator used in the Model 340 is shown in Figure 9. This is an electron coupled circuit using a 6K6GT tube in which the screen is used as the oscillator plate and, with the cathode and control grid, forms

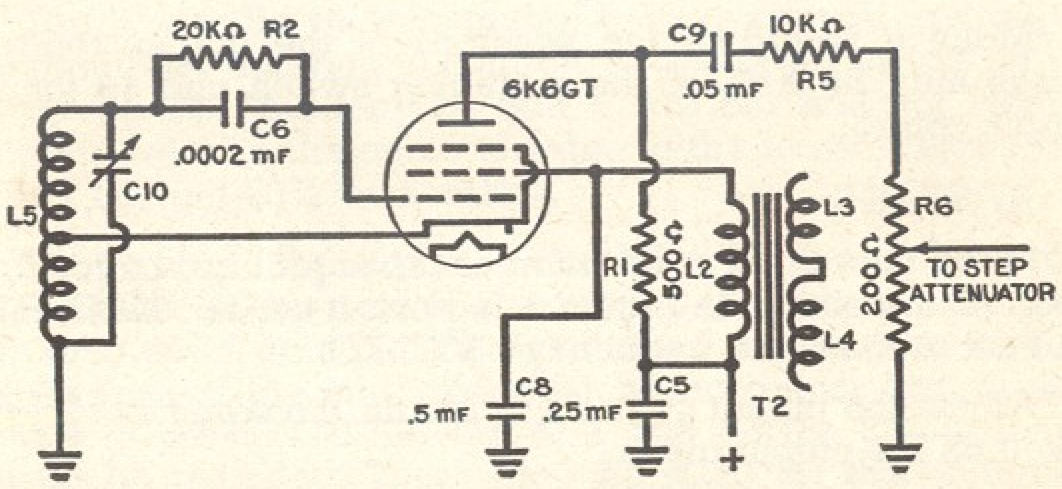


Figure 9 Simplified Circuit of Model 340 Radio Frequency Oscillator

a Hartley triode oscillator. The inductance L5 and condenser C10 is the oscillator tank circuit and determines the frequency, while the cathode connected to the tap on L5 provides the feedback.

The oscillator plate is operated at RF ground potential due to the .5 MF bypass condenser C8, thus providing an effective shield between the output plate and other elements of the tube. The DC voltage is applied to the output plate through resistor R1. C6 is the grid condenser and R2 is the grid leak. Bypass condenser C5 keeps the RF out of the power supply. The output plate is coupled to the output level control R6 through condenser C9 and resistor R5.

The output system is coupled to the RF oscillator only through the electron stream flowing from the cathode to the output plate of the tube. Thus frequency drift due to changes in the output load are held to a minimum, resulting in extreme frequency stability of the generator.

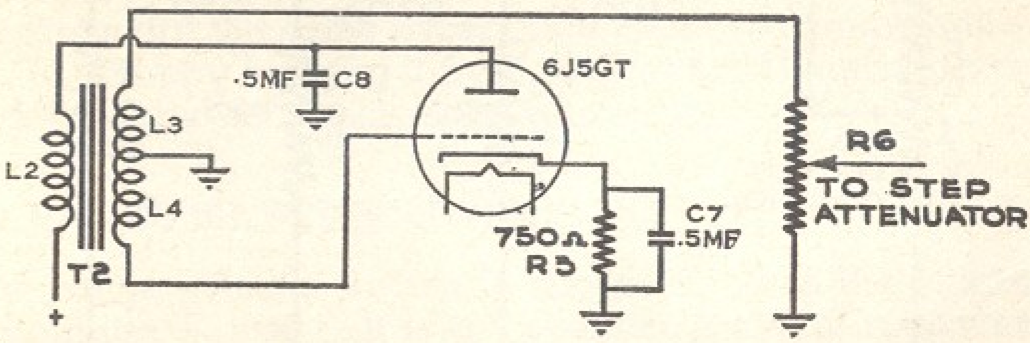


Figure 10 Simplified Circuit of Model 340 Audio Oscillator

2. AUDIO FREQUENCY OSCILLATOR

A simplified circuit of the audio oscillator used in the Model 340 is shown in Figure 10. Windings L2 and L4 of transformer T2 provide plate-grid feedback and are of such value together with condenser C8 as to produce a frequency of 400 cycles per second. The output is taken from the winding L3 directly to the output control R6. Resistor R3 is the bias resistor and C7 its by-pass condenser.

