Radio
BUSINESS BUILDERS
Which help you build a growing business
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO ADD VOLUME EXPANSION TO A RECEIVER AMPLIFIER

BUSINESS BUILDER NO. B-32

VOLUME expansion is a method of improving the reproduction from a phonograph record when compression was used during the recording of the record, also it is needed to reproduce music and speech through the receiver so that it will sound exactly as it occurred at the studio of the radio station.

The purpose of this Business Builder is to show you how volume expansion can be added to a receiver or amplifier. This should give you some good experience; and if you can properly demonstrate the value of volume expansion to some of your customers, it may well prove to be profitable. If you point out its value to them, they will probably want you to add it to their receiver or amplifier.

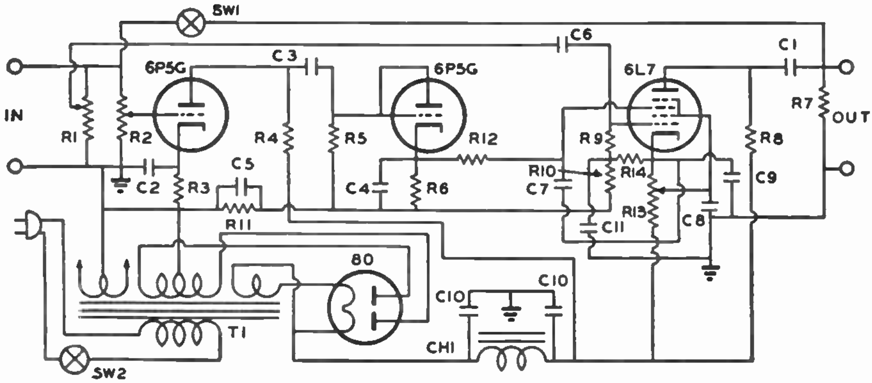
It is always a good idea before applying new circuits, such as these expander circuits to try them out on your own equipment first. In this way you can become familiar with the common troubles encountered in building the system before attempting to install one for a customer.

Figure 1 shows a diagram of a typical expander. The value of the parts are given below the diagram. Use good standard parts. The value of the components are calculated to give maximum performance. Any substitutions may cause the wrong effect.

The components can be laid out on the chassis as indicated in Fig. 2. Drill holes for mounting each component. Then mount the parts. After mounting the parts, wire the circuit from the diagram of Fig. 1, making sure each connection is properly made. After the circuit is wired, go over it again making an accurate check of the complete wiring. By doing this you should avoid trouble with its operation.

As you gain experience you will learn what minor changes can be made and still give good operation. The power supply could be eliminated by taking voltages from the receiver or amplifier itself, but unless the receiver or amplifier has a power supply large enough to handle this extra load, you better use the power supply as shown in the diagram.

How is this expander added to the receiver? This is a fairly easy task, but you must take certain precautions to insure proper operation. If your receiver uses tubes such as 6Q7 or 6F5 in the audio section, it is an easy matter to add the expander. Simply remove the grid cap from the tube and unsolder the cap from the lead. Now connect this lead, which was previously connected to the grid cap, to the center conductor of a length of shielded cable. This length of shielded cable is then connected to the input of the expander as indicated in Fig. 1. The grid cap is now soldered to the center conductor of another length of shielded cable and the other end of the shielded cable connected to the output of the expander. The grid cap is then placed back upon the tube and the outside shielding of these two cables grounded to the receiver chassis, and at the other end the shields are grounded to the expander chassis. With these



R_1—1 Megohm pot.
R_2—1 Meghom pot.
R_3—10,000 ohms, ½ w.
R_4—100,000 ohms, ½ w.
R_5—100,000 ohms, ½ w.
R_6—250,000 ohms, ½ w.
R_7—1 megohm, ¼ w.
R_8—100,000 ohms, ½ w.
R_9—1 megohm, ¼ w.
R_{10}—100 ohms, 1 w.
R_{11}—100 ohms, 1 w.
R_{12}—500,000 ohms, ½ w.
R_{13}—10,000 ohms, 50 w. adj.
R_{14}—400 ohms, 2 w.
C_1—.05 mfd. 600 v. paper.
C_2—.5 mfd. 200 v. paper.
C_3—.01 mfd. 600 v. paper.
C_4—.5 mfd. 200 v. paper.
C_5—5 mfd. 50 v. electro.
C_6—.05 mfd. 600 v. paper.
C_7—.5 mfd. 200 v. paper.
C_8—2 mfd. 550 v.
C_9—5 mfd. 50 v. electro.
C_{10}—8-8 mfd. 550 v. electro.
C_{11}—5 mfd. 50 v. electro.
T_1—650 v. @ 40 ma., CT, 5 v. @ 2A., 6.3 v. @ 1.6A. CT.
CH_1—25 henry, 50 ma.
Chassis—7"x9"x2".

FIG. 1

—Courtesy of Radio News

connections made, the expander should be ready to operate.

In case your receiver does not use the type tubes as mentioned, two leads must be brought out of the receiver. The expander should be inserted in the audio amplifier in such a way that the expansion can take place ahead of the speaker. If one output tube is used, the expander can be inserted at the input to the final stage. If push pull output is used, it will be necessary to add the expander ahead of the driver or input AF tube. To connect the expander, all that is necessary is to find a point where the audio signal of the receiver can be made to drive the expander and the expander in turn, with the expansion added, returns the signal to the audio amplifier. It is added at the input or grid side of one of the audio tubes. To insert the expander, disconnect the grid lead of the tube where the expander is to be added and connect the center conductor of a length of small shielded cable to this lead. The other end of this cable is connected to the input of the expander. The center conductor of another length of shielded cable is connected to the grid of the tube, and the other end of the cable is connected to the output of the expander. The outside or shield of these cables are connected to the chassis of the receiver on one end and to the chassis of the expander on the other. Figure 3 shows a diagram of how these connections are made in a typical audio amplifier stage. To make these connections, disconnect the lead from the grid of an AF input tube and connect this lead to one of the unused terminals on the tube socket (there is usually a blank terminal on an octal socket) and connect the length of shield cable to this terminal. This allows a solid connection for the cable.

