PROFITABLE SERVICING OF 3-WAY PORTABLE RADIO

by LYLE C. TREAKLE

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PREFACE

• The beginner in radio servicing has plenty of trouble in locating even the simplest defects in radio circuits if those defects are not obvious, such as damaged parts, or a wide open electrolytic in the power supply. When the three-way portable radio is confronted by the novice, he not only encounters difficulty in FINDING the defect, but he also introduces so many more defects before he gets the portable radio going again that it is frequently impossible to charge the customer enough to cover even the cost of the damaged parts.

• Many old-time radio men dislike to work on the three-way portable radio because of the ease with which they can be damaged during the servicing procedure.

• I have observed any number of good radio service men over long periods of time and have never seen one who could outdo Lyle C. Treakle in speedy analysis and repair of the three-way portable radio.

• Mr. Treakle has a simple method of explaining his technique, and has written the following treatise with the idea in mind of getting his simple methods across to the old-timer, as well as the beginner, in the fewest possible words.

• A careful reading of the treatise, coupled with a careful analysis of the circuits presented, should enable anyone to make money from servicing the three-way portable.

Ivan D. Long, President
Western Radio Institute, Inc.

THREE WAY PORTABLES

Three-way portables are so named because they operate on either AC or DC power lines or on self-contained batteries. There are three general types of Three-Way portables, and they will be listed as Type One, Type Two, and Type Three. Type Two is perhaps the most difficult to service. However, all of these types will have to be given special consideration, due to the tricky circuits involved and the possibility of burning out a full set of tubes, which are expensive. The greatest difference between the three-way portable and the conventional battery or electric receiver is in the power supply providing A, B, and C voltages for the receiver. Therefore, we will first study the power supplies of these receivers.

POWER SUPPLY—TYPE ONE

The power supply for Type One is shown in Fig. 1. It will be noted that the filaments of the 1½ volt tubes used in the RF-IF and Audio Frequency Amplifier are connected in series. As these tubes require that

DC be applied to their filaments, they are supplied this direct current power through R_1 and the rectifier tube, V_1, C_1 and C_3 acting as conventional filter condensers to smooth out the voltage to a sufficient degree to reduce hum to a reasonable level.

The tubes listed, 3Q5, 1N5, 1A7, and 1H5, require a total voltage across this series string of 7½ volts. Therefore, if the voltage from the cathode of V_1 to ground is 120 volts, the IR drop across R_1 must be equal to 112½ volts. Then, according to Kirchoff's Law, the voltage across the series string of the filaments will be 7.5 volts. As the current required to heat these filaments to operating temperature is 50 milliamperes, the value of R_1 will be 2,250 ohms and the wattage rating must be EI or a minimum of 5.6 watts. The heat dissipated in this resistor is considerable and is often-times placed in the line cord or in a ballast tube similar in appearance to the ballast tube in the conventional AC-DC receiver.

This system is by no means new but was first used about 1927 on an early model AC receiver. The tubes in the series string were of the 199 type.

R_2 acts as the filter choke for the B supply circuits. This resistor combined with C_1 and C_2, provides sufficient filtering due to the low current consumed by the B circuit. R_3, R_4, and R_5 are by-pass resistors; That is, they by-pass the currents consumed by the plates and screens of the individual tubes. Consider the power amplifier tube V_2. Assuming that the total plate and screen current is 11 milliamperes, and tracing out the circuit using electron flow, it will be found that in the absence of R_3, R_4, and R_5, this current would have to pass through the filaments on the lower end of the string before being supplied to the filaments of 3Q5. Therefore, this current would add to the regular filament current and cause an excess amount of voltage to be developed across their filaments; thereby greatly reducing the life of these tubes. R_3 (Fig. 1) is so chosen that this 8.5 milliamperes will be bypassed through this circuit. The value of R_3 can easily be determined by Ohm's Law.

$$R::E / I$$

E being the desired voltage across R_3, the voltage across the 1N5 plus the voltage across the 1A7 plus the voltage across the 1H5 or 4.5 volts. I in the above formula will be the total plate and screen currents of the tube or tubes current it is by-passing. (In Fig. 1, the 3Q5) The total plate and screen current is 8.5 Ma. with reference to the tube manual. Therefore, R_3 will have a value of approximately 4.5 / .085 or 530 ohms. R_4 and R_5 can be determined by the same procedure, substituting the values of voltage across the resistor and current of the tube it is by-passing, in the above formula.

Another method of connecting by-pass resistors is shown in Fig. 4A. This circuit is used in the P6 Admiral. It will be noted that the resistors are by-passed across the individual filaments rather than to ground. This method can be used to raise the voltage on any one particular tube by selecting the value of the by-pass resistor. The higher the value, the less current this resistor will by-pass and, therefore, a greater amount of current will be passed through the filament of that particular tube. The 200 ohm resistor across the 1A7 filament is purposely chosen to have a higher resistance, raising the voltage on the 1A7, and causing the oscillator to function more efficiently. This will be stressed in a later paragraph.

C_3, (Fig. 1) the 200 mfd, 10 volt electrolytic condenser, serves the double purpose of a filter condenser to reduce the ripple voltage present at the 3Q5 filament and as an audio frequency by-pass condenser. Oftentimes, it will be found when the audio frequency gain is low that C_3 has opened and still the hum appears normal. This is due to degeneration taking place through R_3 in the absence of C_3.

The rectifier tube, V_1, may be of several conventional types; popular types being 25Z6, 35Z5, 117Z4, and 117Z6. These rectifiers will all be connected in the half-wave variety.

When the circuit is switched to battery operation, it is general practice to connect a 7½ volt battery across the series string. This is to be preferred to switching the filaments into parallel and thereby complicating the set considerably. However, in the case of peewee type sets, switching to 1½ volt operation is resorted to, to reduce the size and weight of the A battery.

Referring to Fig. 1, consider the

effect should one of the filaments on the negative end of the string become open. The value of R_3 was previously stated to be 530 ohms. Therefore, the voltage developed across R_3 will be greater than the normal amount. The voltage across R_3 will be 18 volts. As C_3 is in parallel with R_3, the voltage across C_3 will be raised and damage to the condenser may result. If excessive hum is present after the tube is replaced, the electrolyte from C_3 has probably been dissipated due to excess current flowing through these condensers. When replacing the condenser, if it is found to be of the low voltage type, use one of a voltage rating greater than the voltage developed across R_3. It may also be found that R_3 will be completely burned away. This condition may also exist should one of the filaments on the ground end of the string (with respect to R_3) open. As R_3 is a resistance of 530 ohms and is in series with R_1, 2,250 ohms, the total resistance equals 2,660 ohms. The current through R_3 will be 45 milliamperes and it will be necessary for this resistor to have a wattage rating of one watt if it is to withstand this heavy current. Since these resistors are generally of the one-quarter watt type and may burn out, it is essential that the repairman know how to compute the values that should be used in these positions. Thus, he can make computations in the absence of printed information turned out by the manufacturer. Refer to the preceding paragraphs on how to compute these values.

Fig. 4 shows the complete circuit of the Admiral P6 receiver. This particular receiver is designed to use a 1½ volt A battery. Note the complex switching circuits involved.

POWER SUPPLY-TYPE TWO

The power supply in Type Two receiver differs considerably from that in the Type One. A dual purpose tube
in the Type One. A dual purpose tube
such as the 117L7 is employed as both the rectifier and power amplifier tube on AC operation only, and a seperate power amplifier tube is used when the receiver is switched to battery operation. This system has the advantage of much greater undistorted audio output when used on AC-DC operation. It also eliminates use of the high wattage, heat-producing resistor such as R_1 in Fig. 1. It will be found by reference to

the tube manual that the total cathode current of the power amplifier section of the 117L7 is approximately 50 milliamperes. This is equal to the current required to heat the filaments of the battery type tubes to operating temperature. Therefore, this current can be passed through the filaments of tubes V_1, V_2, V_3 (Fig. 2) before it is applied to the cathode of the power output tube, V6.

Now, referring to Fig. 2, trace out thc electron flow from the ground through the filament of V_1, V_2, and V_3 to the cathode of V_6 and then to its screen and plate. This current will total 50 milliamperes if the grid bias is correct on V_6. These tubes in the cathode circuit of V_6 also serve as the bias resistor for V_6. Note that R3, the grid resistor, is returned to ground, and therefore the grid of V_6 is 4½ volts negative to its cathode. C_3 in Fig. 2 serves the same purpose as C_3 in Fig. 1.

The total current drawn from the rectifier section of 117L7 is equal to the plate and screen current of V_6 plus the B supply current to the rest of the receiver. R_1 and R_2 are by-pass resistors and serve the same purpose as R_3, R_4, and R_5 in Fig. 1.

L_1, C_1 and C_2 comprise a conventional filter circuit. Note that when the 117L7 is used its heater is placed across the AC line, no line cord, ballast tube, or heavy wattage resistor being necessary.

POWER SUPPLY- TYPE THREE

Type Three power supply is very similar to the power supply used in auto radio receivers in that it has a wet battery, synchronous vibrator, and conventional buffer, filter condensers, and choke. No troubles should be encountered with this power supply not commonly found in the auto radio types, the only difference being the supply voltage, which is only two volts in the Type Three portable as compared to the 6 volts in the conventional auto radio. The receiver proper is a battery operated receiver and only varies from the usual battery radio in that small value resistor is placed in series with the tube filaments, which are connected in parallel to drop the 2 volt supply to the required 1.4 volts.

TYPE ONE AC OPERATION

The receiver proper varies from a conventional battery receiver in that the filaments are wired in series. As the filaments of these tubes also act as their cathode, the grid must be returned to the negative filament if the tube is to be operated at zero bias; or if it is desired to operate the tube with bias, to return the grid to a point more negative than its filament.

Should it be desired to bias the grid of the power tube (say a 1A5) 4½ volts negative to its filament, it would only be necessary to place the negative filament of the 1A5 at a point in the series string 4½ volts positive with respect to the chassis and then return the grid of that tube directly to the chassis. (See R_{11}, Fig. 8)

AUTOMATIC VOLUME CONTROL

In Fig. 8 the 1A7, 1N5, and 1H5 tubes may be operated at zero bias and the grid return can be made directly to its negative filament, or as shown in the schematic, partial

AVC may be applied. Simple AVC is not practical when the filaments are in series and a form of delayed AVC is generally used. As the diode must be returned to its negative filament if detection is to take place on weak signals, the AVC voltage developed will be negative with respect to the 1H5 filament. If the 1H5 were the last tube on the series string and the grid of a preceding tube returned to the AVC circuit, this tube would have a constant negative voltage applied to its grid. If the tube were a 1N5, a sharp cut off type, its gain would be seriously reduced. Therefore a system of partial AVC is used on these receivers. The AVC circuit in Fig. 3b is composed of R_2, R_4, R_5, R_6, R_7 and the volume control R_8. The voltages indicated in the circuit are with respect to the chassis when circled. Voltage differences between other points are indicated by the arrows. The grid of the 1A7 tube at zero signal is .7 of a volt positive with respect to its negative filament which is connected to the chassis. Therefore AVC action takes place immediately. On the 1N5 IF amplifier, the AVC action is delayed by .4 of a volt. This is caused by the IR drop across R_4 being .4 of a volt.

Fig. 4b is that of an Admiral P6, Three-Way portable receiver and shows a breakdown circuit of the AVC circuit. The grid of the RF amplifier tube at zero signal is biased by .29 volts. This is developed by the resistor R_1, R_2, R_3, and R_4. The grid of the 1N5 IF amplifier tube is .28 volts negative with respect to its filament. Therefore on these tubes no AVC action takes place until the signal strength at the detector is sufficient to overcome the delay voltage. These two types of AVC systems described are representative of the AVC systems used in all Three-Way portable receivers. Little trouble will be encountered in these receivers until they are somewhat older. At that time changes in the resistor values will be such that a larger delay voltage than those indicated in the circuits will be developed and these resistors will have to be replaced. Should the receiver have low sensitivity with no apparent cause, these voltages should be measured, and will require the use of a high resistance input vacuum tube voltmeter and must be measured from the grid to the negative pin of its filament.

Measurements with the conventional thousand or twenty thousand ohm per volt meters will be useless. Of course when low sensitivity is found and all voltages seem to measure OK, be sure and check all the AVC by-pass condensers although not shown in the breakdown circuit. They have been eliminated to simplify the drawings. It is not necessary to disconnect these condensers from the circuit to check the condenser. As the resistance across the units is extremely high if these are checked with an ohmmeter, a definite indication will be obtained.

BURNED OUT TUBES

Whenever a tube is found burnt out in these receivers, never replace the tube unless the other tubes have been checked for satisfactory emission and found to be OK. Should one tube be burnt out and the other tubes have low emission, this is a definite indication of excessive voltage being applied to them and should be treated in the same manner as if all the tubes were burnt out.

Remember a full set of tubes will never burn out unless there is a reason for it and it must be the repairman's job to locate this reason and not plug in a new set of tubes which may burn out the first time the receiver is jarred or even turned on. Therefore, follow the examples given in one of the following paragraphs on every job where there is an indication of excessive filament voltage.

There are a number of causes responsible for burnt out tubes and these should never be replaced without a thorough check of receiver circuits to insure against another set of these tubes being burned out. Referring to Fig. 3, consider the result should C_{18} short. This would place the positive filament of the 1A5 at the same positive potential as the plate, this being 90 volts, and would be directly across the entire filament string. The result would be a complete set of burned out tubes.

Oftentimes it will be found that all tubes in the receiver will have low emission. These should be treated in exactly the same manner as if all the tubes were burned out, as excessive current through their filaments will greatly reduce the ability of the filaments of these tubes to emit electrons during normal operation.

It may be found that on occasion the tubes all check very low and yet when they are placed in the receiver apparently operate normally. This is caused by the tubes being run beyond their rated voltage in the receiver, and due to the excessive temperature developed within the tube, sufficient electrons will be emitted by the filament to give apparently normal operation.

However an early breakdown of these tubes can be expected and if this condition is found by the repairman, steps should be taken to reduce the filament to the normal voltage and a new set of tubes installed. As Fig. 3 will be a wire wound type of resistor, it is very unlikely that its value will change. Other causes for the above condition can be leaky C_{18}, C_{17}, or external leakage between B and C of C_{19}.

When a set of tubes is found to be completely burned out, a new set should never be inserted in the receiver but shunt a 30 ohm resistor across the filament pins of each of the 1½ volt tubes and 60 ohms across the 3 volt tubes. Inserting the rectifier tube only, the set is then turned on and the actual voltage measured across each individual tube socket. If this is found in excess, the investigation should continue until the cause is found and remedied.

If the voltage is found normal, an extensive search for the short circuit itself should be made until the repairman is positive that an insertion of a new set of tubes will not be damaged. C_{17} should always be checked for leakage. Leakage as great as 20 megohms can cause the trouble in these receivers.

Many times it will be found that the filament voltage on the tubes will be so low that the set will not perform satisfactorily. This is generally first noticed when the set operates over only the high frequency end of the dial, the oscillator ceasing to function on the low frequency end when the L/C ratio becomes lower. This can generally be traced to low emission on the 1A7 tube which may be normal deterioration of the tube or may be caused by low filament voltage. These receivers will require that the line voltage be of full value if they are to perform satisfactorily.

Should the receiver be stationed

in an area of low line voltage, it may be necessary to reduce the effective value of R_{12} in order to supply sufficient current to the filaments of these tubes to obtain satisfactory performance of the receiver. R_{12} may be shunted with another resistor of greater value to lower the effective resistance. Never use a carbon type resistor in this position as any heating of the carbon resistor due to excessive current flowing through it or excessive external heat will cause the ohmic resistance of this carbon resistor to be reduced in value, raising the voltages applied to the battery tube and either burning them out or reducing their ability to operate. Great care must be taken when undertaking this type of job and you must be certain that the receiver will always be operated on this low voltage.

Whenever it is found that the oscillator has a tendency to cut out whenever an appliance is plugged into the line, it may be necessary to raise the filament voltage across the 1A7 tube. The above condition will be most noticeable on the low frequency end of the dial. This may be corrected as described above, or the system below may be used if the voltages of the filaments check normal, yet replacement of the 1A7 tube with a new one has no effect on the oscillator's performance.

Perhaps a much better method of raising the voltage across the 1A7 converter tube F_{11} is shown in Fig. 1a. Note that R_3, the by-passed resistor for the 3Q5 tube, is disconnected at the ground end and placed at the positive filament of the 1A7. Now, the plate and screen of the 3Q5 must flow through the 1A7 filament before being applied to the filament of 3Q5. This increases the total current through the converter filament by approximately 11 milliamperes, and is usually sufficient to start the oscillator operating efficiently. This may not sound like good practice by raising the filament voltage of any particular tube; it has been found that these 1A7 tubes must be operated at their full rated voltage or more if satisfactory life is to be obtained from them.

Therefore, it will be often found advisable to make this change. Note that when R_3 is applied to the positive filament of the 1A7 that this current must also flow through the 1H5 filament unless precautions are taken to avoid this condition. This can be most easily done by changing the ohmic resistance of R_5, the proper value being found by Ohm's Law,

$$R :: \frac{E}{I}$$

E being the voltage across the resistor 1½ volts in Fig. 1A and I will be the total of the plate and screen currents of both the 3Q5 and 1A7 tubes or approximately 110 ohms.

Other causes of low voltage would be A section of C_{19} open or extremely high power factor. B, or C having high leakage, or normal deterioration of the rectifier tube. All of these should be thoroughly checked before altering the value of R_{12}. (Remember that a tube checker is very unreliable when checking rectifier tubes. Replacement of the rectifier tube is the only sure check of this condition.)

Another cause of low filament voltage on the tubes would be when the line cord containing R_{13} has been replaced with a higher value of resistance. This would lower the heater voltage of the 35Z5 tube, and lower the efficiency of the tube. Never increase any battery 1.4 volt tube beyond this value in trying to make the receiver perform more satisfactorily unless necessary to cause oscillator to operate. If it is found necessary to do this in order to make it perform satisfactorily, a complete check of all components including the impedance of the RF-IF transformers and the oscillator coil should be made. Using the vacuum tube voltmeter check the bias voltage on the RF-IF tubes. Consider the effect should R_4 become open. (Fig. 3b) This would place the grid of the IF amplifier 1N5, 1½ volts negative with respect to its filament and lower its mutual conductance from the 750 micromhos at zero grid voltage to 100 micromhos greatly reducing the gain of the stage.

TYPE TWO-AC OPERATION

The Type Two portable receiver will have most of the faults of the Type One receiver plus several more peculiar to this type. One common trouble of the Type Two receiver is a recurrence of the rectifier power amplifier tube burning out. This is due to the fact that the heater of this tube is placed directly across the 117 volt line. As the material used in the heater is TUNGSTEN, its resistance when cold is quite low, and, therefore when applied to the line voltage, currents, flow momentarily through the heater far beyond the rated value of the tube. This trouble can be eliminated by placing a 100 ohm resistor in series with the heater of the tube. This will lower the voltage somewhat across the heater of the 117L7 but will not materially affect operation of the receiver.