3. OUTPUT ATTENUATOR

Figure 11 shows the circuit used in the Model 340 output attenuator. With the output control R6 in its maximum position, the entire output is available with the multiplier switch in the "X1000" position. The ladder type network consisting of R7, R8, R9, R10, R11 and R12 provides 3 additional positions of the multiplier switch at X100, X10, and X1, to reduce the output in multiples of 10. The output control R6 provides smooth control over the output, the maximum being determined by the position of the multiplier switch.

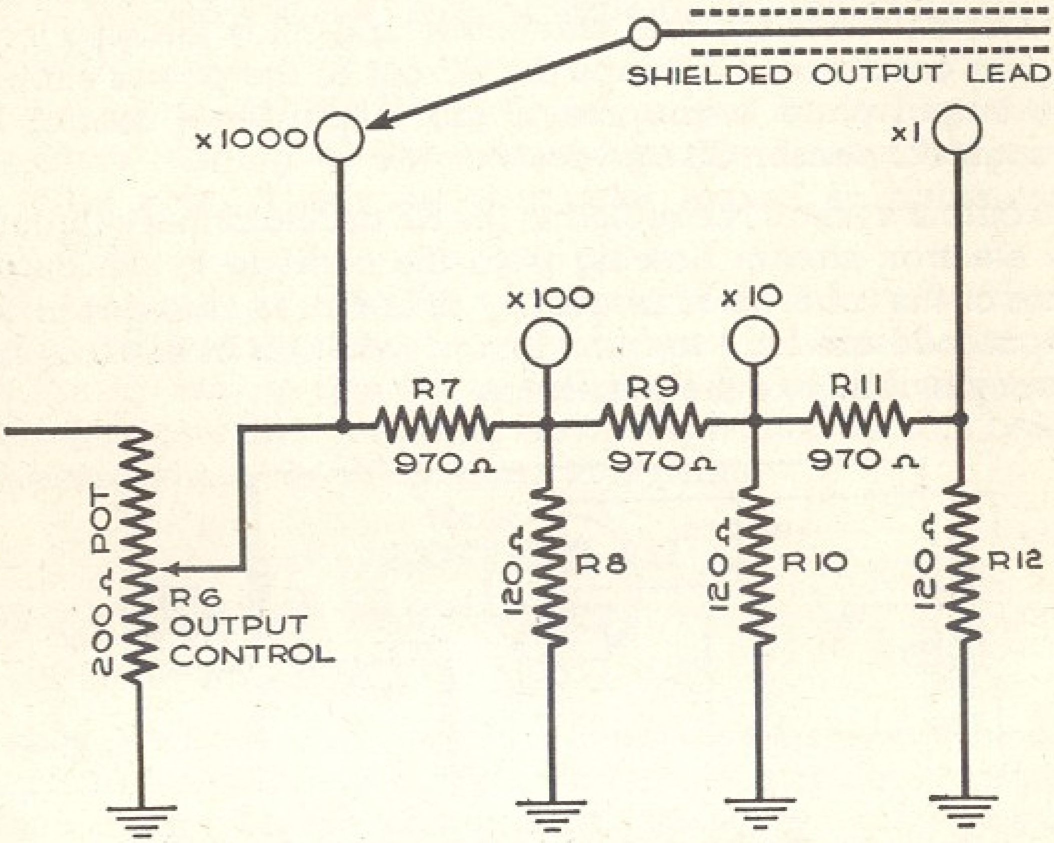


Figure 11 Model 340 Output Attenuator

4. SIGNAL SELECTOR SWITCH

The signal selector switch is shown at S1 in the Model 340 schematic, Figure 6. This is a 4 position, 4 circuit, rotary type switch. Contacts 1, 2, and 3 are used as the power supply switch and being connected together close the circuit "X X" in any one of the three positions "AUDIO", "MOD. R.F.", or "UNMOD. R.F.".

When the switch is placed in the "AUDIO" position, contact 6 connects the grid of tube V3 to winding L4 of transformer T2, allowing the tube to start oscillating. Contact 9 has no connection and contact 12 connects the output winding L3 of transformer T2 to the output attenuator. The 400 cycle signal therefore appears across potentiometer R6.