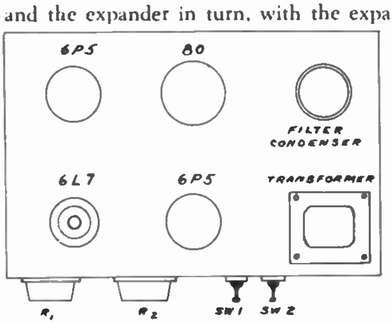


FIG. 2

If a phonograph pick-up is used with the receiver, all that is necessary for its operation is to connect it direct to the input of

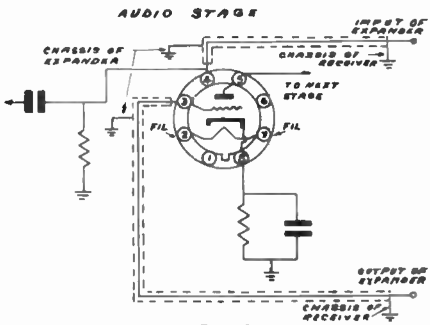


FIG. 3

the expander. It may be convenient to place a phone jack in the expander chassis for plugging in the pick-up unit. If a short circuiting jack is used and the switch on the jack connected in such a way that the expander input is disconnected from the receiver, when the phone plug from the pick-up is placed in the phone jack, the necessity of a separate switch is eliminated.

The additional gain produced by the expander unit, when used in conjunction with the audio section of the average radio receiver, is likely to cause distortion unless the unit is properly operated. To set the volume of the expander right so that distortion will be avoided, the following procedure should be followed: With switch S1 in the *off* position, S2 in the *on* position, and the two expander controls turned to the left (near the *off* position), turn up the volume control of the receiver until the volume is at the right level. With the volume control on the receiver set at this level, turn switch S1 to the *on* position, allowing the expander to operate. Now turn up the expander volume by rotating potentiometer R2 to the right until the same level of sound is indicated by the speaker. For a check, turn the expander on and off (switch S1) and note that the volume of the signal does not change. This gives you the proper adjustment of the volume from the expander.

The amount of expansion can be adjusted with switch S1 and S2 turned on and R2, as previously discussed, set properly. Rotate R1 to the right until a point is reached where the degree of expansion is most pleasing to the ear. After these adjustments have been made, the controls need not be touched again.

With the expander adjusted in the above manner, no difference will be noticed with stations using little or no compression; but with the majority of the large stations, which are of the high fidelity type, a definite improvement will be evident.

When the pick-up is used and a record of a symphony orchestra played, the improvement will be sufficient to sell an expander to any music lover if demonstrated to him properly. For showing the contrast between expansion and no expansion, switch S1 off and on while the record is playing.

A simpler method of attaining volume expansion is shown in Figures 4, 5, and 6. Here a small pilot light and a resistor is placed across the secondary of the output transformer as indicated by the diagram. The DC value of the resistor is one-half the AC impedance of the speaker.

The type light to use varies somewhat depending upon the size of the amplifier. As the pilot light draws power from the circuit, the smaller the output of the amplifier

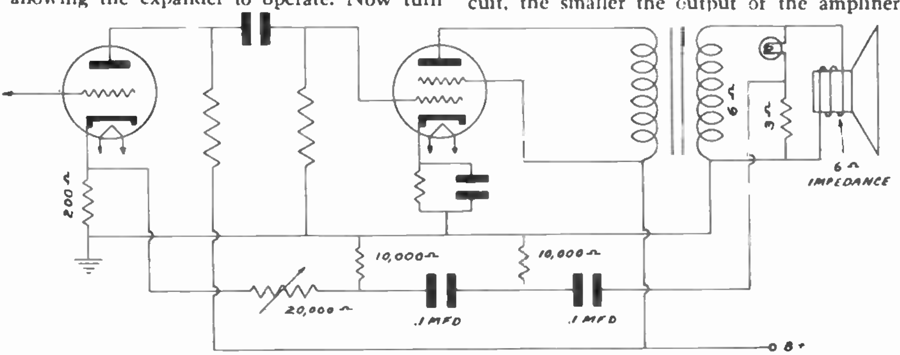


FIG. 4

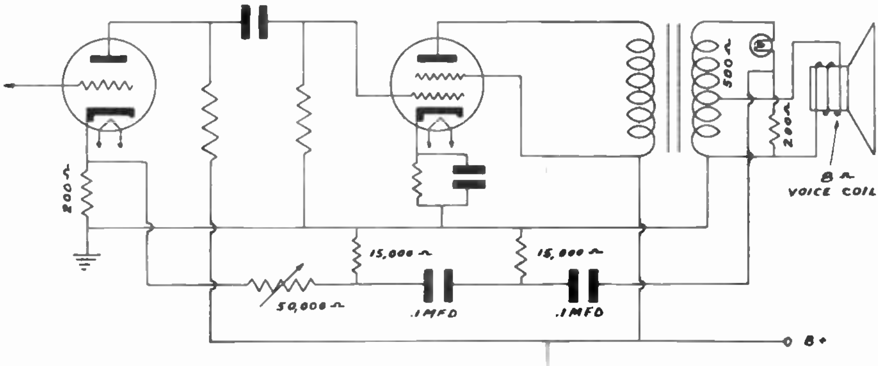


FIG. 5

the less power is available for lighting the pilot light. Therefore, the smaller the circuit drain of the light, the better. A .15 ampere brown-bead pilot light will operate with slightly less than 2 watts. When there is a large audio amplifier in the receiver, you should use the .25 ampere brown-bead light but for small amplifiers, use the .15 ampere blue-bead light. The connections from the resistor and the pilot light back to the input are shown in the diagrams. Care must be exercised when making these connections or hum and even audio howl may occur. This type of expansion is due to the feed back principal and this feed back can be controlled by the variable resistors as indicated in Figs. 4, 5, and 6.