When the battery type tubes are found burnt out in these receivers, they can generally be traced to the 117L7 tube, or its circuits being defective. As the battery type tubes are heated by the total plate and screen currents of the beam power section of the combination tube, any of the components which vary the grid voltage on this tube will also vary its plate current, such as C_4. (Fig. 2) If this becomes leaky and the grid of the 117L7 goes positive, excessive current will be allowed to pass through the tube. As this current passes through the filament of the battery type tubes, they also will be raised beyond their normal operating value and damage if not outright burning out of the filament will result.

Fig. 5 is a complete schematic of the Emerson Model FU 424 which is the Type Two portable. C_{12} which connects from the plate to cathode of the 117L7 tube can become shorted, and burn out the four tubes through which this current would flow. It is also possible for internal shorts within the output tube to cause this condition.

A precaution which must be taken by the repairman is to keep from burning these tubes out while making the regular voltage tests. The test leads used should be completely insulated excepting for about 1/8 inch of the prong at the very end. If the plate voltage should be checked and the prong was allowed to slip from the plate pin and momentarily short to the filament pin, all tubes on the negative end of the series string would be burned out. Another common cause of tubes being burned out in the repair shop is the neglect to discharge condensers. If the set comes in with a complaint of hum, it is general practice for the repairman to bridge another electrolytic condenser across each condenser in the receiver and try to locate the one which is open. However, care must be exercised when repairing these receivers in that the condensers are completely discharged before being applied across the next condenser. In referring to Fig. 2, should a condenser be bridged across C_1 and charged, the voltage normally across there is 120 volts, and then without being discharged apply this condenser to C_3. The condenser would be charged to the voltage of C_1 and sufficient energy will be stored within a 40 mfd. electrolytic condenser to completely burn out the filaments of V_1, V_2, and V_3.

When it is found that the rectifier tube has zero emission it should be inspected to see if the cathode tabs have been burned off. These tabs can be seen through the glass at the base of the structure of the tube and acts as a fuse if excessive current is passed through the rectifier section. If the tabs are burned off as determined by inspection, tests should be made before replacing this tube. If the input filter condenser were shorted the tabs would immediately burn off the replacement tube. If a reliable condenser checker is not at hand, plug the old tube into the socket and turn on the receiver allowing it to warm up. Then with a 100 volt B battery, apply the voltage from ground to the cathode terminal of the rectifier tube socket. If the receiver is normal, it will start to operate. An ohmmeter test from cathode terminal of the rectifier tube to ground may determine the trouble on the Type One receiver. It should always be greater than 2,000 ohms and on Type Two receiver always greater than 5,000.

Cutout cases in the Types One and Two portables are quite common. Most likely, the trouble will be the oscillator ceasing to function when the line voltage is slightly down. This condition is described under servicing of Type One receivers. However, one condition not common to the Type One receiver is when the emission of the power amplifier tube has become sufficiently low so as not to pass enough current to operate the 1A7 properly.

Unless great care is exercised on the part of the serviceman, some rather embarrassing developments can result when making repairs on these receivers. Consider the hypothetical case of the customer bringing into the shop a receiver whose circuit is shown in Fig. 5, the Emerson

Model FU 424. The complaint is distortion on all signals, otherwise everything is OK. The repairman removes the tubes from the receiver and tests them. He finds that four of the battery type tubes, 2-1N5's, 1-1A7, and 1-1H5, all have very low emission. The 117L7 and the 3Q5 tubes are normal. He replaces these tubes with new ones from stock. Upon placing the receiver in operation, no improvement in the performance has resulted. After a complete check of the receiver, he finds that C_{11} has a leakage of 20 megohms and since C_{11} is a coupling condenser, he reasons this could be the trouble as the grid voltage could be changed enough to cause the distortion. The repairman then replaces C_{11}. To his surprise, the receiver fails to function altogether. After a considerable amount of checking and finding no apparent cause for the trouble, the tubes are again tested. Four of these are the new tubes that were replaced previously, and all four are found to have the same defect as the original set--low emission. After these tubes are again replaced the receiver operates normally. These battery type tubes are quite expensive and surely the customer cannot be charged for two new sets of tubes. The repairman winds up with a financial loss on this particular job.

Now let us analyze why this new set of tubes and the original set were rendered useless. When C_{11} developed that 20 Meg leak, it placed a bias voltage of -4 on the grid of the 117L7. This increased the plate and screen current to approximately 100 milliampéres. Plate and screen currents flow through the filaments of the battery type tubes and excess current flowing through these filaments will render the tubes inoperative at their normal operating voltage; then after C_{11} was replaced and the normal operating voltage and currents were applied to these tubes they refused to function, but operated normally when greater currents were flowing through their filaments.

The proper method of handling the above servicing job would have been for the repairman first to investigate the cause of having low emission on these four tubes. If one or more of the tubes had been burned out, perhaps he would have used more caution. When emission is low on all the tubes, they should be treated in the same manner as if all these tubes were burned out. This is best when it is done as mentioned previously by placing a one watt, 30 ohm resistor across the filament contacts of the tubes and then taking the required measurements of the voltage and the current to the beam power section of the 117L7.

Voltage measurements on some types of portable receivers can cause the tubes in the entire string to be either burned out or reduced in their ability to operate. This may sound rather astounding to the service man who is accustomed to measure all voltages in any receiver using his regular voltmeter without any injurious effect to any components of the receiver.

However consider the circuit of Fig. 6, which is a breakdown of the power output and filament section of Spiegels Model K, a Type 2 receiver. The tube, V_1, is the beam power section of a 70L7 tube, used for the rectifier and power output tube on AC-DC operation. As with all of the Type 2 circuits, the resistance of the filaments of the battery type tubes is used for the bias resistor and the plate and screen currents pass through these filaments heating them to operating temperature. As there are 3 battery type tubes in the series and if the total plate and screen current of the 70L7 equals 50 milliamperes, the bias voltage of grid No. 1 of the 70L7 is 4.5 volts. R_g is three megohms. Consider the case of measuring the voltage from the grid to the cathode of the 70L7 tube. Using a 1,000 ohm per volt meter on a 7½ volt scale, this places the effect of R_m in the circuit and the tube is biased to a point near zero. (see Fig. 6A) which is an equivalent circuit of the previous Fig. 6. The voltage from grid to cathode in this circuit equals that of the battery, or 6 volts. But when the resistor R_m is switched into the circuit, the voltage between the grid and the cathode becomes .09 volts. This is exactly the same effect as if an attempt were made to measure the voltage from the cathode to the grid of the 70L7 tube. As this small voltage is now applied to the grid, the plate current would increase to a sufficiently high value (Approximately 125 milliamperes) to burn out the filaments of V_2, V_3, V_4, and V_5. Therefore, it should be remembered that the grid voltage of these tubes should not be checked except with a VTVM.

When it is found that all the battery type tubes are burned out or have low emission, it would be impractical to replace these tubes before a complete check of the circuit is made. However, it is sometimes difficult to check the circuit except under operating conditions. This can be conveniently solved by placing a 30 ohm resistor across the filament contacts of each socket of the battery type tubes and checking the voltage across these to be sure it is not in excess as described previously.

Biasing of filament tubes when operated in series becomes quite dificult. If the tube is to be operated at zero bias. The grid must be returned to its negative filament. If it is desired to bias it at a negative voltage, the grid may be returned to a point more negative than its filament. Complications set in when AVC is incorporated in the receiver. Consider the circuit of Fig. 7. Here the 1N5 tube has AVC applied in the conventional manner used in AC operated receivers. However, this is delayed AVC as the grid of the 1N5 is normally 1½ volts negative with respect to its filament. As this tube is of the sharp cut off type, the mutual conductance of the tube has been greatly reduced. A preferred system is shown in Fig. 8, and this becomes simple AVC with the 1N5 operating at zero bias with no signal input. This works quite well when only one stage is applied to the AVC. If more than one stage is to be supplied with automatic volume control voltages, this resistor network becomes quite complex. A system of this type is shown in Fig. 3 and the breakdown circuit is shown in Fig. 3B.

Another arrangement of the Type One Portable Receiver is shown in Fig. 9. This circuit makes use of a power tube with a 1½ volt 100 milliampere filament such as the 1Q5. The 100 milliamperes is supplied from the rectifier tube in much the same manner as shown in Fig. 1. Where all types of tubes are of the 50 ma. variety. The main difference is that when 50 ma. tubes are placed in series with the 100 ma. type, 50 ma. must be by-passed around its filament or two such tubes must have their filaments connected in parallel as V_3 and V_4 in Fig. 9a, this breakdown circuit is of the Motorola Model 51D. The peculiar rectifier circuit will be taken up later.

The advantage of the parallel filaments of the 1A7 and 1N5 is the simplicity with which AVC can be applied. It would also be possible to apply simple AVC to the 1N5, the IF amplifier tube using this arrangement. The bias voltage applied to the grid of the power amplifier tube 1Q5 is developed across the filaments of V_3 and V_4 plus the drop across the 27 ohm resistor and the filament of V_5, as the grid is returned to ground through resistor R_5. x When the receiver is to be operated from the self contained batteries the grid bias voltage for the 1Q5 power tube is developed across R26 Fig. 9, which is in series with the negative battery lead and develops the proper voltage from the B supply current flowing through it, the grid being connected to the negative terminal of it, the positive terminal being grounded as well as the negative filament of the 1Q5. One particular advantage of the parallel filament arrangement is simplicity of switching to 1½ volt battery operation.

Disadvantages of the system are: Short rectifier life owing to the fact that the tube is operated at full capacity. Higher current is required through the series dropping resistor R_3, thus requiring a greater amount of filtering by C_1 and C_3. Therefore, the capacity of these condensers must be increased.

Another serious disadvantage is that when either V_3 or V_4 burn out due to normal circumstances, its complementary tube also burns out, causing undue tube replacement costs. Care should be exercised by the repairman in all types of portable receivers not to remove any of the tubes when the set is operating, particulary in this type, since if either V_3 or V_4 is removed from the socket, the other tube would either be burned out or ruined by the excessive current passing through its filament.

Referring again to Fig. 9, it will be noted that the rectifier is in the negative leg. This is quite different from the conventional circuit shown in Fig. 1, where the rectifier is in the positive leg. The arrows shown in Fig. 9a, show the DC electron flow from the AC line through V_1, the rectifier tube, and to the chassis, then back through the filament circuits of the V_3, V_4, V_5, and V_2. Should the filament of V_3 V_4 fail and the other tube which is in parallel to it burn out also, due to the excessive current flowing through its filament, the only path for this current to flow would be through R_3 and R_5 as the ohmic resistance of these are nearly equal, the voltage developed across R_4 would be approximately half the supply voltage of 120 volts or 60 volts. C_4, the 500 mfd filament filter condenser, is rated at only 4.5 volts. This condenser is across the 60 volts developed across R_4, such voltage being far in excess of the rated operating voltage may short or boil out the electrolyte due to the leakage through it caused by the abnormal voltage and it, along with the two tubes before mentioned, would have to be replaced.

Concerning R_4, the ohmic resistance was stated to be 1000 ohms, its wattage rating listed as ½ watt, but under the conditions, considered the voltage across the resistor is 60 volts.

$W::E^2/R$ or 3.6 watts a 750% overload, so it too may burn out

The total result can be a sizable repair job, all from a tube normally developing an open filament. Note that R_4, the by-pass resistor across V_5, divides the current equally so that 50 ma. is flowing through each branch. R_1 is the conventional line voltage dropping resistor reducing the voltage to the rated value across the heaters of the 25Z5. R_2 supplies the normal filter choke needs of the B filtering circuit. R_5 is the conventional by-pass resistor as described previously. Note that C_1, the input filter condenser, is connected from one side of the AC line to the chassis; its capacity is one hundred microfarads. However, tracing the flow through V_1, only pulsating DC voltage is applied across the V_1.

R_3 will be approximately one-half the value used in portable receivers using all 50 ma. filament tubes. However, its wattage rating will remain the same due to the lowered resistance of R_3.

The bias voltage for the 1Q5 power amplifier tube is developed across the series parallel combination of the filaments of V_3 and V_4, V_5, and R_4.

HOW TO CURE HUM IN PORTABLES

When operated on AC power hum in 3-way portables can be very difficult to reduce to an acceptable level. Oftentimes the hum was present when the receiver left the factory as a new set, yet the radio repairman may be expected to reduce the hum level still further. Normally the hum level will be higher in the 3-way portable than is the case with the conventional AC home-type receivers. However, the hum level can be reduced if care is taken to study out a suitable method to accomplish the desired end.

The system here offered can be utilized in handling stubborn cases.

Let the serviceman remember this, however: First make certain that all filter and bypass condensers are good and of the proper value. Do not attempt to remove hum by the method here given until the original components in the set are determined good and thus eliminated as suspects. In checking condensers quality, value and power factor should be checked with a condenser checker. It is not possible to check electrolytic condensers with an ohmmeter and obtain an intelligent check on them.

Three checks must be made to determine the condition of an electrolytic condenser. 1--Leakage, which can be checked to a certain degree with an ohmmeter. Due to the low voltage applied by the ohmmeter, this test may be inaccurate, since it is possible for the condenser to have leakage only when high voltage is applied.

2--Capacity. Many servicemen feel that it is possible to judge the capacity of a condenser by observing the initial deflection of the needle when the ohmmeter prods are applied to the condenser terminals. In 3-way portables the value of electrolytic condensers used is so much higher than that of electrolytics used in conventional receivers to which the serviceman is accustomed that his skill in estimating the capacity values is useless. Also, the power factor of the condenser must be taken into consideration. All electrolytic condensers have an internal resistance that is in series with the capacity itself, which with the reactance of the condenser determines the power factor--the power factor being the cosine of the phase angle of these two components present. The power factor of an electrolytic condenser increases as the electrolyte within the condenser drys out with age or excessive heat.

The power factor of an electrolytic condenser increases with age, or when excessive heat is present either from an AC component being present in the circuit, from leakage through the condenser, or from external heat which may be caused from the condenser being placed too near a high-wattage resistor developing considerable heat, or from the power tube. Such heat increases the resistance in series with the capacity.

Measure the power factor on a bridge where the phase angle of one voltage can be balanced against the other and calibrated directly in percentages. A high power factor indicates that the unit has started to dry out and its future life is quite limited. New electrolytic capacitors generally have a power factor of less than 10%.

When the addition of capacity to the filter circuits does not reduce the hum, and it has been ascertained that all filter condensers are of the proper values and in good condition, then determine in which stage the hum originates, using the process of elimination.

Reduce the volume control to the minimum setting. If this reduces the hum it may be originating in the detector or the grid circuit of the first audio amplifier tube. In this case, check the shielding of the tube and the grid lead. Also check the placement of the grid lead. Determine whether it is running parallel to any wires carrying AC current. It is unlikely that the hum is being induced in the IF, RF, or oscillator section of the receiver when the above test reduces the hum. (In cases where the hum appears only with the signal, refer to Modulation Hum, which appears later in this treatise.)

If the above test does NOT reduce the hum, place a 20 mfd. electrolytic condenser between the grid of the power tube and ground (negative terminal to grid.) If this reduces the hum, try decoupling the plate circuit of the first audio tube as shown in Fig. 10, using the approximate values of R and C shown. Should this have no effect, move the R and C filter to the grid circuit. This may accomplish the job.

If shunting the grid with the

condenser does not reduce the hum, the hum is originating in the plate circuit of the power tube and it may be necessary to add degeneration to the circuit.

Adding degeneration to the circuit will reduce the overall gain of the receiver, the amount of reduction being determined by the amount of degeneration that is applied to reduce the hum to a suitable level. Figure 11 shows one method of reducing hum by the addition of degeneration. One side of the voice coil is grounded and the other side is fed to the grid of the first audio tube through the resistor R_1.

If the grid resistor does not return to ground it will be necessary to include C_1 in series with the resistor. Otherwise it is non-essential.

The amount of degeneration used can be controlled by the value of R_1, the larger the resistance the less the degeneration that will be applied. Use only enough degeneration to reduce the objectionable hum. This will also reduce distortion and improve the overall frequency response of the receiver.

In stubborn cases of hum, when degeneration is not sufficient to reduce the disturbance to a suitable level, it may help to increase the size of the coupling condenser between the first and second audio tubes. This will reduce the phase rotation in this circuit and the feed-back voltage will be more nearly 180 degrees out of phase. It is essential that the feed-back voltage be an out-of-phase voltage with the hum. This is determined to be correct by trial, switching the connections leading from the voice coil to the feed-back connections. That is, ground the other side of the voice coil and apply the grid lead to the opposite side of the voice until the effect desired is obtained.

CONCERNING MODULATION HUM

Modulation or tunable hum is that hum which is present only when a signal is being received. This is generally caused by the received signal being modulated by the AC supply voltage and may often be eliminated by placing a condenser from the hot side of the line to the chassis. If one side of the line is not grounded to the chassis, use a condenser from both sides of the line to the chassis. If insufficient filtering is present in the filament or B supply voltages the AC ripple may modulate the oscillator and this modulation would be present in the IF signal. Filtering may then be tried as shown in figure 12.

MISCELLANEOUS CAUSES OF HUM

1. Shields removed from tubes.
2. Speaker has been replaced with a more efficient type speaker.
3. Heater-to-cathode leakage in rectifier tube.
4. Worn volume control.
5. Loop open or leads broken, causing modulation hum.
6. Open condenser in AVC circuits.
7. Open decoupling condensers in plate or grid circuits of audio stages. Try large values of capacity from different points of the filament circuit to ground. Make sure condenser is discharged before applying. Also have leads of condenser covered with spaghetti to within a quarter inch of the ends as an assurance against shorting a prod to B plus and burning out the tube filaments.
8. Back the speaker away from the baffle about one-quarter inch.
9. In stubborn cases, remove the plate resistor of the first audio

SERVICE PROCEDURE FOR THREE WAY PORTABLES

When the portable receiver is brought into the shop for repair, care should be taken of the hardware as most of this is of a special nature and hard to replace. Place it in a container and keep it with the receiver itself.

When removing the receiver from the cabinet, first disconnect the batteries as a precaution against burning out the tubes. Should bare spots on the wire short, or a strain be placed on the leads, it may cause shorts inside the receiver itself which may damage the tubes. While the batteries are disconnected and convenient, check them on a battery tester. An ordinary 5000 ohm per volt meter is not suitable for checking batteries. A load must be placed on batteries to determine their condition.

In the absence of a suitable battery tester, put a ten milliampere drain on the 'B' battery, selecting the proper resistance by using Ohm's law. This will be approximately 4,500 ohms for a 45-volt 'B' battery and 9,000 ohms for the 90-volt 'B' batteries. On the 'A' batteries, if they are the 1½ volt type, use a 200 milliampere drain. The resistor size will be 7½ ohms. On six and nine volt batteries, use a drain of 50 milliamperes. If the batteries are bad and the customer should not want them replaced with new ones, do not put the batteries back in the cabinet, but keep them with the radio and explain to the customer that run-down batteries will soon leak and cause corroding of the wires and other parts of the receiver.