When S1 is placed in the "MOD. R.F." position, contact 5 connects the grid of tube V3 to winding L4 of transformer T2, allowing the tube to start oscillating. Contact 11 grounds winding L3 of transformer T2 through resistor R4 to maintain the proper load and wave form. Contact 8 connects the DC voltage to the oscillator plate of the RF oscillator tube V2, allowing it to start oscillating. Since tube V3 is oscillating, a variation in plate current takes place as it goes through each cycle. This causes a voltage drop in the DC supply corresponding to the variation in plate current. Since the RF oscillator plate current is supplied from the same source, the 400 cycle frequency of the audio oscillator V3 is superimposed upon the plate current of the RF oscillator V2, thereby causing plate modulation. Values are such as to provide approximately 30% modulation.

When S1 is placed in the "UNMOD. R.F." position, the connections are the same except that contact 4 grounds the grid of V3, thereby keeping it from oscillating. Therefore, only the unmodulated RF reaches the attenuator.

5. RANGE SELECTOR SWITCH

The range selector switch is shown at S2 in the Model 340 schematic, Figure 6. It is a 6 position, 2 circuit rotary switch that selects any one of the six tuning circuits corresponding to the ranges A, B, C, D, E and F. Each coil is tuned by a trimmer and an adjustable core in the coil. Tuning throughout each range is accomplished by condenser C10.

6. POWER SUPPLY

The power supply for the Model 340 is shown in the schematic diagram, Figure 6. The line filter consisting of RF Chokes L5 and L6 and condensers C1 and C2 prevents any RF in the power supply from getting into the power supply line. Transformer T1 supplies the high voltage for the 6X5GT rectifier and filament supply for the three tubes. Choke L1 and condensers C3 and C4 form the DC filter. The voltage at the output of the filter is approximately 160 volts DC.

SECTION IV

MAINTENANCE

1. REPLACEMENT OF TUBES

The tubes in the Model 340 will normally have a long life but should be checked occasionally and, if they show any weakness, should be replaced with new ones. The RF oscillator tube, 6K6GT, should be replaced with a GT type of tube only. The location of tubes is shown in the top view of the chassis, Figure 14.

2. CALIBRATION

The sturdy construction of the Model 340 and the care used in its calibration insures that it will maintain its accuracy over long periods of time. However, in cases where it may be necessary to recalibrate it and where the facilities are available, the following instructions should be observed. Adjustment should be made at the following frequencies; one point at the high end and one point at the low end of the band.

BAND	CALIBRATION POINTS
A	100 KC - 200 KC
B	300 KC - 500 KC
C	700 KC - 1500 KC
D	2 MC - 4 MC
E	5 MC - 12 MC
F	10 MC - 26 MC

a. EQUIPMENT REQUIRED

A frequency standard and all wave radio receiver are necessary. The frequency standard should be what is known as a calibrator, having crystal controlled frequencies of 100 KC and 1000 KC. The radio receiver should have continuous coverage from the broadcast band to about 30 megacycles.

b. CALIBRATION PROCEDURE

1. Connect the calibrator and Model 340 Signal Generator to the antenna terminal of the radio receiver through dummy antennas as shown in Figure 12. Details of dummy antennas are shown in Figure 2.

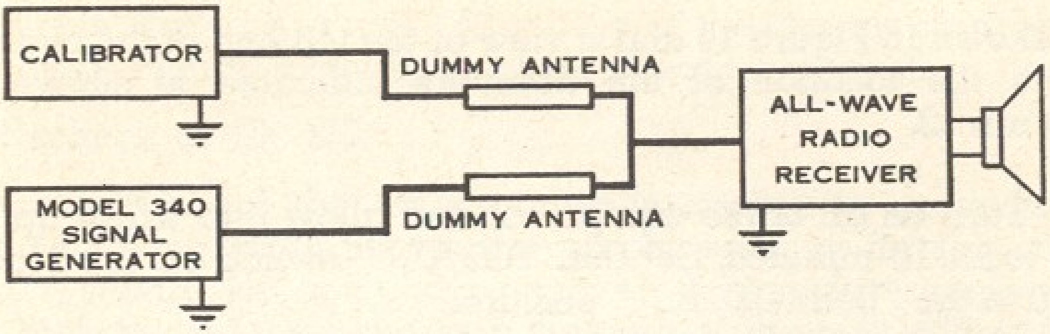


Figure 12 Block Diagram Showing Method of Calibration of Model 340

2. Remove the 10 screws holding the Model 340 panel in the case (1 screw in back on some) and remove the chassis far enough from the case to make the top and end accessible. A top view of the chassis showing the location of the coils