The resistors and condensers labelled in the diagrams of Figs. 4, 5, and 6, are the ones to be added to the amplifier. The other components are those usually found in typical receivers. They are used to show how the feed back from the pilot light and resistor are used to give expansion.

To tell when the expander is operating, watch the pilot light. If the pilot light is varying in intensity as the amplifier is operating, it is working. There will be vary little difference with popular music but symphony orchestra music will be improved remarkably. The usual scratchy noises from static or needle scratches when records are played will be reduced. Try these circuits on your own receiver and when you get satisfactory results, demonstrate it to your customers. They may want you to make an installation of this sort for them.

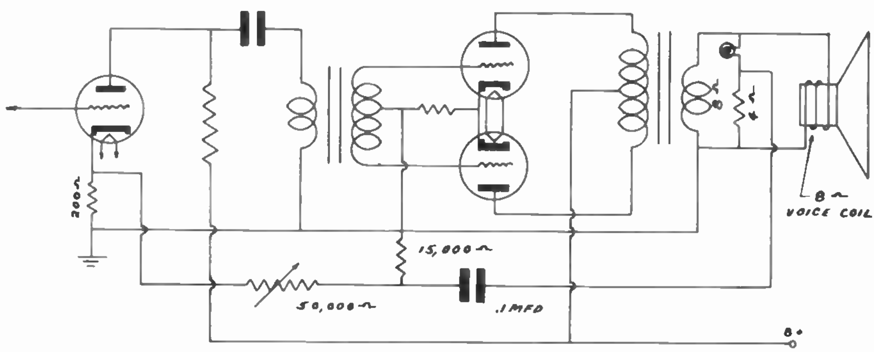


FIG. 6

Radio

BUSINESS BUILDERS

SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO ADD PUSH BUTTON TUNING TO A RECEIVER

BUSINESS BUILDER No. B-33

THE push button tuning system has been in use for a number of years. However, there are still receivers in use today which do not employ this convenient feature. It is the purpose of this Business Builder to present methods for adding push button tuning to the average receiver.

A wide awake service man can always spot receivers that are not equipped with some of the modern conveniences and while he has the receiver in for repair can suggest to the customer the advantages of these new devices, making a demonstration of how they operate. In this way many sales can be made in addition to routine service work.

After you have made one or two installations and by doing a good job, your ability as a serviceman will become known and you

The convenience of operating a push button tuning system is illustrated by the above photograph.—Courtesy of Philco.

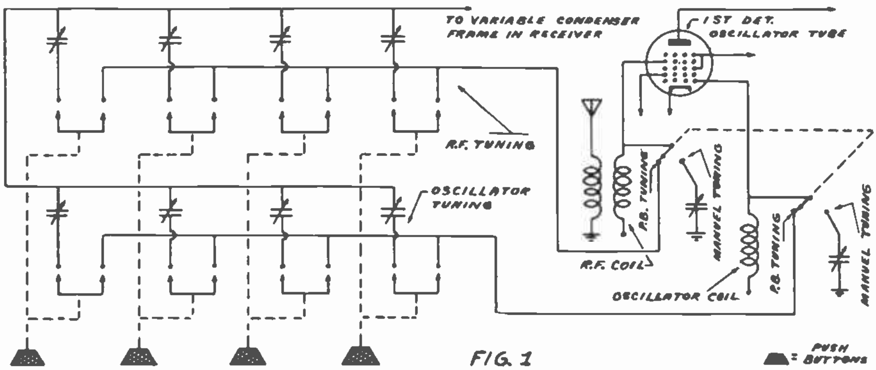


FIG. 1

will, no doubt, receive many requests to modernize other radio receivers.

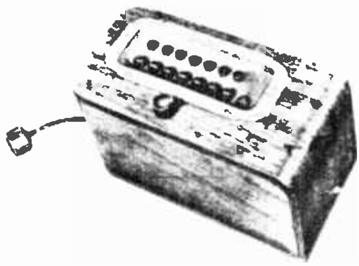
It is the purpose of several of these Business Builders to show you how modern devices can be added to any receiver not already modernized. Radio is such a rapid changing field that ofttimes receivers less than a year old can be improved in one way or another and the radio man keeping up with these changes can usually find many jobs that other service men overlook.

The push button system of tuning is a modern method of tuning a radio without having to rotate the dial by hand. The simplicity of this system will sell itself if properly demonstrated. The simpler the radio is to operate the better it is for the public. With the old method of tuning, which is still used in conjunction with the push button system, it is difficult for most people to tune in the receiver properly. The push button system being an automatic tuning device which is adjusted by an expert serviceman will give perfect tuning for the stations set up on each push button, in this way improving the fidelity of the receiver by proper tuning of the signal.

These push button systems have been greatly improved since the first models were put into use. Many of the early methods were entirely mechanical and any jar, change in temperature, or continued use would cause them to get out of adjustment. For this reason many receiver owners were disappointed with the push button system and discontinued using it because it was always out of adjustment. Also many of the radio dealers were not radio men and did not understand how to set the push buttons and so many receivers were never adjusted properly. Because of this, a radio serviceman can build himself a good business by being on the alert for these receivers where the adjustments were not made properly; and by making them, you will advertise your ability as a good radio serviceman. As many of the older systems proved to be inadequate, you have another source of income if you can sell and install a newer type push button tuning system to your customers with receivers using these older methods.