Remove the chassis, being careful not to break the leads from the loop antenna. If the loop is built into the cabinet itself, put on extensions, using small standard wire. Solder these tightly and give yourself plenty of length to facilitate turning the receiver over to make the tests and adjustments. Check all the tubes and replace those which are defective.

Check the receiver for proper operation to determine whether the tube replacement has cleared the trouble. If the radio is apparently acting normal, use an auto transformer if available or a variable resistor. Lower the voltage which is applied from the AC line to approximately 107 volts to determine whether the oscillator will stop functioning when the voltage is low. If the oscillator does stop, refer to the text under 'Intermittent Operation'.

If the radio still does not operate, do not plunge into the receiver with a voltmeter and a pair of test leads. Tape the leads thoroughly to the point of the prod, allowing only 1/16 or 1/8 of an inch to extend beyond the tape as a precaution against shorting the plate connections of any tube to the filament connection and burning out all tubes on the negative end of the string.

In the Type One portable receivers, first check the plate and screen voltage on the power amplifier tube. Determine if voltage is normal. When making voltage tests, measure the voltage across the oscillator grid leak to determine if the oscillator is functioning. This test will not give an indication as to which frequency from the oscillator may be operating but will give a definite indication of the oscillator's operation. The oscillator grid leak resistor is R1 in Fig. 3. If voltage is present and the receiver does not operate, measure the filament voltage directly across the filament pins being very careful not to short any part of the test leads to the chassis or any other connections. Filament voltage should be the rated voltage of the tube. If the voltage is low, check the power supply. Measure the voltage from the 'B' minus which can be obtained easily at the AC switch, when the chassis is not grounded, to the cathode of the rectifier tube.

If the line voltage is normal, the 'B' voltage should be a minimum of 120 volts. If 'B' voltage is less than 120 volts, try replacement of of the input filter condensor, as it may have high power factor causing a low output voltage. If the input filter condenser proves to be O. K., try replacement of the rectifier tube since rectifier tubes check normal in many tube testers, but when placed in actual operation under normal load will not perform satisfactorily. If tube replacement or filter substitution does not raise the voltage across the filaments of the battery type tubes, check for a resistor which has increased in value in the plate circuit of the rectifier tube. These are generally from 15 to 50 ohms and may have increased in value or be burned partially away. On some particular receivers when the pilot light is burned out, the output voltage of the rectifier may be low.

If the filament voltage on the power amplifier tube proves to be normal, check the filament voltage on the other tubes in the circuit. It is possible that the electrolytic filament-filter condensor may be shorted thus by-passing the current which would normally flow through the other tubes. This condensor is referred to as C3 of Fig. 1. Also a by-pass resistor may have reduced in value from excessive current flowing through it, the result of an open filament, and be by-passing more current than was intended for it; thus lowering the voltage on certain tubes.

If all voltages in the receiver appear normal and yet the receiver is still dead, try signal injection. Touch the grid of the first audio frequency amplifier tube 'A 60-cycle buzz should be heard in the speaker.

It will not be the loud buzz that may be heard on an AC receiver, but will be present in sufficient volume when the set is operating satisfactorily so that there will be no confusion as to the audio frequency amplifier operation normally. If this buzz is not heard when touching the grid cap of the first audio amplifier tube, remove the grid cap and try again. If a buzz is heard, the trouble may be a shorted volume control. If not, the trouble is in the audio frequency amplifier.

Try touching a screw driver to the grid of the power amplifier tube. A click should be heard but this will not be of too great amplitude. Be very careful not to short the grid to any of the other terminals or to the chassis of the receiver. If there is no response from the last test, check the speaker, output transformer, etc. This can most easily be accomplished by listening to the speaker intently. If it is performing, there will be some hum present at all times. Probable trouble with the speaker would be open or shorted voice coil or the speaker cone is badly out of adjustment and the coil is frozen to the poles.

If the entire audio amplifier system is operating normally as determined by touching the grid cap of the first audio frequency amplifier tube, using a signal generator, try injecting a signal at the IF frequency, which can be determined in the receiver index in the back of this text.

First, place the output of the signal generator to the plate of the IF amplifier tube, and if the signal cannot be received, try adjusting the trimmers of the IF transformer. If this brings no results, check the IF transformers for possible shorted trimmer condensors, open windings, etc.

If the above tests prove that the output IF is operating normally, place the signal generator prod to the grid of the mixer tube. If the signal is still heard with good volume, the trouble may be in the oscillator or loop antenna.

Check these. When applying the signal generator to the grid of the mixer tube and no signal is received, check the AVC by-pass condensers, IF transformers, and screen by-pass condensers.

DISTORTION

Distortion in portable receivers is quite common in the peewee type using the miniature tubes. If it is audio distortion, it is generally caused by the plate resistor of the 1S5 tube being of too high value. Reduction of the value of this resistor will generally clear such distortion. Another cause of audio distortion is leaky coupling condensers.

Speakers are a common cause of distortion on the portable type receivers. A speaker may be damaged by rough treatment, thus causing misalignment of the voice coil. Speaker cones warp when they get damp, and cause distortion.

RF distortions can be caused from excessive AVC voltage. This can be most easily determined by rotating the receiver to the null point of the loop and noting whether the distortion decreases or disappears. If AVC voltage is found to by causing distortion, first determine if the power input from the transmitter is excessive in your particular neighborhood. If not, perhaps some of the AVC filter resistors have changed value, and are applying excessive AVC voltage to a sharp cutoff tube such as the 1N5.

Open AVC condensors or oscillation in the receiver will also cause distortion.

To the trained ear distortion

identifies its source of origination. The repair man should practice constantly to develop the ability to determine by ear whether distortion is originating in the audio frequency section or in the radio frequency section. To the beginner, all distortion may sound alike--just bad. To the experienced repair man who has practiced the listening technique, the particular trouble can be traced to a particular section of the receiver without much waste of time in testing the components in the other sections.

Nothing could be written describing a type of distortion so that a reader could learn to identify distortion. In this case, experience is the only teacher.

HUM
TROUBLE

If the complaint on the receiver is hum, first determine in which circuit it is originating and whether it is present at all times.

There are three general types of hum; Audio Pickup, Filter, and

Modulation Hum. Filter hum will be the most common and is caused by the filter condensers drying up and losing their capacity. Filter hum will be present at any setting of the volume control. If one filter condenser is bad, it can be expected that the other section will deteriorate shortly, and it is therefore advisable to replace all filter condensers. Replacement of filter condensers is sometimes very difficult in miniature portables which have special condenser blocks that are not available. Remember to keep new filter condensers away from the large heat-producing resistors which will dry them up very rapidly. It is always preferred to have the exact replacement for filter condensers.

Grid pickup hum from the first audio amplifier tube will disappear when the volume control is turned to minimum, whether the radio is tuned to a station or not. Grid pickup hum is generally caused by the tube shield of the first audio amplifier tube having been removed or making poor contact with the chassis. Sometimes the volume control has been replaced and the shielded grid lead is not properly grounded. Tunable hum is only present when the receiver is tuned to a station and can be quite annoying in the receiver. Tunable hum may be caused by the electrical wiring in the house where the receiver is being operated. For this reason, when this radio is brought into the repair shop, hum will not be present. In that case, the repairs will have to be made at the point where the receiver is to operate. Measure the AC line voltage from both sides to a water pipe or other good ground. One side should measure the full line voltage and the other side of the AC line should read zero voltage. If one side does not measure zero, call the power company and have them ground the lines. This will perhaps cure the trouble.

If the receiver hums at any location, it may be caused by an open loop antenna, no condenser across the AC line within the receiver, or the 'B' plus filter which applies the oscillator voltage may be open.

INTERMITTENT OPERATION

When the portable receiver has intermittent operation, this will most often be caused by the oscillator ceasing to function. It will be most noticeable at the low frequency end of the dial. Other causes of intermittent operation will be coupling condensers opening or AVC by-pass condensers opening. These can sometimes be determined by inspection and noting whether the wax has become loosened from the end of the condenser. If it is determined that the oscillator is not at fault, clip in a vacuum tube voltmeter across the diode load resistor and allow the receiver to operate, noting the reading on the meter. When the receiver cuts, refer again to the meter and compare the reading with that taken when the receiver was operating normally. If it is the same, the trouble is the audio frequency amplifier. If the reading is appreciably less, the trouble is in the radio frequency amplifier and is perhaps caused by an intermittent by-pass condenser opening up. Using an insulated tool as a prod move all condensers in the circuit, pushing the body of the condensers away from the leads to try and make contact to the foil again should the condenser be open. If the receiver cuts back in, you have probably located the offender. If it is in the audio end, use the same process as above.

Occasionally, speaker voice coils will open intermittently. Under that condition, absolutely no hum will be heard in the speaker and can be determined by listening intently.

Filter condensers which open and then remake contact are often a source of intermittency. They will generally, however, be accompanied by a filter hum. If an attempt is made to bridge this particular filter condenser with another one, the shock of charging the condenser may cause the offending filter to go back into normal operation. Then it cannot be determined exactly which one it was at fault. It will be well worth while to replace the entire filter assembly.

ALIGNMENT OF 3-WAY PORTABLES

Alignment of the Three-Way Portable receiver is sometimes difficult. When an AC operated signal generator is used, connection to the grid of the mixer tube generally results in a loud modulated hum in the output. If the receiver does not have a radio frequency state, this hum can be overcome by connecting the lead from the signal generator to a metal plate approximately the size of the loop antenna and placing this plate near the loop. Adjust the signal generator to the IF frequency, which can be determined by looking in the receiver index in this book, and adjust the IF trimmers. Using an output indicator of some type, measurement of the developed AVC voltage by the use of a vacuum tube voltmeter is to be preferred to an output meter connected across the voice coil of the speaker. Go over the IF trimmers several times to get peak adjustment since the gain in these receivers is generally quite limited and many portable receiver are used at remote locations from any broadcast stations. Sensitivity is therefore very important.

To adjust the oscillator and RF trimmer, set the signal generator at approximately 1500 KC and the dial af the receiver to the same frequency. Then adjust the oscillator until the signal comes in at that point, next adjust the R.F. trimmer. Often the R.F. trimmer is placed on the loop or mounted on the rear of the tuning gang. As most portable receivers do not use a padding condenser, it is not possible to make a 600 KC adjustment. If the set does have a padding condenser, it is preferable to set the signal generator at 600 KC and rock the dial, making different settings, taking the indication on the output indicator and setting it at the maximum indication. The dial may be in error at the low frequency end but nothing can be done about it without detuning the receiver. It may be necessary to move the metal plate connected to the signal generator further away from the loop while making the oscillator and RF adjustments. Always use as weak a signal as possible and still get an indication on the output

LOW SENSITIVITY

When the receiver is found to have low sensitivity and everything apparently checks normal then, using a vacuum tube voltmeter, measure the bias voltage on the RF-IF tubes from the negative filament to the grid. This voltage should be near zero. A voltage of 1½ volts on the grid of a 1N5 tube will reduce the gain by more than 50%. Be sure that no signal is being received which might develop AVC voltage while making the above tests and if a voltage is found biasing this tube, a thorough check of the AVC circuits should be made. Other causes of low sensitivity will be IF transformers which have absorbed moisture greatly reducing their "Q." The impedance of these can be measured with the use of a signal generator and vacuum tube voltmeter.

On reassembling the receiver after repairs are made, be very careful that stud bolts holding the receiver in place are the original ones or not of excessive length which may penetrate into the chassis and short some part as serious damages may result. Keep all battery leads from shorting and if the batteries are not to be replaced, tape up the connections. Make the connections to the loop antenna in the original manner being sure all are soldered or otherwise thoroughly connected. It would be advisable for every repair man to place a seal upon the chassis and tubes and inform the customer if this seal is broken, the guarantee is void as so much damage can result from a tinkerer burning out a complete set of tubes. As these receivers occasionally have severe treatment, be sure that all bolts are down securely with the lock washers they were originally equipped with.

GENERAL

When replacing components in the receiver, be sure they are in the same position as the original part. This is especially true of resistors such as R1 in Fig. 1 which develop considerable heat and may cause damage to the coils or condensors. It will always be preferable to replace R1, (Fig. 1), with an equivalent resistance in the line cord; thus keeping the heat out of the cabinet and assuring against future breakdowns. Never try to repair a ballast tube by connecting the wires together. If it is bad and another one is not obtainable, try mounting wire would resistors within the ballast tube itself. They come apart quite easily when they are of the metal type. When replacing coupling condensors which have become leaky or open, it is preferable to use mica type. This will assure against further breakdowns which may cause some of the tubes to burn out. The additional expense is very good insurance.

USING VTVM IN IMPEDANCE MEASUREMENTS

A good vacuum tube voltmeter which is capable of measuring A.C., D.C., or R.F. voltages up to 100 Mc. is a must in every modern repair shop, but it is of little value unless the user has complete knowledge of all its uses. This, combined with a signal generator of high output, can be used to check any circuit commonly found in the receivers to be serviced.

The following are several uses of the vacuum tube voltmeter signal generator combination:

Often it will be found that a receiver will have low R.F. gain and no amount of testing with a volt ohm milliameter uncovers any trouble. After new sets of tubes have been tried with no success, the serviceman may be a little inclined to blame it on the design of the receiver and pass it backtto the customer as completed. However, in many cases the trouble is in the R.F.-I.F. coils of the receiver, whose "Q" has been sufficiently lowered to cause this condition. And testing with the volt ohm milliameter would not uncover this trouble.

When it is found that R.F.-I.F. gain of a receiver is low, and no apparent cause can be found for it, a measurement of the impedance of the coils used in the circuit will probably uncover the cause of the trouble. This is not complicated or difficult, as only two pieces of equipment need be used, a vacuum tube voltmeter with a R.F. probe and a signal generator. Connect the signal generator across the L.C. circuit in question (see Fig. 12) but in series with a potentiometer of 250,000 ohms. Place the R.F. probe of the vacuum tube voltmeter across the coil points 2 and 3 and tune the L.C. circuit to resonance with the signal generator which should be set at the operating frequency which the R.F. transformer is designed to operate at. Read the voltage across the coil. Remove the R.F. probe and place directly across points 1 and 3. Read the voltage at this point; then reapply the probe across points 2 and 3 and adjust the potentiometer until the reading across the L.C. circuit is exactly one-half the full scale as read between points 1 and 3. Using an ohmmeter, measure the resistance of the section of the potentiometer used.

This resistance will equal the impedance of the coil.

Radio Frequency coils for the broadcast band should measure greater than 10,000 ohms, I.F. transformers from a half to greater than 1 megohm, depending upon the I.F. frequency, the higher the impedance should be. If the impedance is appreciably lower than these figures, replacement will give a definite improvement in reception.

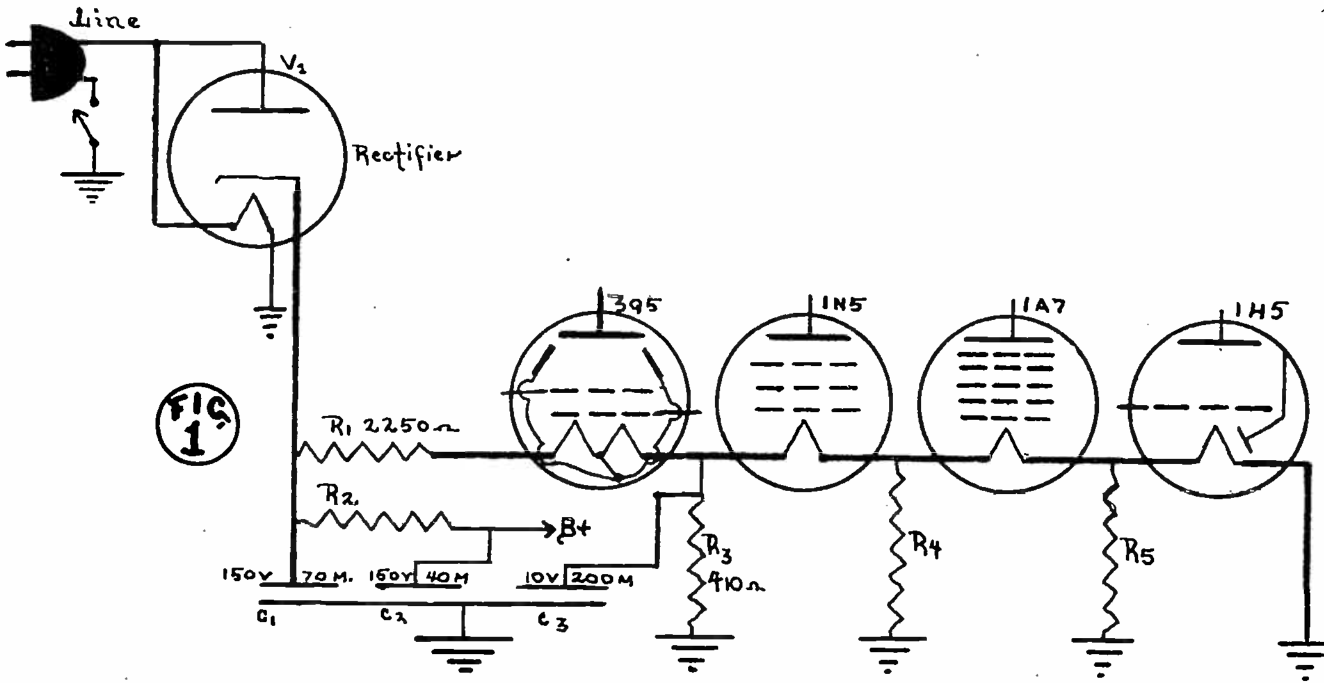
The reason R.F. coil "Q" is lower is that moisture is absorbed into the coil or that turns may be shorted within the winding. This is especially true of Pl wound coils as used in I.F. transformers. Should the coil be wound with Litz wire, the "Q" will be very effectively lowered should a few strands of the coil become broken. The breaks are most likely to occur at the terminals of the coil. Often visual inspection of this point will uncover this trouble. If the coils have absorbed moisture, they can be improved by boiling them in wax or common paraffine. It will be noted that bubbles will arise from the coils for some time after they are immersed in the boiling wax. These bubbles are steam caused by moisture within the coils. When the bubbles cease coming to the surface of the molten wax, all moisture has been removed from the coil and its "Q" will be greatly improved.

On the four tube T.R.F. receivers where only two stages are used, it is often found that the selectivity is insufficient, while the gain may apparently be normal. This is usually caused by the coil "Q" being lowered due to moisture being absorbed into it. Performing the above process will show a definite improvement in the selectivity of the receiver.