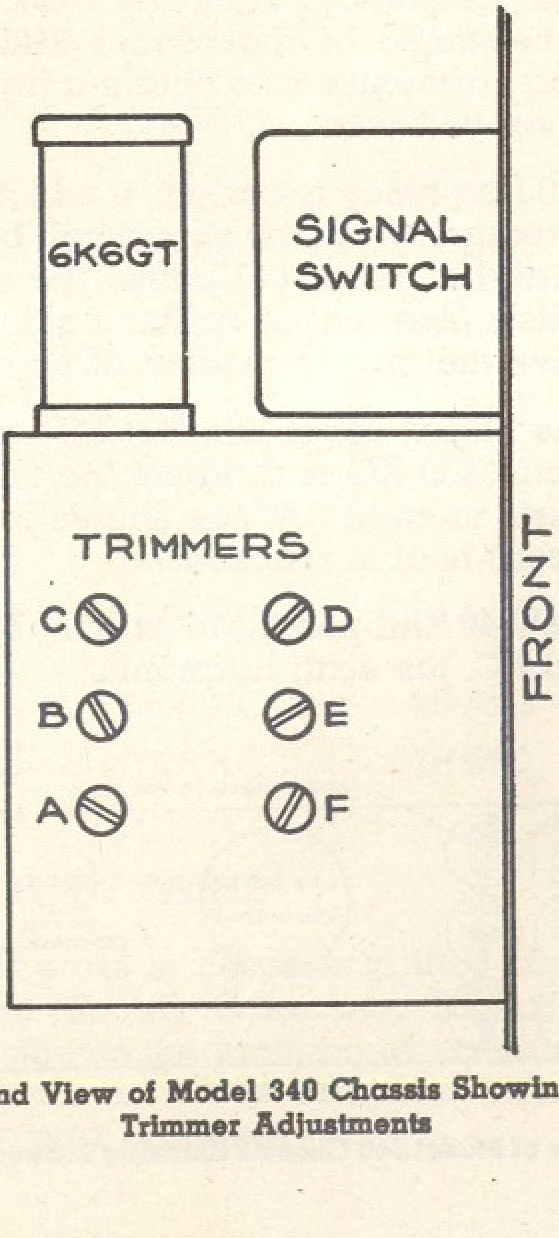


Figure 13 End View of Model 340 Chassis Showing Location of Trimmer Adjustments

is shown in Figure 14 and a view of the left end of the chassis with the location of the trimmers indicated is shown in Figure 13.

3. Turn on all of the equipment and allow it to warm up for at least 10 minutes. Set the "SIGNAL" switch on the Model 340 to the "UNMOD. R.F." position.

4. BAND A—75 - 200 KC

a. Set the calibrator in the 100 KC position.

b. Set the Model 340 "RANGE" switch in the 75-200 KC position and set the dial pointer at exactly 200 KC, using the 4th arc from the inside of the scale. This is the second harmonic of the calibrator frequency. Tune the radio receiver to 600 KC, the third harmonic of the Model 340 frequency. The purpose of using harmonics is to obtain a frequency to which the radio receiver will tune.

If the Model 340 frequency is correct, it will zero beat against the calibrator frequency and no signal will be heard. Moving the Model 340 dial slightly will cause the signal to appear and vary in pitch. The output controls should be adjusted, of course, to give the proper amount of signal.

c. To adjust the Model 340 in the 200 KC position, leave the dial set at exactly 200 KC and adjust the trimmer in the left end of the chassis marked "A", as shown in Figure 13, until a condition of zero beat is reached.

d. Set the Model 340 dial pointer to exactly 100 KC and leave the radio at 600 KC, the sixth harmonic.