When push button tuning first became popular, several types were used. However, as practically all radio receivers manufactured today have a push button system installed, some of the earlier expensive push button systems have practically dropped out of the picture. However, these methods can still be used if conditions warrant their use. One of these systems was a converter which could be attached externally to a receiver and operated from a remote position. These units can be used with any type of receiver regardless of the circuit design of the receiver if it can be tuned to about 540 KC. This unit is almost as expensive and as large as some of the small portable receivers on sale today. Therefore, its advantages are limited and it is not used very much. Other methods were used similar to the remote tuner, but have been replaced by simpler less expensive tuners.

One push button tuner that is in wide use today is the substitution tuner. This tuner has a group of condensers so arranged that as the push button is depressed separate condensers for the (see Fig. 1) oscillator and mixer tubes replace the original tuning con-



A PUSH BUTTON REMOTE CONTROL TUNER

densers. If the receiver is a TRF, these condensers replace the usual tuning condensers in two of the RF stages. Each button has a separate set of condensers which are tuned in such a way that each button relates to a different station. Usually these buttons are of the self locking type. When a button is pushed in, it remains in that position until another button is pushed and then it is released as the new button is locked in place. One of the buttons in the receiver is usually used as a switch for manual operation. When it is pushed in, it releases all the other buttons returning the receiver to manual operation.

Figure 1 shows a schematic diagram of this type tuner. You can see from the diagram that only three wires are connected to the receiver, making the installation very simple. The earlier types of push button tuners using this method were very unstable but better designed condensers and switching systems have greatly improved on this system.

The installation problem consists mainly of finding a suitable location for the unit. It should be located so that the push buttons are in an easily operated position and as the

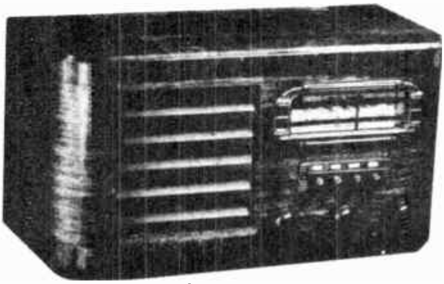


FIG. 2

circuit is connected to the RF portion of the receiver, it should be located near the variable condensers or near the band switch in case the receiver has more than one band. For ease of removing the chassis from the cabinet it should be fastened to the chassis in such a way that it will slide into place when the chassis is pushed into the cabinet. When locating the proper position for the tuner, be sure that you allow enough room for the unit. A hole should be cut in the cabinet large enough for the push buttons to enter, leaving enough room for the embossed push button escutcheon to be screwed in place. (see Fig. 2) *Be sure there is enough room behind the front panel of the cabinet for the unit before cutting a hole in it.* After you have found the right location, cut the hole in the cabinet using extreme care not to mar the cabinet. The hole can be cut without jagged edges if the top layers of veneer are first cut with a sharp pen knife. Determine the size of the hole and then with a pencil mark the position of the hole. Cut through the top layer of veneer following the pencil pattern. Then with the aid of a carpenter keyhole saw and a bit for drilling a hole to start the saw, cut out the hole following the cut lines very carefully. Don't allow the saw to come in contact with the outside edge of the veneer while sawing, else the edges of the veneer will be split, ruining the cabinet. If the cabinet is solid wood, these precautions aren't necessary.

After the hole is drilled, place the unit in place. Now mark the exact position of the unit on the chassis. From these marks, mount the unit on the chassis. When the unit is rigidly mounted; replace the chassis in the cabinet with the push buttons mounted. With the chassis in its proper place, note the position of the tuning buttons. If they are clear of the cabinet, place the escutcheon over the buttons and adjust it so that it is symmetrical with respect to the buttons and will allow them to pass in and out of the holes when the chassis is removed. Hold it firmly in place and mark the correct position. Then fasten it to the cabinet. This completes the mechanical operation.

Each unit and each receiver requires slight variations in the general instructions. The manufacturer of the tuner will supply

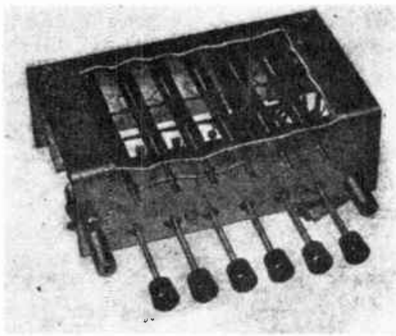


FIG. 3

you with the necessary information as to the proper electrical connections to make. How ever, Fig. 1 shows a typical layout and by following this diagram, most tuners of this type can be installed without difficulty.

After the unit has been installed, it is an easy matter to adjust the push buttons. Secure a list of stations preferred by the customer, noting the frequency of these stations and from your own experience which of them have fairly strong signals. Don't try to set up the push buttons on weak stations. Then starting at one end of the frequency spectrum, adjust the push buttons to these stations. Each individual push button is not capable of tuning through the entire broadcast band. So care must be exercised in selecting the proper push button for the station involved. The frequency that each button will tune is usually stamped on the unit near the button. From this you can see which stations to use with each button. After the stations are selected, cut out the station call letters from the list included with the unit and place them in the space provided for them. Now with the aid of an insulated screw driver adjust the oscillator and RF condenser of each button until the station selected is tuned properly with the button locked in position. An easy way to do this is to tune the receiver with manual tuning until you have the station desired. Then push the button that is to tune this station and adjust the two condensers until the station comes in with maximum volume. If the receiver has a tuning indicator, use it to indicate the proper resonance point. The location of the condensers for each button is usually very near the button so that they are easy to identify. Before attempting to set up the push buttons always allow the receiver to warm up to operating temperature.