With the same equipment, it is possible to check the gain of any R.F. or I.F. transformer and compare it with a similar transformer. Connect the signal generator to the primary of the R.F. Coil. Connect the R.F. probe of the vacuum tube voltmeter across the secondary. Tune the secondary to resonance with the signal generator. Note the reading on the vacuum tube voltmeter when applied to the secondary. Remove the R.F. probe and measure the voltage across the primary of the coil. Should the voltage on the primary be three volts and voltage on the secondary, as measured by the vacuum tube voltmeter, be nine volts, the gain of the coil is said to be 3 to 1. By comparing this with tests made on another coil, the coil of the highest gain can be selected to be used in any piece of equipment. (Should both primary and secondary be tuned it will be necessary to tune both coils to the same frequency)

The vacuum tube voltmeter can also be used to measure the gain of any I.F. or R.F. coil directly in the receiver under operating conditions. Merely connect the ground lead of the vacuum tube voltmeter to the chassis and the R.F. probe to the plate connections of the coil in question, and make a note of the voltage reading. (This reading in no way will be affected by the D.C. plate voltage.) Apply the probe of the vacuum tube voltmeter to the grid connection on the secondary of coil and you have the proportion of the secondary voltage to the primary voltage giving the actual gain of the coil. The gain of the tube may also be measured in the same way, by first applying the R.R. probe to the grid and noting the R.F. voltage present, and then applying the R.F. probe to the plate and reading the plate R.F. voltage. This is perhaps the most effective method of testing tubes which are functioning in the circuit under test. It would be necessary, however, to replace a tube with a similar type and comparing the two readings before judgment could be passed upon the tube. How ever, after this has been used a few times the repairman soon becomes familiar with the gain that a tube will produce in any given circuit. Remember that the R.F. probe will have capacity which will vary from 4 to 25 MMFd.: therefore, when the R.F. probe is applied to the grid, the trimmer condensor of the grid coil must be adjusted to give a maximum response on the vacuum tube voltmeter. Then as the R.F. probe is placed upon the plate pin of the tube under test, the grid trimmer must be readjusted until maximum response is indicated on the plate circuit. This effectively compensates for the imput capacitance of the vacuum tube voltmeter and no error is to be expected in the readings.

When checking the gain from stage to stage it must be remembered that as the R.F. probe is placed on the antenna post of the receiver the R.F. reading will be that of the combined signals present in the antenna. And, therefore, it may be greater than the voltage reading on the grid of the first amplifier tube because the signal has passed through a parallel resonat circuit and effectively by-passed all signals except the signal which is resonant with the L.C. circuit of the grid.



Line
V1
Rectifier
R1 2250Ω
R2
B+
150V
70M.
150V
40M
10V
200M
C1
C2
C3
R3
410Ω
R4
R5
3Q5
1N5
1A7
1H5

FIG. 1

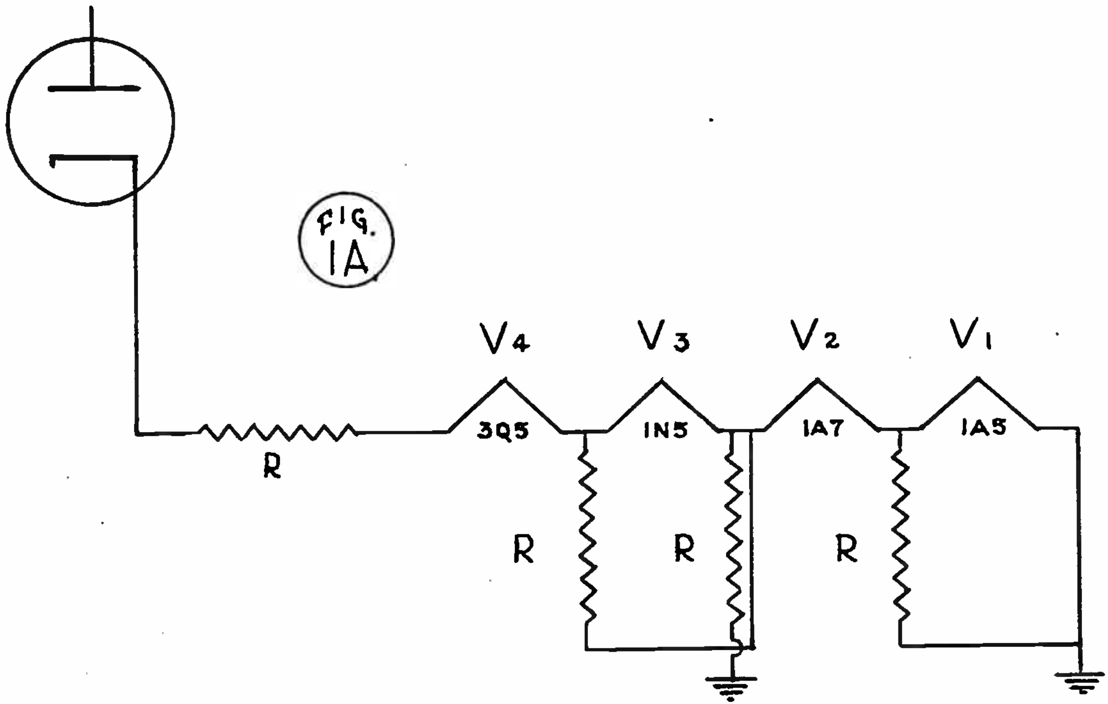


FIG. 1A

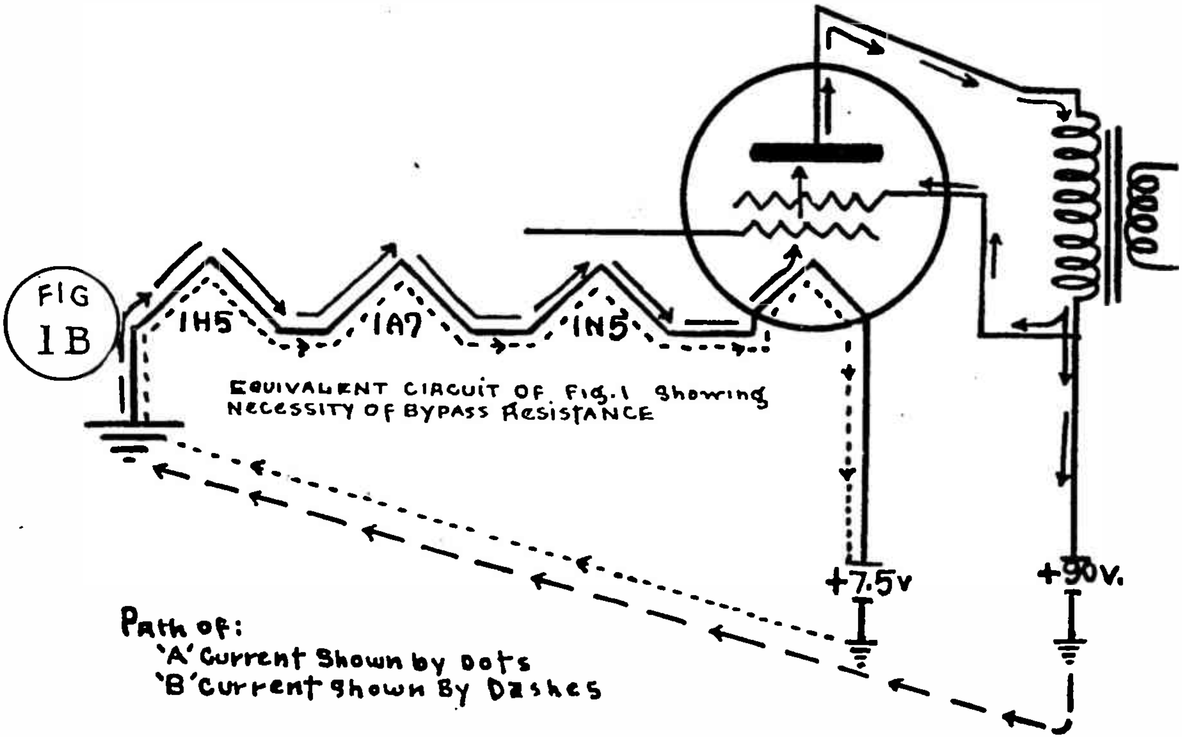
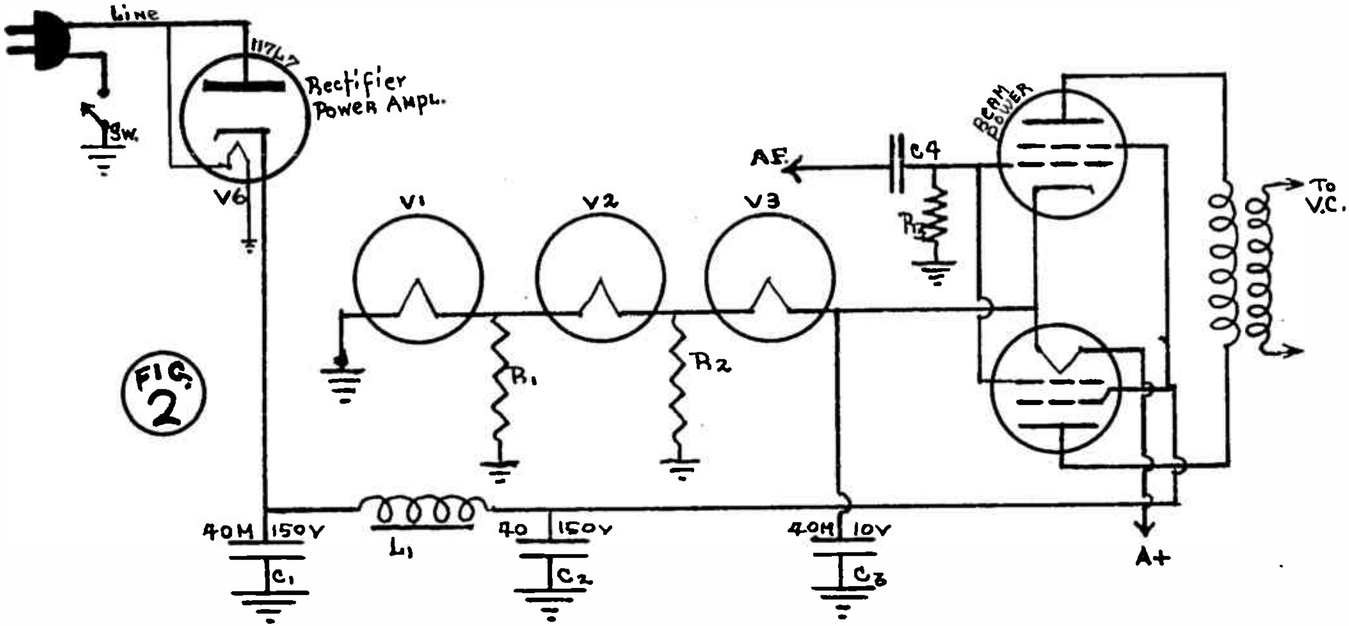


FIG 1B
1H5
1A7
1N5
EQUIVALENT CIRCUIT OF FIG. 1 SHOWING NECESSITY OF BYPASS RESISTANCE
+7.5V
+90V.
Path of:
'A' Current Shown by Dots
'B' Current Shown By Dashes


Line
117L7
Rectifier
Power Ampl.
SW.
V6
V1
V2
V3
AF.
C4
Beam Power
To V.C.
R1
R2
40M 150V
L1
40 150V
40M 10V
C1
C2
C3
A+
FIG. 2

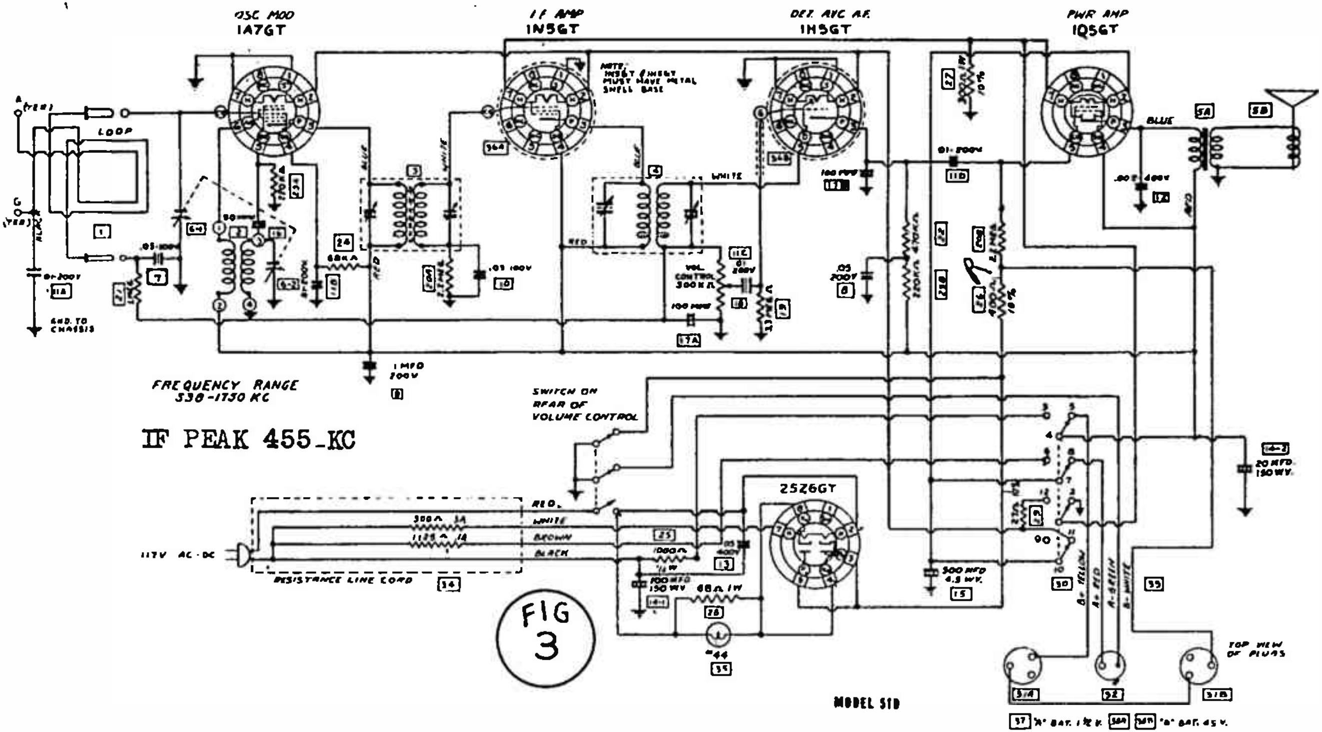
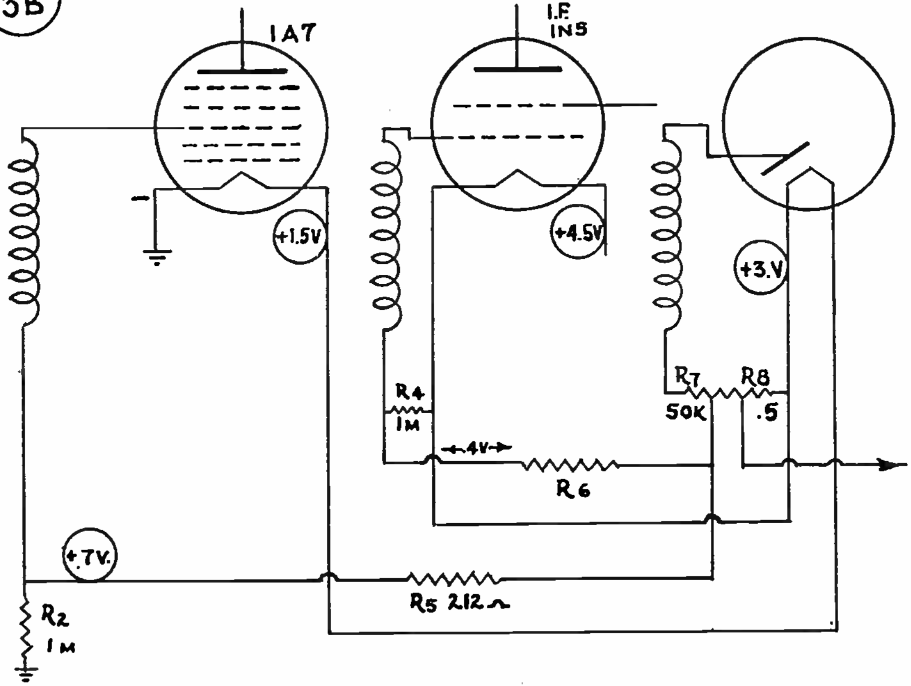
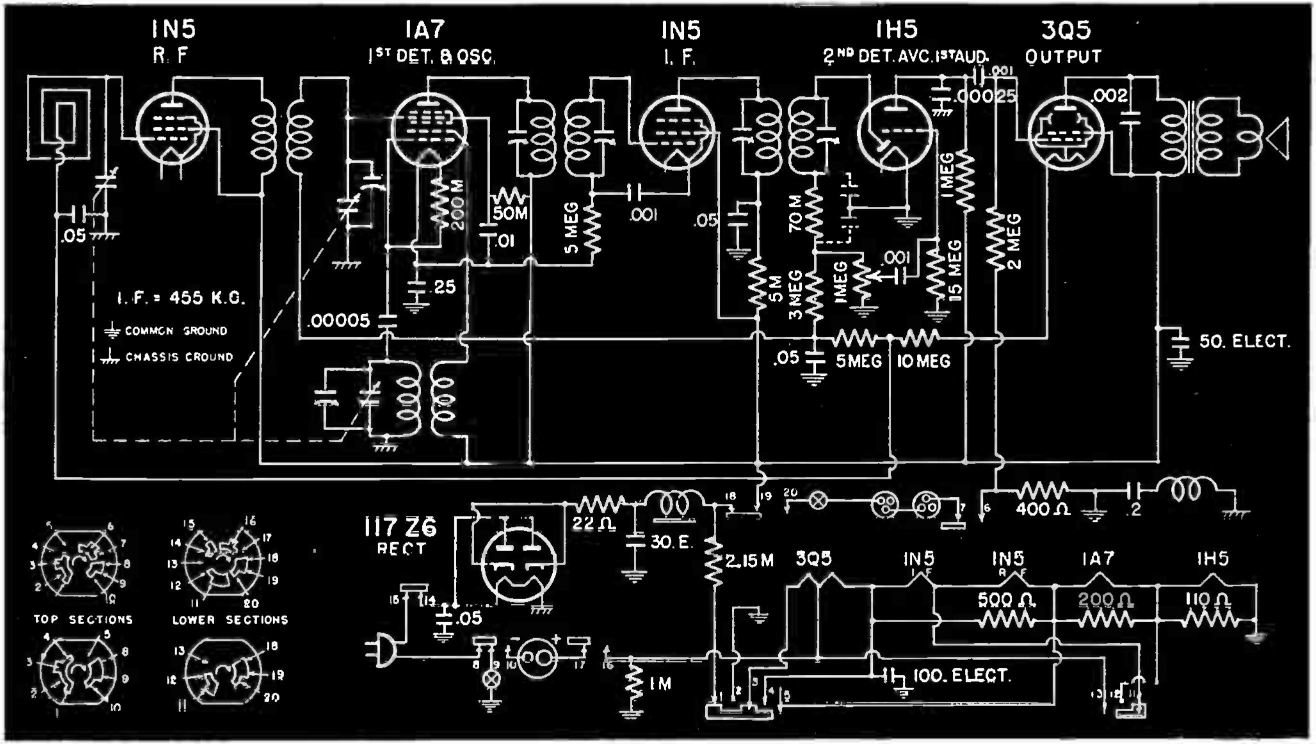
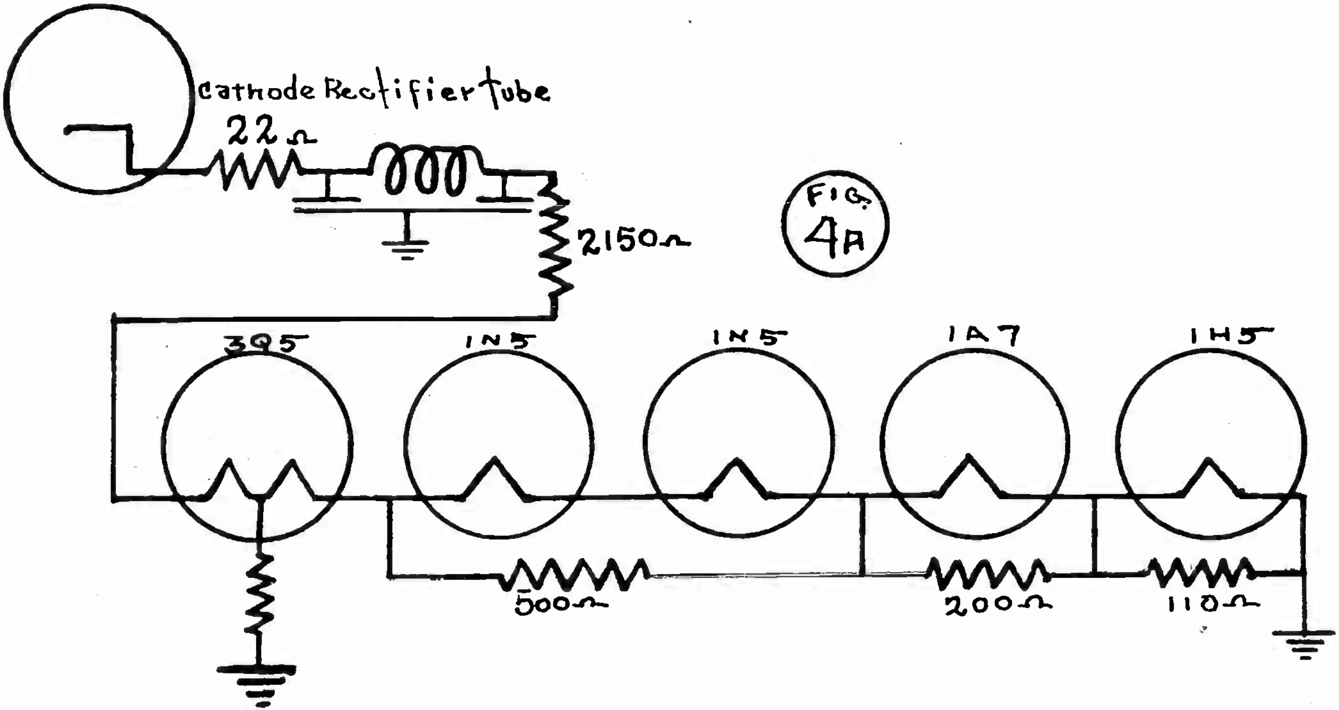