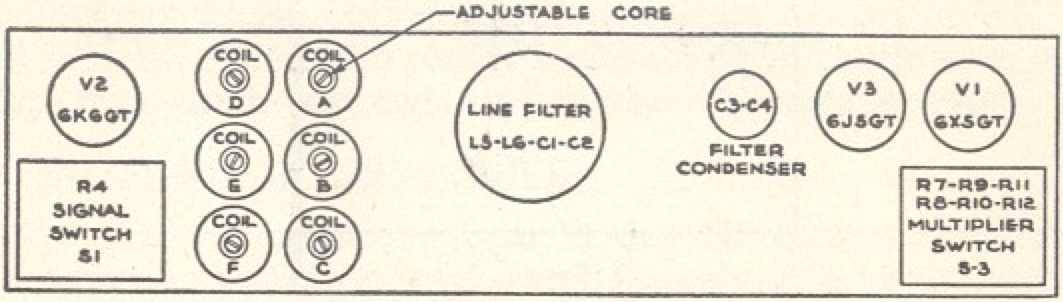


Figure 14 Top View of Model 340 Chassis Showing Location of Coils and Tubes

e. Adjust the core in coil "A" on top of the chassis as shown in Figure 14 until a condition of zero beat is reached.

f. Recheck at 200 KC.

g. Calibration of the other bands is similar in procedure. The following table shows the proper settings for the calibrator, Model 340 and radio receiver. Adjust the trimmer at the high end of the band and the core of the coil at the low end. Always recheck the high frequency position after adjusting at the low frequency.

BAND	MODEL 340 SETTING	CALIBRATOR SETTING	TUNE RADIO TO	ADJUST TRIMMER	ADJUST COIL
A	200 KC	100 KC	600 KC	A	
	100 KC	100 KC	600 KC		A
B	500 KC	100 KC	1000 KC	B	
	300 KC	100 KC	600 KC		B
C	1500 KC	100 KC	1500 KC	C	
	700 KC	100 KC	700 KC		C
D	4 MC	1000 KC	4 MC	D	
	2 MC	1000 KC	2 MC		D
E	12 MC	1000 KC	12 MC	E	
	5 MC	1000 KC	5 MC		E
F	26 MC	1000 KC	26 MC	F	
	10 MC	1000 KC	10 MC		F

3. REPLACEMENT OF PARTS

If replacement of parts is necessary, they may be obtained from the Simpson Electric Company. The parts layout diagram, Figure 15, shows the location of various parts and the accompanying parts list gives complete information. When ordering, specify part numbers.