Another type of push button tuner is mechanically the same as the previously described type. The main difference is in the type of tuning. This type is called a *permeability* tuned push button system. Instead of the usual adjustable condenser tuning, it uses adjustable inductance tuning. This is possible because of a new type of powdered iron core used for the inductance. This core changes the inductance of the coil as it is moved in and out of the coil. Fig. 3 shows a pictorial view of a permeability tuner, showing the coils and push button mechanism. With these units, one adjustment for each station is all that is necessary. The schematic diagram of Fig. 4 shows how this unit is added to a receiver.

The advantage of permeability tuning over the condenser tuning is stability of operation. Jars and temperature changes have little effect upon permeability tuning. There is only one adjustment necessary making it simpler to adjust.

The installation of this system is identical to that of the previous system. However, when setting up the push buttons, there is usually only one adjustment to make for each button.

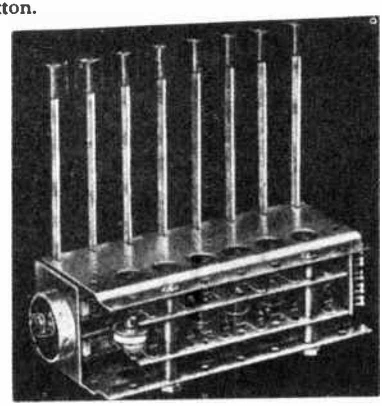


FIG. 4

HOW TO TEST PARTS WHILE CONNECTED IN CIRCUITS

RADIO SERVICE BULLETIN NO. 15

It is always desirable and many times possible to test receiver parts while they remain connected, thus saving the trouble of unsoldering them. By the correct application of test principles, it is possible to test many more parts than ordinarily supposed in this way. This method will not always show the exact nature of the circuit fault, but will localize the cause and permit a fast analysis of the circuit.

First consider an ordinary capacity coupled AF amplifier, with the plate of one tube using a 100,000 ohm load supplying the grid of the next which uses a 500,000 ohm grid resistor. Consider the coupling condenser is rated at .01 mfd.

If you at first measure the resistance from B+ to ground where the plate resistance connection is made and find it to be 25,000 ohms, then measure from the plate to B+ and find it to be 100,000 ohms, you will know that the plate resistor is in good condition. If the tube is removed from its socket it cannot affect the circuit with respect to continuity tests. Of course, if the 100,000 ohm resistance tests far below this value, you would suspect a short at the socket (tube removed). Or, if the resistance becomes low, only when the tube is in place, the tube must have an internal short or its socket lug or prong shorts to some other part of the circuit when inserted. Even if the coupling condenser is shorted it will have little effect on this reading, because of the high grid resistance involved. Accordingly, from plate to ground would test 125,000 ohms. This constitutes a satisfactory test of the plate resistor without detaching it.

Now if you test from grid to ground, you are likely to get the exact value of the grid resistor with the tube removed. If inserting the tube after removal makes no difference in the resistance reading, the input, that is, the grid-cathode circuit of the tube is in good condition, as there is no grid short to any other element of the tube.

With this test, if the coupling condenser were shorted, the reading would be greatly affected by the plate resistance. In fact, the reading would be lower than 125,000 ohms where it should be 500,000 ohms. All coupling stages and the tube connections may be tested in this way as it is the result of a combination of tests that gives the solution to the circuit condition. These principles, of course, hold true for any receiver.

One test will give information usually about two or more circuits, but other tests can almost always be made in such a way as to isolate the defect to one unit part.

The removal of tubes breaks the circuits at the sockets in such a way that one end is always a free end. No matter what may be connected to the other end of the coil, resistor or transformer its exact resistance may be measured. Removal of a speaker connecting cord breaks the transformer circuit in such a way as to make the testing possible from free ends of the winding just as when removing tubes.

With the rectifier tube removed, the high voltage secondary of any power transformer may be tested just as well as though the entire transformer were removed. Also, with the line cord removed from the power outlet the primary including fuses, the various voltage taps and any actual or unintended short to ground would be noticed immediately.

To test filter condensers for shorts while connected in their circuits, remove the rectifier tube and first test across the filter input condenser. See lesson on testing condensers. If there is a short, it is most likely the first filter condenser. If the second or output condenser is shorted, the first reading as just described will show the resistance of the filter choke which, of course, will usually be the speaker field. (See lesson on testing speakers.) Being of a low resistance value as compared to that of the plate and divider circuits, the field coil or filter choke may be tested for continuity very accurately by removing the rectifier. If the rectifier is known to be good and its socket is known to be good it is not even necessary to remove it.

Sections of a shunt type voltage divider, that is, one which is across the high voltage, may be tested in general without disconnecting. See lesson on testing resistors. All of the circuits which are across the sections of the divider being tested are usually so high in value that they will not materially affect the values under test. Many of the connections to the divider are to high value resistors, transformers or coils which terminate at tube terminals and are consequently in open circuits when the receiver is turned off. That is, the tube plate and grid circuits are essentially open circuits when the filaments or heaters are cold.

If there is a parallel bias divider across the speaker field, each section of it should be tested individually. When testing the highest value of the two in series across the choke or speaker field, the field and other resistor in series with it must be considered as being in parallel. If the test is at variance with the calculated value, one of the resistors or the field is defective. Of course, they must be unsoldered and tested individually if this is true.

HOW TO ARRANGE YOUR SHOP WORK BENCH FOR BEST USE OF EQUIPMENT

RADIO SERVICE BULLETIN NO. 16

Although there are a large number of ways that any bench can be arranged for work, there are some general ideas that will be found helpful in all cases. Every work bench need not be alike for the best conditions in every case, because of the positions of lights, windows and the general arrangement of the room in which the shop is located. Then, there is the individual taste to consider.