OSC MOD
1A7GT
IF AMP
1N5GT
DET. AVC A.F.
1N5GT
PWR AMP
1Q5GT
LOOP
FREQUENCY RANGE
530-1730 KC
IF PEAK 455_KC
SWITCH ON
REAR OF
VOLUME CONTROL
25Z6GT
RED
WHITE
BROWN
BLACK
117V AC-DC
RESISTANCE LINE CORD
FIG 3
TOP VIEW
OF PLUGS
MODEL 51D

FIG. 3B

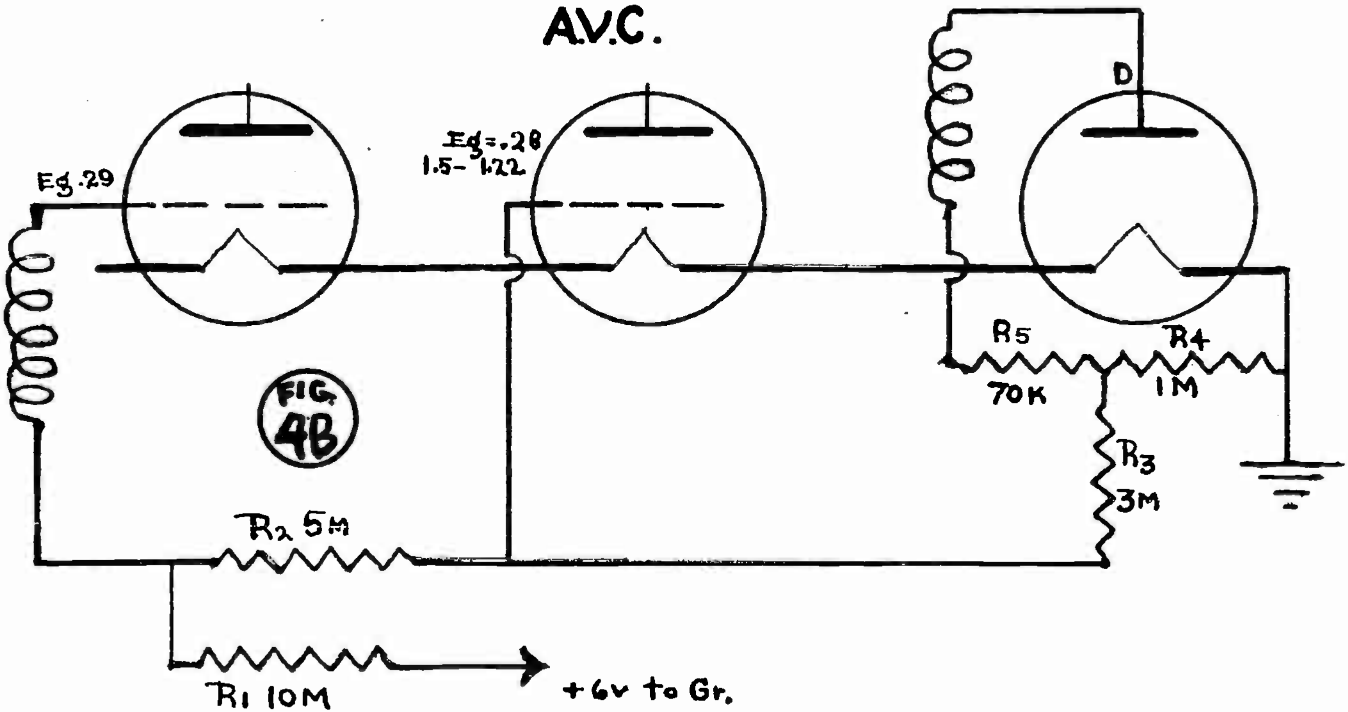


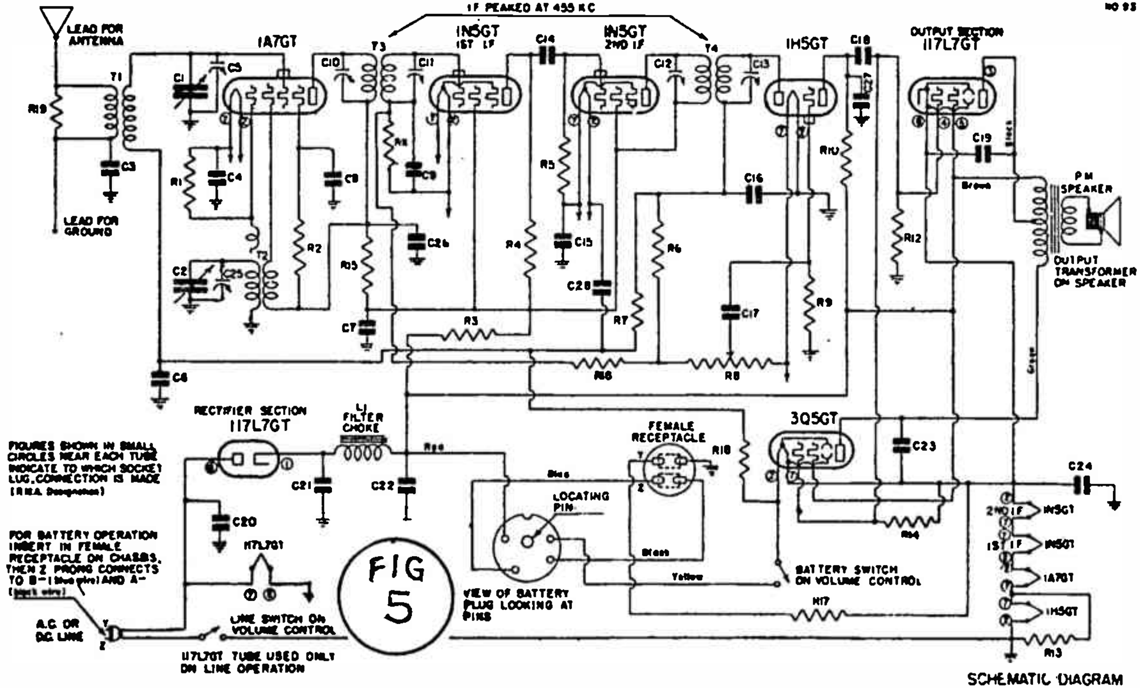

1N5
R. F
1A7
1ST DET. & OSC.
1N5
I. F.
1H5
2ND DET. AVC. 1ST AUD.
3Q5
OUTPUT
.05
200 M
50M
.01
.25
.00005
5 MEG
.001
.05
70 M
5M
3 MEG
1MEG
.001
15 MEG
1 MEG
2 MEG
.00025
.001
.002
.05
5MEG
10MEG
50. ELECT.
I. F. = 455 K.C.
COMMON GROUND
CHASSIS GROUND
117 Z6
RECT
22 Ω
30. E.
2.15M
400 Ω
.2
.05
1M
3Q5
1N5 I.F.
1N5 R.F.
1A7
1H5
500 Ω
200 Ω
110 Ω
100. ELECT.
TOP SECTIONS
LOWER SECTIONS



cathode Rectifier tube
22Ω
2150Ω
3Q5
1N5
1N5
1A7
1H5
500Ω
200Ω
110Ω

FIG. 4A


A.V.C.
D
Eg .29
Eg = .28
1.5 - 1.22
FIG. 4B
R5
70K
R4
1M
R3
3M
R2 5M
R1 10M
+6v to Gr.