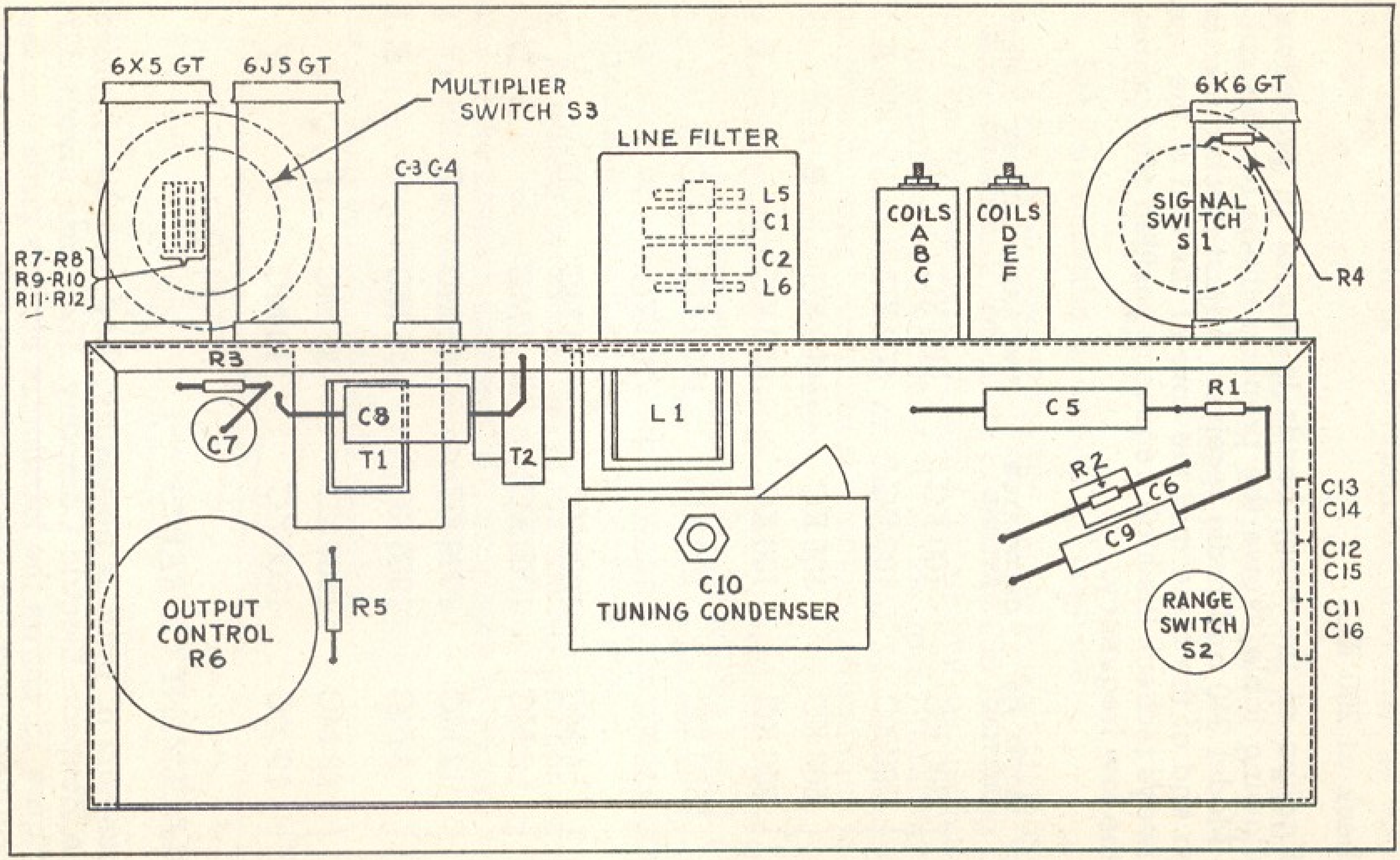


Figure 15 Rear View of Model 340 Chassis With Shield Removed Showing Location of Parts

4. PARTS LIST

PART No.	DESCRIPTION	REFERENCE SYMBOL FIGURES 6, 14, 15
0-008938	Power Transformer	T1
0-008928	Filter Choke 20 H, 20 MA	L1
0-008931	Modulation transformer	T2
1-112969	.05 MF. 400V condenser	C1-C2-C9
1-112575	Filter condenser, dual 10-10 MF. 250V	C3-C4
1-112535	.25 MF. 400V condenser	C5
1-112536	.5 MF. 400V condenser	C7-C8
1-112579	.0002 MF. mica condenser 5%	C6
1-112533	Condenser trimmer assembly (3 trimmers)	C11-C12-C13-C14-C15-C16
1-112513	Variable condenser 440 MMF.	C10
0-008897	Dual 250 Microhenry RF Choke	L5-L6
1-111683	500 ohm resistor ½ watt 5%	R1
1-111670	20,000 ohm resistor ½ watt 10%	R2
1-111684	750 ohm resistor ½ watt 5%	R3
1-111945	45 ohm resistor ½ watt 5%	R4
1-111671	10,000 ohm resistor ½ watt 10%	R5
1-112486	200 ohm potentiometer	R6
1-112576	Candohm resistor 970 ohms and 120 ohms	R7-R8-R9-R10-R11-R12
0-008898	Coil A with shield and leads—iron core	A
0-008899	Coil B with shield and leads—iron core	B
0-008900	Coil C with shield and leads—iron core	C
0-008901	Coil D with shield and leads—iron core	D
0-008902	Coil E with shield and leads—iron core	E
0-008903	Coil F with shield and leads—iron core	F
1-112511	Switch, 2 deck—4 pos.—4 circuit	S1
1-112512	Switch, 1 deck—6 pos.—2 circuit	S2
1-112510	Switch, 1 deck—4 pos.	S3
1-112319	Octal socket	
1-112042	Retaining ring	
1-112529	Line cord (shielded) 6 ft.	
0-008355	Shielded RF lead—36"	
1-111875	Crocodile clip	
1-112648	6K6GT tube	V2
1-112563	6J5GT tube	V3
1-112649	6X5GT tube	V1
1-112596	Tube shield	
1-112595	Tube shield cap	
3-310139	Tube shield base	
0-006128	Dial pointer assembly	
3-230066	Panel 16" x 10" x 3/64"	
3-327822	Case—black wrinkle finish	
0-005576	Bakelite dial cover	
1-112330	Glass for 0-005576 cover	
1-112580	Handle loop	
1-112581	Leather handle	
1-112578	Dial knob	
3-262871	Bar knob	S1-S2-S3-R6
1-111519	Set screw	

Quality is the indispensable component of every Simpson instrument . . . . . .