One of the most important considerations is the location of the power outlet. Through long experience with a great number of shops, the best location for the outlet is directly under the front edge of the bench. There are still a few shop men who have their power outlets at the top rear of the bench along with their various mounted test instruments. It is very possible that this is preferred only because test equipment was installed in that way and they have not seen fit to change it and have simply become accustomed to working with it in this way.

If the line cord comes from the back of the bench, it is often difficult to reach over the chassis to put it in place and the line is in the way when the chassis is to be moved or turned. All of the surplus cord is on the bench as a rule and soon will become tangled with the soldering iron and cords of testing equipment.

If the power cord hangs from the front of the bench, all of the surplus length of cord is off of the bench and out of the way. With the soldering iron connected here also, it has a maximum freedom of the bench with a given length of cord and the cord never rests on the bench to get tangled with tools, instruments, and other cords.

There should be a light directly over the work and for a large bench, several lights will be needed. Shades are helpful but not essential.

The position and application of the bench antenna and its lead is another important point. Many servicemen use a wire lead-in extending to the entire length of the work bench in a horizontal position above the bench. To make a connection to a receiver for testing actual reception, a lead is clipped on to this wire at the most convenient point and then the other end is attached to the antenna of the receiver. This is sometimes called a **trolley line** antenna. A ground connection is rarely needed on test but when used may be of this type as well. Most usually it is convenient to connect to a ground lead going under the bench.

More convenient and accessible than the tool kit or bag for the bench is a rail at the back of the bench with holes in it for tools or nails or screws placed to hang each tool. In this way they are instantly available. If possible, it would be well to have a duplicate set of the more common tools for portable use on the job so that the tools need not be removed from the bench for outside work.

The placing of the various pieces of test equipment depends to a great extent on the type of mounting. For example, if the equipment is mounted on a vertical panel, it is of course, placed at the back or end of the bench. On the other hand, if it is portable separate equipment such as a unit tube tester or a multimeter, they may be used both on outside jobs and in the shop and mounting is not necessary.

Some servicemen have a slanting rack with a base rail at the back of the bench for portable equipment. Thus the instrument in use may be placed at a convenient place for observation while test leads are attached and measurements or tests are made.

It is a very good idea to have a shelf along the back of the bench 12 to 18 inches high and 9 to 12 inches deep for such apparatus as signal generators, audio oscillators, oscilloscopes while in use and other instruments while not in use. Even if you have plenty of room on your bench it is not well to use it as storage space.

Various types of stock, such as condensers, resistors, tubes, etc., should be kept on shelves or in drawers, and classified for immediate location. Drawers should be in the base of the bench and not in cabinets on top of it, unless they are well to the side of most of the working space. The reason for this is that they should be accessible at any time with any ordinary work on the bench in progress. If storage cabinets are behind the work it usually will have to be moved to get at the various parts which will mean delay and inconvenience.

The soldering iron may be in a rack on the bench or under the front edge of the bench, the rack if on the bench, however, should be movable so that the iron is in reach from the work at all times.

All spare parts that are not defective, wire scraps, nuts, bolts and screws should be classified as to size and placed in small bottles on a convenient shelf or in sectioned drawers. Since a large amount of time is spent with the mechanical arrangement of receivers and in finding the correct values of parts, it is best to have your bench and stock arranged for greatest convenience.

Radio
BUSINESS BUILDERS

SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO USE ELECTRIC TIME SWITCHES AND PHOTO-CELLS

BUSINESS BUILDER No. B-23

AN automatic time switch is usually in the form of an electric clock, fitted with a switch usually of the mercury pool type and two auxiliary dials for setting the time when the switch is to be closed and the time when it is to be opened. These dials are set exactly as you would set an alarm clock, and they have a similar appearance.

The electrical power is brought to the clock by means of its regular cord, and it is quite heavy. From this point, one terminal is connected to a wall type socket in the side or back of the clock and the other side of the line is connected through the switch to the other socket terminal. The cord and switch are both designed to conduct well over the current rating for any radio receiver and hence will be suitable for any receiver. The mercury pool type switch used in most of the time switches will carry 5 or 6 amperes.

The receiver power plug is plugged into the socket on the clock. The on-off switch of the receiver is turned on and its volume control is set at the desired level. In fact, the receiver is adjusted for the desired reception while operating as usual and then the power plug is simply removed from the regular wall or floor socket and placed in the clock control socket. When set correctly, the clock will then turn on the power at the pre-determined time and turn it off any time later for which it is set. Usually, of course, all operations must be within a 12 or 24 hour cycle. Such operations as have been set up will repeat every 12 or 24 hours.

One type of electric time switch manufactured by Telechron has an appearance similar to an ordinary electric clock. There are 48 keys representing each 15 minute interval of the 12 hours around the face of the clock. These keys are so arranged that if one is pulled out the 15 minute period represented by this key will cause the switch to operate for the 15 minutes involved. If more than 15 minutes is required, consecutive keys are pulled out for the length of time the switch is to operate. To represent its operations suppose you would like to hear a radio program between 10:30 and 11:00 o-clock on your radio. The radio would be adjusted before hand to the frequency of the station you wanted to hear and the volume of the radio would be set to the volume level you preferred. With the radio turned on, and the power cord of the radio plugged into the power outlet on the back of the time clock, the two keys just opposite the 10:30 and 10:45 time positions are then pulled out. When the clock hand reaches 10:30 the radio will be turned on automatically by the clock and turned off again at 11:00. After the time interval for which the clock was set has passed, the keys drop back into their original positions. For this reason this clock has to be reset each day.