SCHEMATIC DIAGRAM FOR MODEL EB AND EW

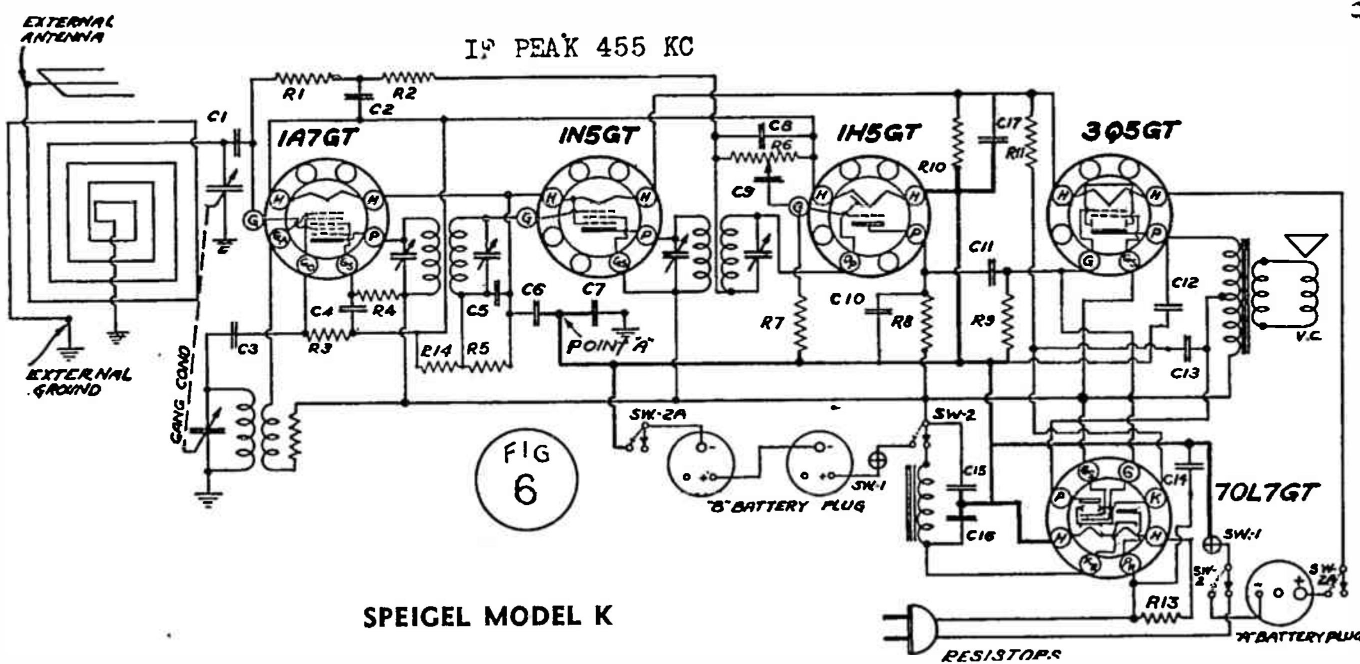


FIG 6

SPEIGEL MODEL K

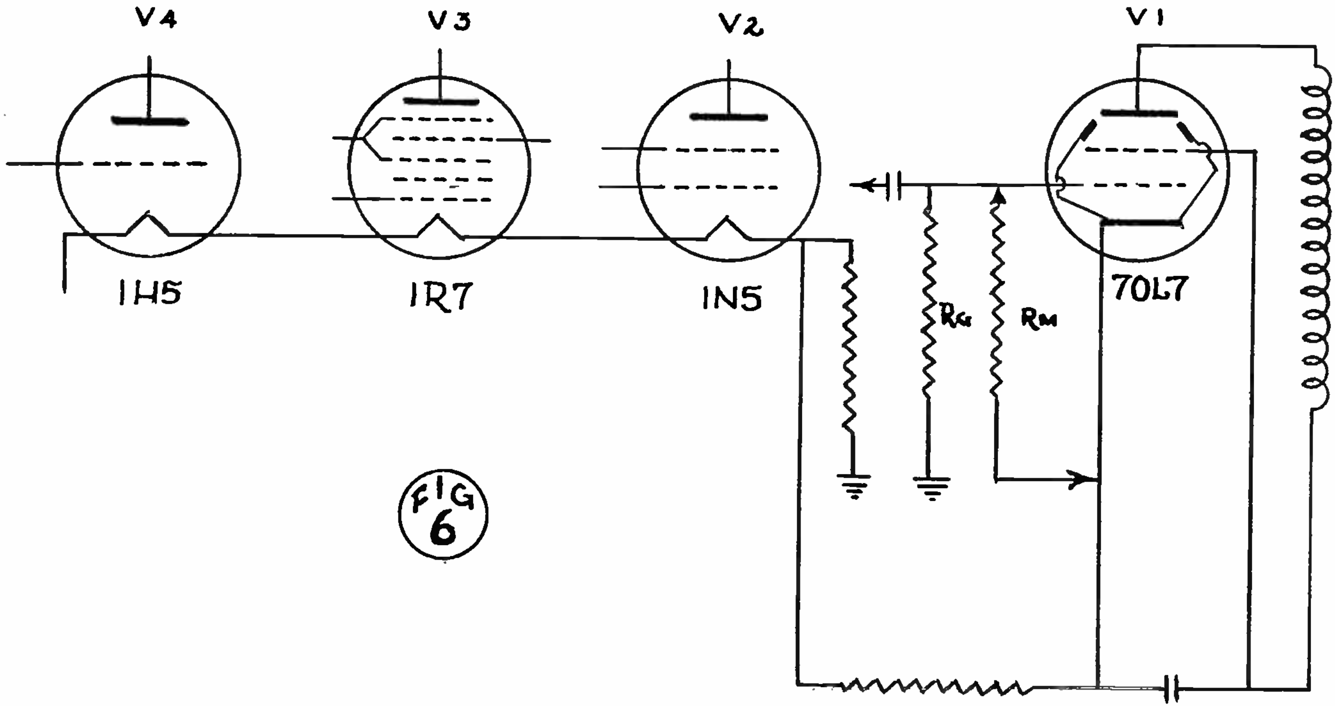


FIG 6

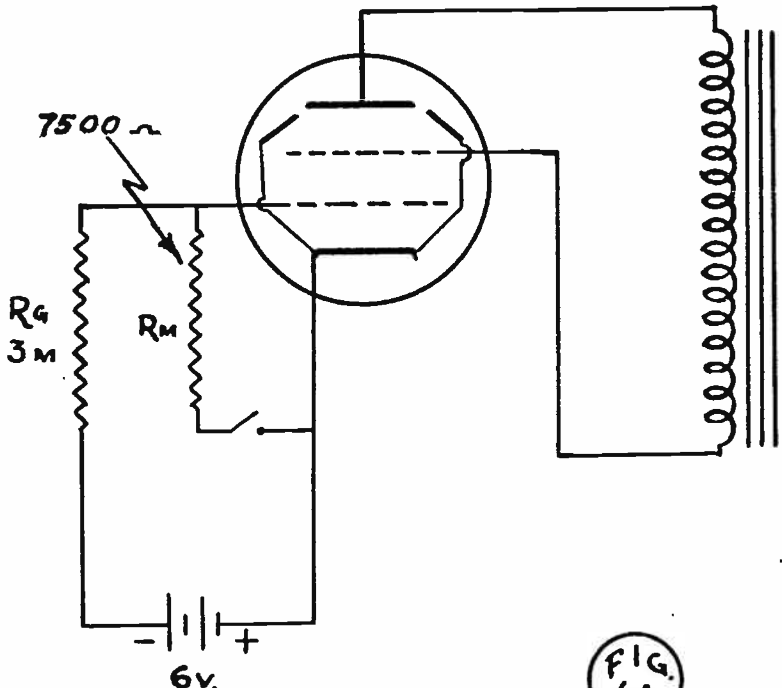


FIG. 6A

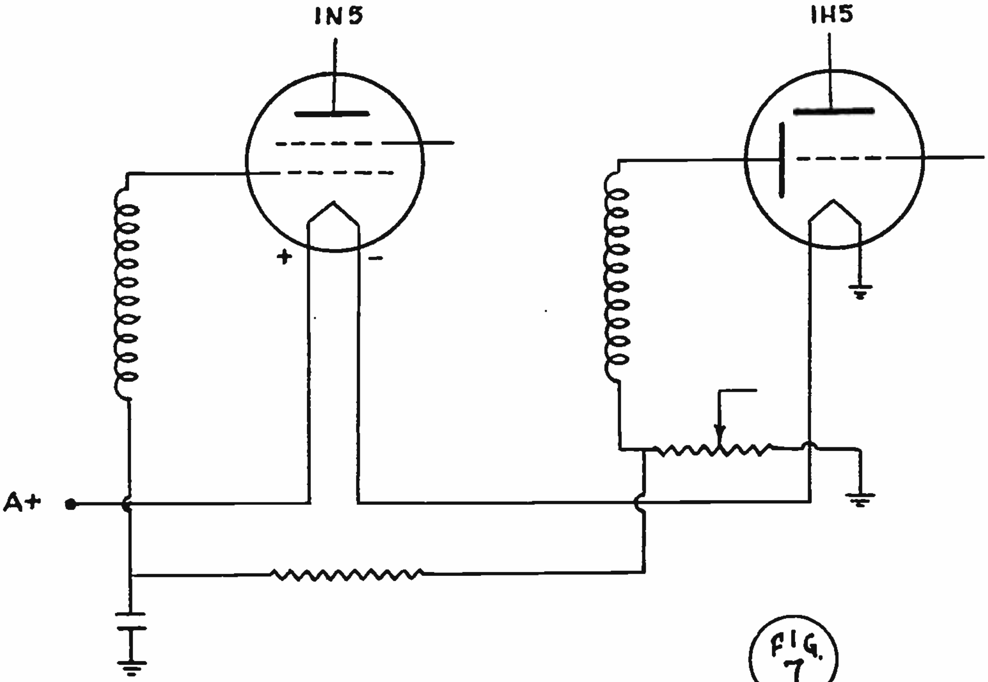
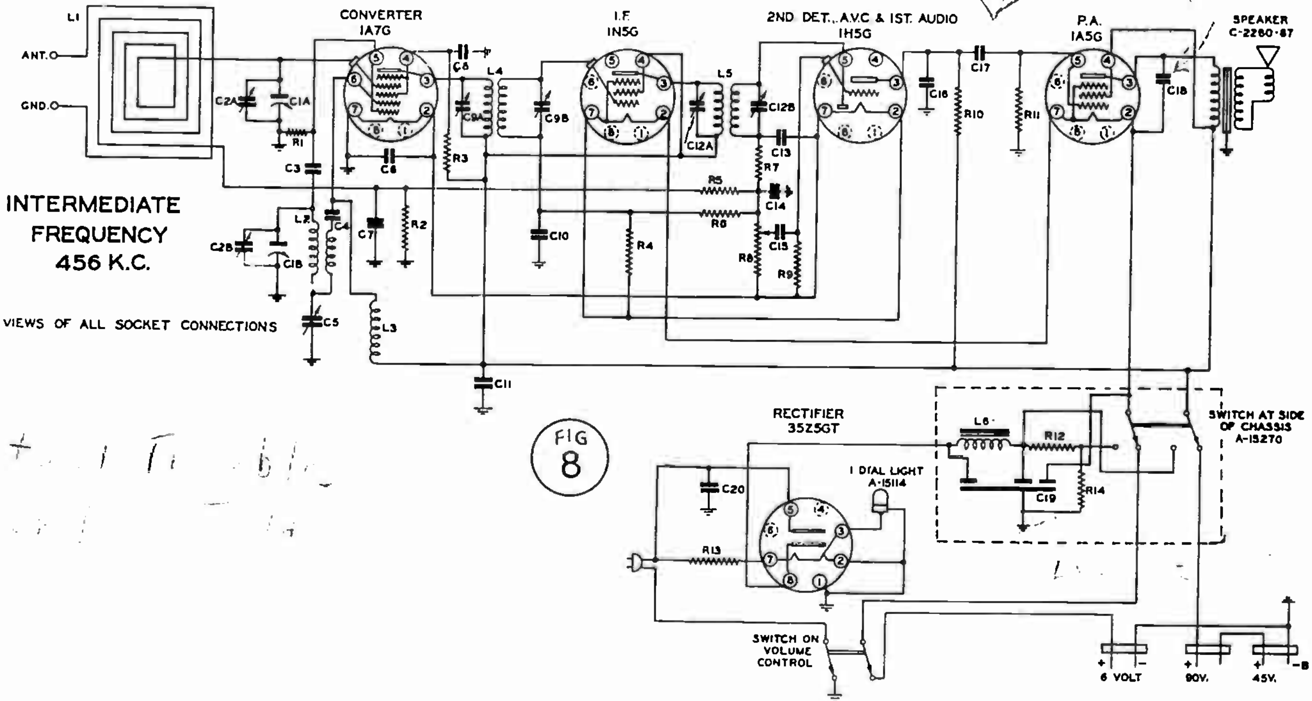


FIG. 7



INTERMEDIATE FREQUENCY 456 K.C.

TOP VIEWS OF ALL SOCKET CONNECTIONS

FIG 8

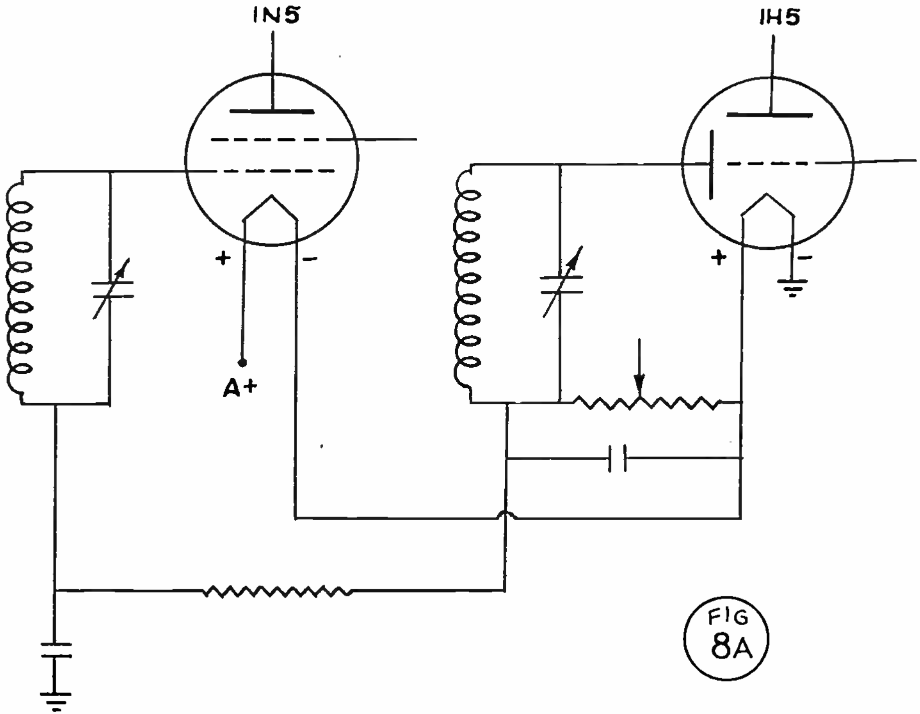


FIG 8A

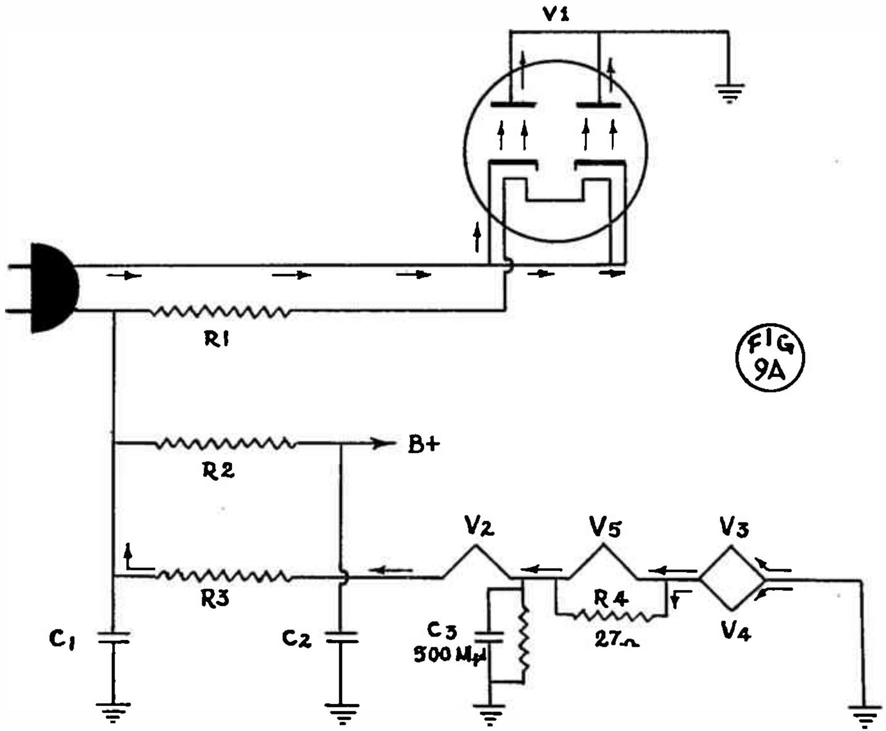


FIG 9A

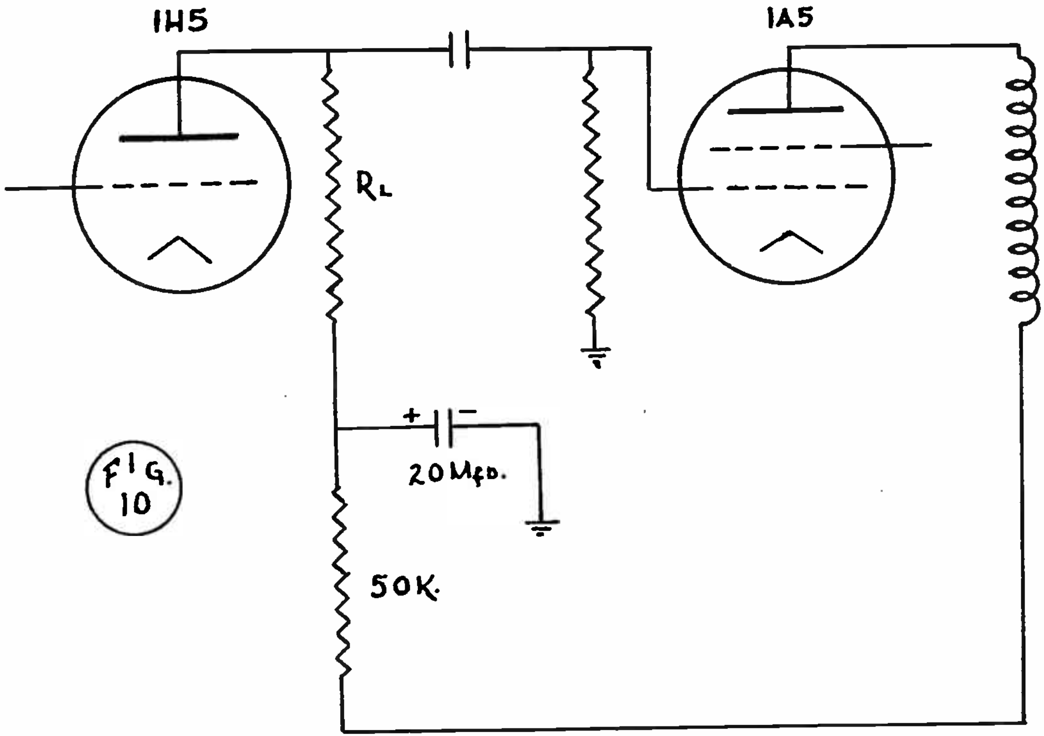


FIG. 10

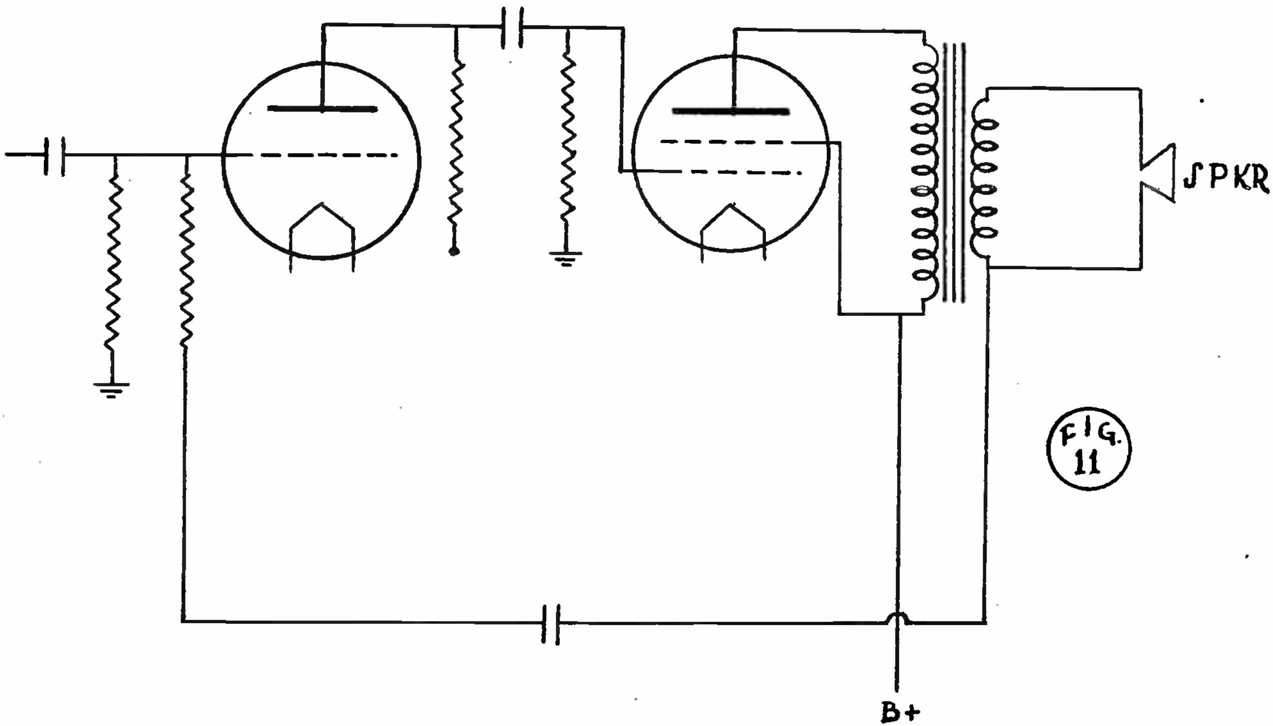
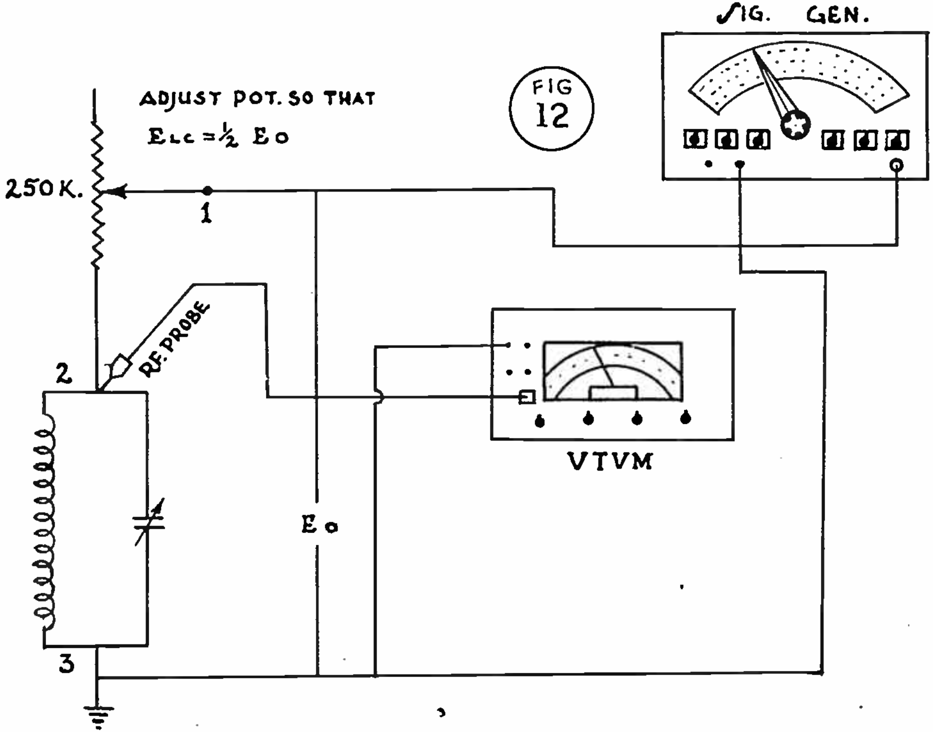


FIG. 11



ADJUST POT. SO THAT
$E_{LC} = \frac{1}{2} E_0$
FIG 12
SIG. GEN.
250 K.
1
2
3
R.F. PROBE
VTVM
Eo

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
AIRKING						
3912	5	1A7G 1N5G 1H5G 1A5G 35Z5	455	V11 p5	1	70 24 100
3916	5	Same as 3912	455	V11 p5	1	70 24 100
3950	5	1A7G 1N5G 1H5G 1A5G 50Z7	455	V11 p6	1	20 20 24 125
ALLIED RADIO						
A10700 A10701	5	1A7 1N5 1H5 3Q5 117Z6	455	...	1	
A10725	6	2-1N5 1A7 1H5 3Q5 117Z6	455	...	1	
A10748	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5GT	456	...	1	
A10795	5	1A7G 1N5G 1H5G 1A5G 35Z5	455	...	1	

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
ALLIED RADIO						
D160 D161	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z4	455	V14 p19 p20	1	30 30 150
D165	7	2-1N5 1A7GT 1H5GT 3Q5GT 50L6 35Z5	456	V14 p21	2	30 30 100 100
D366 D367	5	1A7GT 1N5GT 1H5GT 3Q5GT 35Z5	456	V14 p32	1	40 30 150 150
ANDREA						
6G61 6G63A ch. 6G3	6	1A7GT 1N5GT 1H5GT 3Q5GT 35Z5	455	V13 p4	1	40 40 100 100
6G63 6G63A	6	1R5 2-1N5 1H5GT 3Q5GT 35Z5	455	V12 p1	1	40 40 100 100
21AF5	5	1A7GT 1N5GT 1H5GT 1Q5GT 25Z6	455	V11 p14	1	40 80 200 200
21F5	5	Same as 21AF5	455	V11 p14	1	40 80 200 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
ALLIED RADIO						
A10855	5	1A7G 1N5G 1H5G 3Q5G 70L7	455	...	2	
A10873	5	1A7 1N5 1H5 1A5 35Z5	455	...	1	
A10885	5	1A7G 1N5G 1H5G 1A5G 25Z6G	455	...	1	
A10898	5	1A7G 1N5G 1H5G 1A5G 25Z6	455	...	1	
B17109	7	2-1N5 1A7GT 1H5GT 3Q5GT 50L6 35Z5	456	14, p21	2	30 30 100 100
B17111 B17112	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5GT	456	V14 p60	1	30 20 100 100
B17132 B17133 B17134	5	1R5 1T4 1S5 3S4 45Z3	456	V14 p62	1	30 30 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
AUTOCRAT						
120	5	1A7GT 1N5GT 1P5GT 1A5GT 35Z4	455	V11 p10	1	40 40 10 30
131	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455	V12 p1	1	20 20 20 20
531	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455	V12 p1	1	20 20 20 20
533	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455	V12 p1	1	20 20 20 20
AUTOMATIC						
P40	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	456	V12 p4	1	25 30 200
P41	5	1A7GT 1N5GT 1H5GT 1 T5GT 25Z6	456	V12 p4	1	10 20 25 200
P50	5	1A6GT 1N5GT 1H5GT 1T5GT 35Z5	456	V12 p4	1	10 20 25 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
AUTOMATIC						
P51	5	1A7GT 1N5GT 1H5GT 1T5GT 25Z6G	456	V12 p4	1	10 20 25 200
P57 P58	5	1A7G 1N5G 1H5G 1A5G 25Z6	456	V11 p1,2	1	10 10 20 100
P60	4	1R5 1T4 1D8 35Z5	456	V13 p2	1	30 30
P61	5	1A7G 1N5G 1A5G 1H5G 25Z6	456	V11 p1,2	1	10 20 20 100
P72	5	1A7GT 1N5GT 1H5GT 1T5GT 25Z6	456	V11 p5	1	10 20 25 200
Tom Thumb 3 in 1	4	1R5 1T4 1D8 117Z6	456	V13 p1	1	30 30
Tom Thumb Portable	4	1R5 1T4 1S5 1S4	456	V12 p1	1	
BELMONT RADO CORP						
6P11	6	1A7 2-1N5 1H5 3Q5 35Z5	455	V14 p4 p5	1	20 20 40

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
BELMONT RADIO						
507A	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	465	V14 p7 p24	1	20 40 200
507B	5	1A5GT 1A7GT 1N5GT 1H5GT 35Z5	465	V14 p7 p24	1	20 40 200
513ZA	5	Same as 507A	465	V11 p5	1	20 40 200
546	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	465	V13 p23	1	20 40 200
590	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	455	V	1	
CHEVROLET						
985651	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	465	V11 p9 p10	1	20 40 200
985866	5	1A7GT 1N5GT 1H5GT 1 A5GT 35Z5	455	V13 p27 p30	1	10 20 30 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
CONTINENTAL						
P5 XP5	5	1A7 1N5 1H5 3Q5 117Z6	455	V14 p4	1	30 50 100 100
P6 XP6	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V14 p6	1	30 40 100
P6 XP6 late	6	Same as P6	455	V14 p6	1	30 40 100
XF5	5	1A7 1N5 1H5 3Q5 117Z6	455	V11 p3	1	
XG6	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V11 p15	1	30 E0 40 40
5N 5NL	5	1A7GT 1N5GT 1H5GT 3Q5GT 70L7	455	V11 p13	2	20 30 40 40
28G5	5	1R5 1T4 1S5 3S4 35Z5	455	V14 p10	1	20 30 100
29G5	5	Same as 28G	455	V14 p10	1	20 30 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
CROSLEY						
27BD 27BE	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455	V12 p22	1	30 45 200
43BT	5	Same as 27BD	455	V14 p12	1	30 45
52FA 52FB	5	1A7GT 1N5GT 1H6GT 1T5GT 117Z6	455	V13 p11	1	
52FC	5	Same as 52FA	455	V13 p12	1	35 45
52PA 52PB	5	Same as 52FA	455	V13 p12 p13	1	35 45
62FA 62FB	6	2-1N5 1A7GT 1H5GT 1T5GT 117Z6	455	V13 p24	1	30 45 200
62PA 62PB	6	Same as 62FA	455	V14 p28	1	35 45 200
63FB	6	Same as 62FA	455	V13 p28	1	30 45 300
549	5	1A7GT 1N5GT 1H5GT 1A5GT 117Z6	455	V11 p13 p14	1	16 16 16 125

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
DELCO						
R1405	5	1A7GT 1N5GT 1H5GT 3Q5GT 35Z5	455	V12 p62 p63	1	
DETROLA						
295-1	5	1A7 1N5 1H5 1Q5 25Z6	455	V11 p2	1	8 40 40 16
299	4	1A7GT 3A8GT 1T5GT 25Z6	455	V11 p2	1	8 40 40 16
339	6	1P5GT 1A7GT 1N5GT 1H5GT 3Q5GT 117M7	455	V12 p4	1	20 40 100
340 340-1	6	1A7GT 2, 1N5 1H5GT 3Q5GT 117M7	455	V12 p4	2	20 40 100
341 341-1 341-2	5	1A7GT 1N5GT 1H5GT 3Q5GT 117M7	455	V12 p4	2	20 40 100
360 360-1 360-2	6	1A7GT 1N5GT 1H5GT 3Q5GT 50L6 35Z4	455	V12 p4	2	20 40 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
DETROLA						
378	5	1R5 1T4 1S5 3S4 35Z5	455	V13 p2	1	20 30
389 389-1 389-2	6	1A7GT 1N5GT 1H5GT 3Q5GT 50L6 35Z4	455	V13 p3	1	20 40 100
3781	5	1R5 1T4 1S5 3S4 45Z3	455	V13 p2	1	20 30
DEWALD						
544	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z4	455	V11 p5	1	20 20 100
545 545LW 545SW	5	Same as 544	455	V11 p6	1	20 40
564	5	1R5 1T4 1S5 3S4 35Z5	455	V13 p1	1	20 30
565	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455	V12 p4	1	20 40 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
EMERSON						
DF302 DF306	6	1A7GT 2-1N5 1H5GT 3Q5GT 70L7/ 117L7	455	V11 p25 p36	2	20 20 40
DJ310 DJ311 DJ312	6	1A7GT 2-1N5 1H5GT 3Q5GT 117L7/ 70L7	455	V11 p27 p28	2	20 20 40
EA312	6	1A7GT 2-1N5 1H5GT 3Q5GT 117L7	455	V12 p3 p4	2	20 20 40
EA338 EA339	6	Same as EA312	455	V12 p3 p4	2	20 20 40
EA357	6	Same as EA312	455	V12 p3 p4	2	20 20 40
EA385	6	Same as EA312	455	V12 p3 p4	2	20 20 40
EA389	6	Same as EA312	455	V12 p3 p4	2	20 20 40
EA341	6	1A7GT 2-1N5 1H5GT 3Q5GT 117Z6	455	V12 p7 p8	1	20 20 40
EB344	6	Same as EA312	455	V12 p3 p4	2	20 20 40

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
EMERSON						
EB359	6	1A7GT 2-1N5 1H5GT 3Q5GT 117L7	455	V12 p3 p4	2	20 20 40
EE340	6	Same as EB359	455	V12 p3 p4	2	20 20 40
EE390	6	Same as EB359	455	V12 p3 p4	2	20 20 40
EF363	6	Same as EB359	455	V12 p13 p14	2	20 40 40
EW391	6	Same as EB359	455	V12 p23 p24	2	15 15 15
FU424	6	2-1N5 1A7GT 1H5GT 3Q5GT 117PG	262	V13 p19 p20	2	20 20 40
FU427 FU428	6	Same as FU424	262	V13 p19 p20	2	20 20 40
FV426 FV433	5	1A7GT 1SA6 1SB6 3B5G 117Z4	455	V13 p21 p22	1	40 40 40 40
ESPEY						
052	5	1A7GT 1N5GT 1H5GT 1T5GT 70L7	455	V13 p2	2	30 30 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
ESPEY						
958	5	1A7G 1N5G 1H5G 1Q5G 25Z6	455	V13 p2	1	60 100 100 100
964	6	1A7 1N5 1H5 1G4 25Z6	455	V14 p6	1	30 60 30 100
965	6	1A7 1N5 1H5 1G4 1G6 25Z6	455	V14 p7	1	30 30 60 100
FADA						
C-34	5	1R5 1T4 1S5 3S4 35Z5	456	V14 p1	1	20 30 100 100
P22	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	456	V13 p3	1	20 30 100 100
P23	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V12 p1	1	20 30 100 100
P24	7	2-1N5 1A7GT 1H5GT 3Q5GT 50L6 35Z5	456	V12 p2	2	30 30 100 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
FADA						
P28	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	456	V12 p4	1	20 20 20
P28A	5	Same as P28	456	V13 p3	1	20 30 100 100
P41	5	1A7GT 1N5GT 1H5GT 3Q5GT 35Z5	456	V13 p4	1	30 40 150 150
P58 PL58	5	1A7GT 1N5GT 1H5GT 1Q5GT 70A7	456	V11 p5	2	25 25 32 32
FARNSWORTH						
AT31 (C7-1)	5	1A7G 1N5G 1H5G 1A5G 35Z4	455	V11 p5	1	20 40 40
BT58	5	1A7G 1N5G 1H5G 3Q5G 117Z6	455	V13 p5	1	30 30 40
CT43	5	1A7G 1N5G 1H5G 3Q5G 117Z6	455	V13 p2	1	40 50 100 100 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
FARNSWORTH						
CT59	5	1R5 1T4 1S5 3S4 35Z5	455		1	
CT60	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V13 p7 p8	1	20 30
FIRESTONE						
S7397-1	5	1R5 1T4 1S5 3S4 117Z6	455	V13 p8 p9	1	40 40 90
S7397-2 (A-377)	5	1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	455	V13 p11 p12	1	20 40 50
S7397-2 (443)	6	1P5GT 1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	455	V13 p9 p10	1	40 40 50 50
S7427-5	5	1A7G 1N5G 1H5G 1A5G 35Z4	455	V10 p9	1	10 50 50
GALVIN MFG						
3A5	5	1R5 1T4 1S5 3S4 117Z6	455		1	

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
GALVIN MFG						
41H	4	1A7GT 3A8GT 1Q5GT 25Z6	455	V14 p11	1	20 100 500
51D	5	1A7GT 1N5GT 1H5GT 1T5GT 25Z6	455			
51D1 51D2	5	1A7GT 1N5GT 1H5GT 1Q5GT 25Z6	455	V11 p14		
52D	5	1A7GT 1N5GT 1H5GT 1G5GT 25Z6	455			
57BP1 57BP2 57BP3 57BP4	5	1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	455	V12 p39 p40	1	30 50 350
57BP1A 57BP2A 57BP3A 57BP4A	5	1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	455			
62L11 62L12	6	2-1N5 1A7GT 1H5GT 3Q5GT 117Z6	455	V13 p27 p21 p22	1	40 40 40 80

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
GALVIN MFG						
65BP1 65BP2 65BP3 65BP4	6	1P5GT 1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	455	V12 p37	1	
65BP1A 65BP2A 65BP3A 65BP4A	6	Same as 65BP1	455		1	
GAMBLE-SKOGMO						
C590	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	455	V13 p15 p16	1	20 40 40 200
546	5	Same as C590	465		1	
0556	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455	V12 p5	1	20 20 20 20
2543	5	1A6GT 1N5GT 1H5GT 1T5GT 117Z4	455	V14 p13	1	30 30 150
3006	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V13 p26 p27	1	10 20 40 40 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
GAMBLE-SKOGMO						
4002	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V13 p33 p34	1	10 20 40 40 200
GAROD						
BP5	5	1A7G 1N5G 1H5G 1C5G 25Z5	456	V11 p1	1	40 30 80
BP9 BP10	5	1A7GT 1N5GT 1H5GT 1T5GT 45Z5GT	456	V11 p2	1	40 40 80
BP11	5	1R5 1T5 1S5 3Q5 35Z5	455	V12 p1	1	40 40 200
BP1 2A B	6	1A7 2-1N5 1H5 1T5 35Z5	455	V12 p1	1	40 40 2 00
BP15	5	1A7 1N5 1H5 3Q5 35Z5	455	V13 p1	1	40 80 200
BP36A	6	1A7 2-1N5 1H5 3Q5 70L7	455	V12 p2	2	40 40 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
GENERAL ELECTRIC						
HB412	4	1A7GT 3A8GT 1T5GT 117L7	455	V11 p47 p48	2	20 40 100
HB504	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z4	455	V11 p55 p56	1	20 50 100
HB505	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z4	455	V11 p55 p56	1	20 50 100
JB508	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z4	455	V12 p30	1	20 40 100
JB513	5	Same as JB508	455	V12 p63	1	20 40 100
JB514	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z6	455	V12 p63	1	20 40 100
JB523	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z4	455	V12 p63	1	20 40 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
GENERAL ELECTRIC						
JB524	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z6	455	V12 p63	1	20 40 100
JB630	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z4	455	V12 p64 p71	1	20 40 100
JB631	6	1A7GT 2-1N5 1H5GT 3Q5GT 117Z6	455	V12 p64 p71	1	20 40 100
L-622	6	2-1T5 1R5 1S5 3S4 45Z3	455	V14 p56	1	20 30 100
LB-502	5	1R5 1T4 1S5 3S4 35Z3	455	V14 p49	1	40 40 90
LB-603	6	2-1T4 1R5 1S5 3S4 35Z5	455	V13 p41	1	20 30 100
LB-612	6	2-1T4 1R5 1S5 3S4 35Z5	455	V13 p41	1	20 20 100
L B-641	6	Same as LB-612	455	V13 p41	1	20 30 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
GENERAL ELECTRIC LB-700 701 702 703	7	2-1T4 1A7GT 1H5GT 2-1T5GT 117Z6	455	V13 p59 p60	1	40 60 1 00
GENERAL TEL. RADIO CORP. 530	5	1A7G 1N5G 1H5G 1T5G 35Z5	456	V14 p2 p7	1	20 40
GILFILLAN 5L	5	1A7GT 1N5GT 1H5GT 3Q5GT 117Z6GT	460	V10 p2	1	8 8
GOODRICH R429	5	1A7GT 1N5GT 1H5GT 3Q5GT 70L7	455	V13 p1	2	
R460	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V12 p15 p10	1	40 40 30 30
HALLICRAFTER S29	9	2-1G4 1T4 1R5 2-1P5 1H5 3Q5 50Y6	455	V12 p11 p12	1	60 60 60 60 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
HOWARD						
14ACB	6	1P5GT 1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	465	V11 p2	1	20 30 50
LAFAYETTE						
BB73	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V14 p53 p54	1	10 20 20 40 100
BB73A	6	1P5GT 1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	455	V14 p55 p56	1	40 40 40 40
D93	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455	V12 p2	1	20 20 20 20
JS130	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V13 p13	1	20 30 100 100
MAJESTIC RADIO and TELEVISION						
1BR50 1BR-50P	5	1A7GT 1N5GT 1H5GT 1T5GT 25Z6	455	V14 p1	1	8 16 40 100

Manufacturer and Model No.*	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
MAJESTIC RADIO and TELEVISION						
5BD 5BDR	5	1A7GT 1N5GT 1H5GT 1D8GT 70L7	455	V12 p5	2	10 15 40 100
5ULBD	5	Same as 5BD	455	V12 p5	2	10 15 40 100
MID-WEST						
Portable 1940	5	1A7 1N5 1H5 1T5 25Z6	456	V12 p1	1	10 20 40 70
P-5	5	1A7 1N5 1H5 1T5 25Z6	456	V14 p1	1	10 20 40 70
MISSION BELL						
504	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z6	465	V11 p6	1	20 40 100
MONTGOMERY WARD & CO.						
62-2663	6	1A7GT 2 - 1N5 1H5GT 3Q5GT 35Z5	456	V14 p133 p134	1	10 20 40 40 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
MONTGOMERY WARD & CO.						
62-2668	6	1A7GT 2-1N5G 1H5GT 3Q5GT 35Z5	456	V14 p133 p134	1	10 20 20 40 200
04BR-566A	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	465	V12 p13	1	20 40 200
04WG-569	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	456	V12 p15 p16	1	40 40 200
04WG-663	6	1A7GT 1N5-2 1H5GT 3Q5GT 35Z5	456	V11 p1	1	10 20 40 40 200
04WG-668	6	Same as 04WG-663	456	V11 p1	1	10 20 40 40 200
04WG-672	6	Same as 04WG-663	456	V12 p31 p32	1	10 20 40 40 200
04WG-673 674	6	1A7GT 2-1N5 1&5GT 3Q5GT 35Z5	456	V12 p33 p34	1	10 20 40 40 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
MONTGOMERY WARD & CO.						
14WG-680	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V13 p57 p58	1	10 20 40 40 200
14WG-683A	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V14 p33 p34 p35	1	8 40 40 50
14WG-683B	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V13 p59 p60	1	40 40 50 200
14WG-2672C	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V14 p14 p37	1	10 20 40 40 200
93WG-663	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V13 p79 p80	1	10 20 40 40 200
93WG-668	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V13 p79 p80	1	10 20 40 40 200
93WG-2663	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V14 p133 p134	1	10 20 40 40 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
MONTGOMERY WARD & CO.						
04WG-2672	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V14 p13 p14	1	10 20 40 40 200
14BR-573A	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	455	V13 p16	1	20 40 40 200
14BR-684A	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	455	V13 p20	1	20 40 40 200
14BR-685A	6	1A7GT 2-1n5 1H5GT 3Q5GT 35Z5	455	V13 p29	1	10 20 40 40 200
14BR-687A	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	455	V13 p29	1	10 20 40 40 200
14WG-538	5	1R5 1T4 1S5 3S4 35Z5	456	V13 p46 p48	1	40 200 400
14WG-672C	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V13 p56 p55	1	10 20 40 40 200

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
MONTGOMERY WARD & CO.						
93WG-2668	6	2-1N5 1A7GT 1H5GT 3Q5GT 35Z5	456	V14 p133 p134	1	10 20 40 40 200
64BR-1051A	5	1A7 1N5 1H5 1A5 35Z5	455	Photo Fact 462-32	1	20 40 40 200
NOBLITT-SPARKS						
802 Ch. RE57	5	1A7GT 1N5GT 1H5GT 3Q5GT 35Z5	455	V11 p11	1	40 40 100
803	5	Same as 802	455	V11 p12	1	40 40 100
822	5	Same as 802	455	V12 p5	1	20 40 100
PACKARD BELL						
40B	5	1A7G 1N5G 1H5G 1A5G 117Z6	460	V11 p2	1	10 10 20 100
56	5	1A7GT 1N5GT 1H5GT 1Q5GT 25Z6	460	V12 p1	1	20 100 500

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
PACKARD BELL						
57	6	2-1N5 1A7GT 1H5GT 1Q5GT 25Z6	460	V12 p4	1	20 100
57A	6	2-1N5 1A7GT 1H5GT 1Q5GT 117Z6	460	V12 p4	1	20 100
PATHE						
41P	5	1A7G 1N5G 1H5G 1A5G 35Z5	455	V12 p1	1	24 70 100
PHILCO						
40-84	5	1LA6 1LN5 1LH4 1LA4 117Z6	455	V12 p12 p18	1	10 10 10 20 20
41-84	5	Same as 40-84	455	V13 p5	1	10 10 10 20 20
41-85	5	Same as 40-84	455	V13 p6	1	10, 10 10, 20 20
41-841	5	1A7G 1N5G 1H5G/ 1LD5 3Q5G 117Z6	455	V12 p96 p97	1	10 20 20 20