There is a small toggle switch located on the front of this clock which allows manual operation of the radio by shorting out the contacts of the time switch. In this way the radio receiver can be operated at any time

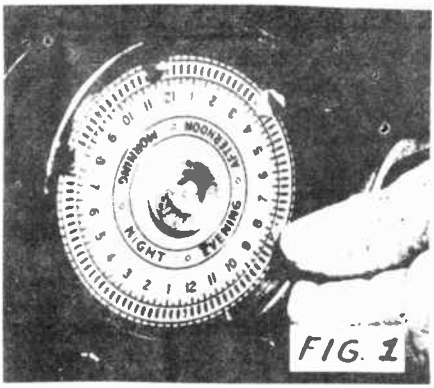


FIG. 1

without having to change the cords or setting the clock. This type of electric switch is a good time piece as well as an automatic switch.

Twenty four hour time switch clocks are also available. One is manufactured by the Tork Clock Co. It can be set to turn on a radio receiver or any other small current appliance to operate for any interval during the 24 hour day. (See Fig. 1).

The dial of this clock is divided into two 12-hour sections with morning, night, evening, and afternoon printed on the dial so that the proper time of the day can be chosen. There are four pointers on this particular model making two on-off operations a day. A model with just one on-off operation is available at a lower cost. Two of the four points select the on position while the other two select the off position. Once the position of the four pointers are set, the action will repeat itself every day. No resetting is necessary.

This type switch is particularly useful for television reception, turning on the receiver when the pictures are transmitted and off again when the transmission is finished.

There are two interlocked switches on the front of this clock. One turns the automatic action on and the other allows manual operation of the radio receiver connected to the electric switch.

The switching mechanism of this clock consists of a single-pole, single-throw switch with pure silver contacts with a current rating of 6 amperes. (600 watts at 110 volts).

If a larger current rating than 6 amperes is necessary, other type timing devices of the commercial type should be used. The General Electric Company makes several types of commercial timing devices. Figure 2 shows one of these made so that it can be used inside or outside. The dial on this electric switch is called an astronomical dial. It is so constructed to change with the different seasons to account for the changes in the length of night and day. It is especially adapted to operation that requires turning on at night and off again in the day, such as safety lights for broadcast stations, antenna towers, etc.

The operation of radio receivers is simply one of the most recent applications of the time switch. In the form of a dial-operated mechanism or simply an enclosed box, similar time switches operate oil burners, electric signs, air conditioning and other equipment in houses, apartments, hotels, theaters and restaurants. The use of a time switch greatly improves the efficiency of heating and cooling conditioning systems, as it permits them to be inoperative when not needed, and attends to their operation at the correct time automatically. Besides these applications, time switches have found use in connection with illumination control, water and air pumping, and circulation draught control, and many other uses.

For some of these applications large motors are required, and the switch cannot carry their current. The arcing of switch contacts and overheating of the elements limits the current which the switch can carry. When it is desired to operate machinery, having a higher current capacity than the switch can carry safely, a relay may be used. The time switch is then used to operate the relay and the contacts of the relay are made to carry

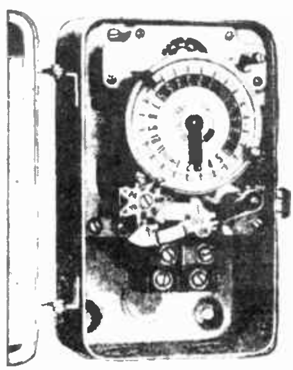


FIG. 2

any load desired.

For AC operation, an AC relay must be used, and practically any relay designed for AC will also operate on DC. To judge the power capacity of a 5 ampere switch, the maximum power that any device connected to it should have would be 550 watts or less, or 3/4 horse power or less.

Time control switches of the mercury pool type must be mounted only in an upright position. The small glass tube containing the mercury and contacts is tilted by magnetism of the solenoid for the relay type and is tilted machanically by the direct time mechanism. The actual switch consists of about one ounce of mercury in a small glass tube about 3/8 inch inside diameter, sealed at each end and about 2 1/2 inches long. At one end, at the top, two contacts are sealed in the tube, having protruding conical carbon points. They reach about to the center of the tube and are approximately 1/4 inch apart. When the tube is tilted sufficiently, the mercury will completely surround and cover these contacts—thus closing the circuit.

External leads are made to the switch by means of very fine and flexible copper braid because the leads must move with the tilting action of switching. When the end of this glass tube in which the contacts are mounted is slightly above the other end, the switch will be open, but when just a little lower, the liquid mercury will connect the carbon contacts and close the switch.

Such a unit can be installed or replaced very easily, because there is a simple mechanical support, usually a clip and only two electrical connections, usually lugs, at the wire ends.

Although the timing applications of this type of switch have been discussed, it is important to realize that such switches are even more often found actuated by thermostats (temperature operated mechanisms), light beams, pressure operated mechanisms and in still other ways.

Repairs to the actual switch unit are not practical and the switch should be replaced if the glass is broken or if the leads are in any way defective.

Electric time clocks with mercury control switches may be obtained from radio mail order firms and from large electrical supply houses.

When ordering a time switch, be sure to specify what you are going to use it for. In this way the manufacturer can help you choose the proper type for your particular use.

These electric clock switches are available for operation on 110-120 volts-60 cycles. Also a hand wound model is available with an eight day clock mechanism.

These hand wound clocks are a little more expensive but they turn the electrical appliance on and off in the same manner as an electric clock. Hand wound clocks of this type for turning on and off the lights in chicken houses can be bought from large national mail order firms.

How to Use Photo-Electric Cells For Turning Lights On and Off, Etc.

Photo-electric cells provide a means of operating electrical apparatus from a source of light. They are wired in the grid circuits of vacuum tubes in such a way that when light strikes them the grid bias voltage of the control tubes will change, and hence change the plate current of the tubes. On application of light, they may be wired to either increase the bias or decrease it a definite amount for a given light intensity. In the plate circuit of the tube is placed the solenoid winding of a relay which opens or closes electrical circuits, depending on how it is wired. A number of practical circuits are given in your SAR lessons on this subject.