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
PHILCO						
41-842 843 844	7	2-1LE3 2-1LN5 1LH4 1LB4 117Z6	455	V12 p98	1	10 20 20 25 100
41-851	5	1A7G 1N5G 1H5G/ 1LD5 3Q5G 117Z6	455	V12 p95 p97	1	10,10 10,10 20,20
42-842	7	Same as 41-842	455	V14 p77 p78 p81	1	10 20 20 50 200
PILOT						
T71	5	1A7GT 1N5GT 1H5GT 1T5GT 25Z6	455	V13 p10	1	30 40 60
T186	6	2-1N5 1 A7GT 1H5GT 1Q5GT 25Z6	262	V12 p6	1	50 50 120
T187	6	Same as T186	262	V12 p6	1	50 50 120
T1351	5	1A7G 1N5G 1 H5G 1T5G 117Z6	455	V11 p5	1	30 40 40

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
PILOT						
X1451	7	2-1N5 1A7G 1H5G 2-1Q5 117Z6	262	V13 p28	1	30 30 40 40
T1452	5	1A7G 1N5G 1H5G 1C5G 25Z6	455	V10 p26	1	10 30 40 40
X1452 1453	7	2-1n5 1A7G 1H5G 2-1Q5 117Z6	262	V12 p12	1	30, 30 30, 40 40
R C A						
P5	5	1A7GT 1N5GT 1H5GT 3Q5GT 35Z5	455	V12 p8	1	20 20 20 200
15BP	5	1A7GT 1N5GT 1H5GT 3Q5GT 35Z5	455	V12 p23	1	20 20 20 200
25BP	5	Same as 15BP	455	V12 p23	1	20 20 20 200
25BP RC1020	5	Same as 15BP	455	V14 p69	1	20 30
26BP	6	2-1T5 1A7GT 1S5 3Q5GT 117Z6	455	V14 p31 p32	1	10 20 30 160

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
R C A						
BP55, 56 Ch RC455	5	1A7GT 1N5GT 1 H5GT 1T5GT 117Z6/ 35Z5	455	V11 p90	1	
BP85	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z6/ 35Z5	455	V11 p90	1	
SEA PAL						
MARINE PORTABLE	6	1A7GT 2 - 1N5 1H5GT 3Q5GT 35Z5	456	V13 p1 p2	1	10 20 40 40 200
6P21	6	1A7GT 2-1N5 1H5GT 1T5GT 117Z6	455	V13 p3	1	10 20 40 200
101 102	6	2-1N5 1A7GT 1H5GT 1 A5GT 117L7	465	V12 p1 p2	2	20 40 200 200
SEARS ROEBUCK CO.						
P6	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V14 p2	1	30 40 100
XP6	6	Same as P6	455	V14 p2	1	30, 50 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SEARS ROEBUCK CO.						
6751A(101, 636)	5	1A7GT 1N5GT 1H5GT 1A5GT 117Z6	455	V12 p63	1	40 80 80
6761 (101, 622-A, 101. 622, 1, 1A)	6	1A7GT 2-1N5 1H5GT 3Q5GT 117Z6	455	V12 p61	1	30 40 80
6761A (101.637)	6	1A7GT 2-1N5 1H5GT 3Q5GT 117Z6	4 55	V12 p60	1	40 80 80
6921 (101.637)	6	1A7GT 2-1N5 1H5GT 3Q5GT 117Z6	455	V12 p60	1	40 80 80
7075 (109.383)	5	1A7GT 2-1N5 1A5GT 35Z5	455	V14 p44 43	1	10 20 30 100
7077 (109.409)	5	1A7GT 2-1N5 1A5GT 35Z5	455	V14 p44	1	10 20 30 100
7079 (101.620-3	5	1A7GT 1N5GT 1H5GT 1A5GT 50Y6	455	V14 p36	1	30 40 80

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SEARS ROEBUCK CO.						
6521 (101, 621-1, 1, 1A 1B, 1C)	6	1A7GT 2-1N5 1H5GT 3Q5GT 50Y6	455	V12 p55 p56 p58	1	30 40 80
6551 (1p1, 620, 1, 2)	5	1A7GT 1N5GT 1H5GT 1A5G 50Y6	455	V12 p57 p58	1	30 40 80
6561 (101, 621-1, A, 1A 1B, 1C, 2)	6	1A7GT 2-1N5 1H5GT 3Q5GT 50Y6	455	V12 p55 p56	1	30 40 80
6621 (101, 637)	6	1A7GT 2-1N5 1H5GT 3Q5GT 117Z6	455	V12 p60	1	40 80 80
6661 (101, 621, A-1, 1A 1B, 1C)	6	1A7GT 2-1N5 1H5GT 3Q5GT 50Y6	455	V12 p55 p56	1	30 40 80
6721 (101, 622-A, 101, 622, 1, 1A)	6	1A7GT 2-1N5 1H5GT 3Q5GT 25Z6	455	V12 p61	1	30 40 80
6751 (101, 623, 1,)	5	1A7GT 1N5GT 1H5GT 1A5GT 25Z6	455	V12 p62	1	30 40 80

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SEARS ROEBUCK CO.						
7081 (101.636)	5	1A7GT 1N5GT 1H5GT 1A5GT 117Z6	455	V14 p36	1	40 80 80
7083 7087 7089	6	1A7GT 2-1P5 1H5GT 3Q5GT 50Y6	455	V13 p89 p90	1	30 40 80
7085 7090	6	1A7GT 2-1P5 1H5GT 3Q5GT 117Z6	455	V13 p91 p92	1	40 80 80
7112 (101.664)	6	2-1P5 1A7GT 1H5GT 1A5GT 117Z6	455	V14 p54	1	10 30 80
7189 (109.378)	5	1R5 1T4 1S5 3S4 45Z3	455	V14 p67 p68	1	20 30 100
7318 (109.369)	6	1A7GT 2-1N5 1H5GT 3Q5GT 117M7	455	V12 p67 p68	2	20 20 40 100
7814 (113.504)	5	1A7G 1N5G 1H5G 1A5G 35Z4	465	V 12 p75	1	20 40 250

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SENTINEL RADIO CO.						
180XL	5	1A7 1N5 1H5 1Q5 35Z5	455	V11 p13	1	25 50 50
200X	5	1A7G 1N5G 1H5G 1A5G 25Z6	455	V11 p43 p44	1	10 50 100
201XL	5	1A7G 1N5G 1H5G 1A5G 35Z5	455	V11 p45 p46	1	25 40 40
213XL 1U213XL 213P	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z6	455	V12 p3 p4	1	40 40 40
217 217P	6	1P5GT 1A7GT 1N5GT 1H5GT 3Q5GT 117Z6	455	V12 p18 p19	1	40 40 40 40
219 219P	6	1P5 1A7 1N5 1H5 3Q5 117Z6	455	V12 p18 p19	1	40 40 40 40
228	6	2-1P5 1A7 1H5 3Q5 50Z7	455	V13 p5 p6	1	40 50 50

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SENTINEL RADIO CO.						
231	6	1A7GT 1P5GT 1N5GT 1H5GT 3Q5GT 35Z4	455	V13 p9 p10	1	40 40 40
262 Late	6	1N5-2 1A7GT 1H5GT 3Q5GT 117Z6	455	V13 p23 p24	1	40 40 50 50
1U262	6	2-1N5 1A7GT 1H5GT 3Q5GT 117Z6	455	V13 p23 p24	1	40 40 50 50
SETCHELL CARLSON						
66	5	1N5 1A7 3A8 1T5 35Z5	182	V14 p3	1	20 40 50
SONORA RADIO & TEL						
KB73	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	456	V11 p5	1	20 40 100
KD75	6	1A7GT 1N5GT 1H5GT 1A5GT 50L6 35Z5	456	V11 p6	2	20 20 40 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SONORA RADIO & TEL						
LR	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	456	V13 p2	1	30 35
SPARTON						
590-1	5	1A7G 1N5G 1H5G 1A5G 35Z5	456	V11 p7	1	20 20 20
6021	6	2-1T4 1R5 1S5 117Z6 3Q5	456	V13 p14 p15 p16	1	10 20 40 40 200
SPIEGEL						
A2122	6	1A7GT 1N5GT 1H5GT 1A5GT 50L6 35Z5	456	V12 p28	2	20 20 40 100
A2125 AP2125	5	1A7GT 1N5GT 1H5GT 1T5GT 25Z6	455	V12 p29	1	8 16 40 100
A2130 A3P2130	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	456	V12 p30	1	20 40 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SPIEGEL A2132 A6P2132	5	1A7 1N5 1H5 3Q5 117Z6	455	V12 p15 p16	1	20 20 30
A2134 A7P2134 A9P2134 ch. BP12	6	1A7 2-1N5 1H5 1T5 35Z5	455	V13 p48	1	20 40 80
A2136 ChBP11S	5	1A7 1N5 1H5 1T5 35Z5	455	V13 p49	1	20 40 80
A14P2148	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455			
CP5125	5	1R5 1T4 1S5 3S4 35Z5	455			
C7P5128	5	1A7GT 1N5GT 1H5GT 1T5GT 35Z5	455			
DP7120	6	2-1N5 1A7GT 1H5GT 3Q5GT 50Y6	456	V13 p77	1	10 25 20 20 40 70

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SPIEGEL						
DP7121	7	2-1N5 1A7GT 1H5GT 3Q5GT 50L6 35Z5	456	V14 p17	2	30 30 100 100
DP7122	5	1R5 1T4 1S5 3S4 35Z5	456	V14 p19	1	20 40 100 100
E11P2108	5	1A7GT 1N5GT 1H5GT 3Q5GT 117Z4	455			
EP2120	6	2-1N5 1A7GT 1H5GT 3Q5GT 50Y6	456	V13 p77	1	10 20 20 25 40 70
EP2121 E11P2121	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z4	455	V14 p6	1	30 30 150
EP2121 ch. 2-54	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z4	455			
EP2122	6	1R5 1T4 1S5 3S4 35Z5	455			

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
SPIEGEL						
F5P624	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z4	455			
Z5P7125	5	1A7G 1N5G 1H5G 1A5G 35Z5	456			
Z7126 ZP7126 Z7P7126	5	1A7GT 1N5GT 1H5GT 3Q5GT 70L7	455	V12 p37	2	20 30 40 40
2122 ch.KD	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	456	V12 p30	1	20 40 100
5120 5121	6	1N5-2 1A7 1H5 3Q5 50Y6	456	V13 p54	1	10 10 20 40
STEWART-WARNER						
05-5L1 to 05-5L9	5	1A7GT 1N5GT 1H5GT 1Q5GT 70L7	455	V11 p12	2	20 20 100
15-5X1 to 15-5X9	5	1LA6 1LN5 1LH4 1LA4 35Z3	455	V12 p35	1	30 30 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
STEWART-WARNER						
15-5Y1 to 15-5Y9	5	1LA6 1LN5 1LH4 3Q5GT 35Z3	455	V12 p21 p36	1	30 30 50
206GA to 206GZ	6	1A7 1N5 1H5 3Q5 35Z5	455	V13 p13 p14	1	20 20 20 50
207CA to 207CZ	7	2-1N5 1A7 Lh5 3Q5 2-35Z5	455	V13 p17 p18	1	20 20 20 50
TRAV-LER RADIO CORP						
B70 B71	4	1A7 3A8 1T5 35Z4	456	V12 p1 p2	1	40 40 40 80
B712	4	1A7 3A8 1T5 35Z4	456	V12 p1 p2	1	40 40 40 80
FB73	4	1A7 3A8 1T5 117Z6	456	V12 p2	1	40 40 40 80
FB82	5	1A7 1N5 1H5 1T5 117Z6		V13 p5	1	

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
TRAV-LER RADIO CORP.						
TB-601	6	2-1N5 1A7 1H5 3Q5 50Y6	456	V14 p4	1	10 10 20 40 40
TB-512	5	1A7 1N5 1H5 3Q5 50Y6	456	V14 p2 p3	1	10 20 20 40 70
556 556B 556BT	5	1A7 1N5 1H5 1T5 25Z6	456	V11 p7	1	40 40 80
1556 1556B 1556BT	5	1A7 1N5 1H5 1T5 25Z6	456	V11 p9	1	40 40 40 80
WALGREEN-AETNA						
P5	5	1A7 1N5 1H5 3Q5 117Z6	456	V13 p1 p2,	1	30 50 100 100
XP5	5	1A7 1N5 1H5 3Q5 117Z6	456	V13 p1 p2	1	30 50 100 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
WALGREEN-AETNA						
529	5	1A7 1N5 1H5 1T4 25Z6	456	V11 p11	1	10 20 40 70
532	5	1A7 2-1N5 3Q5 117Z6	456	V13 p9	1	40 40 40 70
WARWICK						
0-50	5	1A7 1N5 1H5 1A5 35Z4	455	V11 p7	1	10 30 40
0-53	5	1A7 1N5 1H5 1T5 35Z5	455	V11 p5	1	20 20 20 20
0-501	5	1A7 1N5 1H5 1A5 35Z4	455	V11 p7	1	10 30 40
0-530	5	1A7 1N5 1H5 1T5 35Z5	455	V12 p2	1	20 20 20 20
1-53	5	1A7 1N5 1H5 1T5 35Z5	455	V12 p5	1	20 20 20 20

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
WARWICK						
1-541 1-543	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z6	455	V13 p1 p10	1	20 20 20
2-541 3-543	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z4	455	V13 p4 p9	1	30 30 150
2-560 to 2-569	5	1A7GT 1N5GT 1H5GT 3Q5GT 117Z4	455	V13 p7 p9	1	30 30 150
WELLS-GARDNER						
6B10	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V12 p3 p4	1	10 20 40 40 200
6B16	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	456	V14 p3 p4	1	10 20 40 40 200
WESTERN AUTO SUPPLY						
D940 8seuc A,B	5	1A7GT 1N5GT 1H5GT 3Q5GT 70L7	455	V13 p45 p46	2	20 30 40 40

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
WESTERN AUTO SUPPLY						
D940 (5N)	5	1A7 1N5 3Q5 1H5 70L7	455		2	
D1080 1080B	5	1A7 1N5 1H5 1A5 35Z5	465	V12 p29	1	16 16
D1081	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V13 p62	1	20 30 40 40
D1136	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	455	V14 p9	1	30 30 40
D1169	6	1A7GT 2-1N5 1H5GT 3Q5GT 35Z5	455	V14 p10	1	30 30 40
D1180	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	456	V13 p79 p69	1	40 40 200
D1181	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V14 p17	1	30 50 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
WESTERN AUTO SUPPLY						
D1182	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	455		1	
D1183	5	1R5 1T4 1S5 3S4 35Z5	455	V14 p19	1	20 30 100
D1184	5	1R5 1T4 1S5 3S4 45Z3	455	V14 p20	1	20 30 100
D1281	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V14 p18 p28	1	30 40 100
D2269	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V14 p18 p34	1	30 40 100
D3115	5	1A7GT 1N5GT 1H5GT 1A5GT 35Z5	456	V13 p79 p69	1	40 40 200
D3123	5	1R5 1T4 1S5 3S4 35Z5	455	V14 p19	1	20 30 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
WESTERN AUTO SUPPLY						
D3124	5	1R5 1T4 1S5 3S4 45Z3	455	V14 p20	1	20 30 100
D3130	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V14 p17	1	30 50 100
D3230	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V14 p18 p28	1	30 40 100
WESTINGHOUSE						
WR6K1 WR62K2	6	2-1N5 1A7 1H5 3Q5 35Z5	455	V13 p15	1	30 50 160
WR62K3	5	1R5 1T4 1S5 3S4 45Z3	455	V13 p18	1	20 30 100
WR676	5	1A7GT 1N5GT 1H5GT 1T5GT 117Z6	455	V13 p33	1	20 20 200
WR678 WR679	5	1A7 1N5 1H5 1T5 35Z4	455	V14 p19	1	20 40 100

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
WESTINGHOUSE INT.						
M106	7	2-1N5 1R5 1H5 3Q5 50L6 35Z5	455	V14 p7 p8	2	40 80 200
WILCOX-GAY						
9E5	5	1A7 1N5 1H5 1A5 45Z5	456	V11 p15 p16	1	10 30 40 40
ZENITH						
5G401 ch. 5537	5	1A7G 1N5G 1A5G 1H5G 117Z6	455		1	
5G441 5G442 5G461 ch. 5539	5	1A7G 1N5G 1H5G 1Q5G 117Z6	455		1	
5G438 5G467 ch. 5536	5	1A7G 1N5G 1H5G 1Q5G 117Z6	455		1	
5G500 5G501 ch. 5A01	5	1LA6 1LN5 1LH4 1LB4 117Z6	455	V12 p3	1	20 20 20 40

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
ZENITH						
5G504 ch. 5A03	5	1LA6 1LN5 1LH5 1LB4 117Z6	455	V12 p4 p9	1	10 20 20 20 40
5G510 5G534 ch. 5A02	5	1LA6 1LN5 1LH5 1LB4 117Z6	455	V12 p5	1	20 20 20 40
5G537 5G572 ch. 5A02	5	1A7G 1N5G 1H5G 3Q5G 117Z6	455	V12 p6	1	10 20 20 20 30
5G603 Ch. 5B07	5	1LA6 1LN5 1LH5 1LB4 117Z6	455	V13 p7 p5	1	20 20 20 40
5G617 ch. 5B05	5	1LA6 1LN5 1LH5 1LB4 117Z6	455	V13 p9	1	20 20 20 40
5G636 ch. 5B06	5	1LA6 1LN5 1LH5 1LB4 117Z6	455	V13 p9	1	20 20 20 40
5G2617	5	1LA6 1LN5 1LH4 1LB4 117Z6	455	V13 p9	1	20 20 20 40

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
ZENITH						
6G501 6G505 ch. 6A19	6	2-1LN5 1LA6 1LH4 3Q5 117Z6	455	V12 p10	1	20 20 20 40 40
6G533 ch. 6Z25	6	2-1LN5 1LA6 1LH4 3Q5 117Z6	455	V12 p33	1	20 20 40 40 40
6G560 ch. 6A25	6	2-1LN5 1LA6 1LH4 3Q5 117Z6	455	V12 p33	1	20 20 40 40 40
6G601D 6G601L 6G601M 6G601MH 6G601ML ch. 6B03	6	2-1LN5 1LA6 1LH4 3Q5 117Z6	455	V13 p17	1	20 20 40 40 40
6G638 ch. 6B09	6	2-1N5 1A7G 1H5G 3Q5G 117Z6	455	V13 p18 p5	1	10 20 30 40 200
6G660 ch. 6B09	6	2-1N5 1A7 1H5 3Q5 117Z6	455	V13 p18 p5	1	10 20 30 40 200
7G605 ch. 7B04	7	2-1LN5 1LA6 1LE3 1LD5 3Q5 117Z6	455	V13 p25 p26 p42 p46	1	20 20 40 40 40

Manufacturer and Model No.	No. Tubes	Tube Complement	If Peak	Riders	Type No.	Filter Condensers
ZENITH 6G001 6G001Y	6	2-1LN5 1LA6 1LH4 117Z6 3Q5	455	V Foto Fact 463- 14	1	20 40 40 200