One of the principle uses of this type of equipment is in connection with the automatic operation of garage doors. The photo-cell is mounted at the side of the doorway in such a manner that the sensitive surface of the photo-cell is exposed to the driveway leading to the garage. To prevent stray light sources from operating the equipment, the photo-cell is usually provided with a shield or cover in the form of a box or tube about 3 inches in diameter and 6 inches long extending in the direction of the intended light with its outer end open. It should be painted black on the inside or the inside should be covered with a black material to prevent reflection. This device is called a *dark box* and receives only the light for which it is intended.

The relay in the circuit to which the photo-cell is connected closes a switch which turns on the motor or other door opening mechanism. As the motor car approaches, its lights actuate the entire process.

For this particular service a relay of the self locking type is used, so that once the action is started by the light it continues even if the lights are switched off. The same relay can, of course, turn on the lights inside the garage.

While the photo-cell, amplifier and relay power must be on constantly, they do not consume appreciable power. Once in the garage, the driver manually operates a switch to close the garage doors and lights. This operation should be arranged to unlatch the relay for repeating its operation.

Another common application of the photo-cell is for drinking fountain control. The cell is mounted on one side and directly above the water spout while the light source, a small lamp connected to the 110-120 volt line, is mounted directly opposite it. The short beam of light passes horizontally across the fountain just above the spout. When a person is placed to drink from the fountain their head intercepts the beam of light and a relay operating from the photo-cell amplifier completes a power circuit to the electrically controlled water valve turning on the water. This type of relay does not lock in place but opens the circuit as soon as the light again falls on the photo-cell. Thus when the head is lifted away from the fountain the water in automatically cut off. An installation of this kind requires, in addition to the photo-cell and relay, an electrically operated water valve.

In the same manner, that is, by intercepting a beam of light, doors may be opened by a person approaching them. In this case, an electrically operated motor or a pneumatic door operating mechanism is needed.

Essentially the same equipment is used for race timing, where the relay operates a camera shutter to provide an accurately timed photograph.

Another very valuable use of the photoelectric cell is for a burglar alarm. Here a different light source is used. This light source is the so called lark light. It consists of an ultra violet ray which has such a high frequency that the human eye cannot detect it.

If this source of light is placed in such

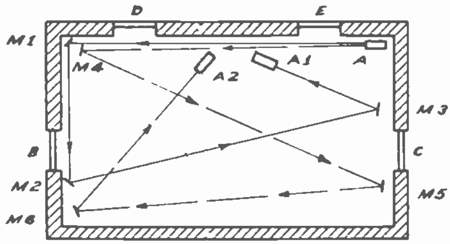


FIG. 3

a way that it will fall upon a photoelectric cell, it will actuate the cell. By the use of mirrors (Fig. 3) the arc of a room can be covered so thoroughly that no one can enter without intercepting the beam of ultra violet light. When this beam is intercepted, some type of burglar alarm is set off. The use of this type burglar alarm has become very popular.

To determine the proper ratings for various pieces of control equipment, first find the current drawn by the device which it is desired to operate automatically. If the power it consumes is rated in watts simply divide the watt rating by the line voltage or W/E to find the current. If it is rated in horse-power, the current will be equal to $\frac{746 \times HP}{E}$.

Once you have the current value, a relay must be chosen which can carry this current in its contacts and which requires the smallest possible current to operate its solenoid. From the value of solenoid current required to operate the relay, the amplifier tube for the photo-cell can be chosen. It must be able to carry at least the full solenoid current without overload. (See your Electronic SAR Lessons).

Now from the difference between the current required to actuate the relay and that to release it, the grid bias change of the tube can be determined. It is equal to this change in plate current in amperes divided by the mutual conductance of the tube in mhos. Thus, if the plate current change, as described above, is 30 ma. and the mutual conductance of the tube is 2500 micromhos (.0025 mhos), the grid voltage must be .01/.0025 or 12 volts. The photo-cell input circuit must, therefore, be designed to change the grid voltage by 12 volts.

Radio
BUSINESS BUILDERS
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO GET MAXIMUM USE FROM RADIO DIAGRAMS

BUSINESS BUILDER No. B-24

IN your SAR lessons you are given complete instructions about radio symbols and diagram reading. It is not the purpose of this Business Builder to repeat what you already know but to emphasize the use of radio diagrams and how they can assist you in becoming a better and more efficient radio serviceman.

In scientific fields, short cut methods of analysis are always being devised to minimize memory work. Radio, being a scientific field, has many short cut systems. Radio symbols and their use in constructing circuit diagrams are good examples of a short cut system.

A radio serviceman, understanding the use of these short cuts and applying them to his service work, can do a much faster and in most cases a better job.

The task of learning these short cuts may seem tedious. In many instances you may feel that the short cut is more time consuming than other methods, but as more knowledge in the subject is acquired, the usefulness and the simplicity of these well chosen methods becomes apparent.

If any of the symbols used in this Business Builder are not familiar to you, go back over your lesson on radio diagrams and symbols. It is very important that you know from memory what each symbol represents. Once you have all the symbols of the radio parts in mind, it is an easy matter to identify them in the circuit diagram or in the chassis of the receiver.

In the radio service field, there are certain types of diagrams put out by the manufacturer to aid the serviceman in repairing the equipment. Each manufacturer uses a slightly different type of diagram, although they may differ in detail, they all follow a general pattern and are easy to follow. As you gain experience by continued use of these different type diagrams, they will become more and more useful to you.

Your lesson on diagrams and symbols covers the general types of diagrams. Therefore only one typical type will be treated in this Business Builder.

Schematic Radio Diagrams

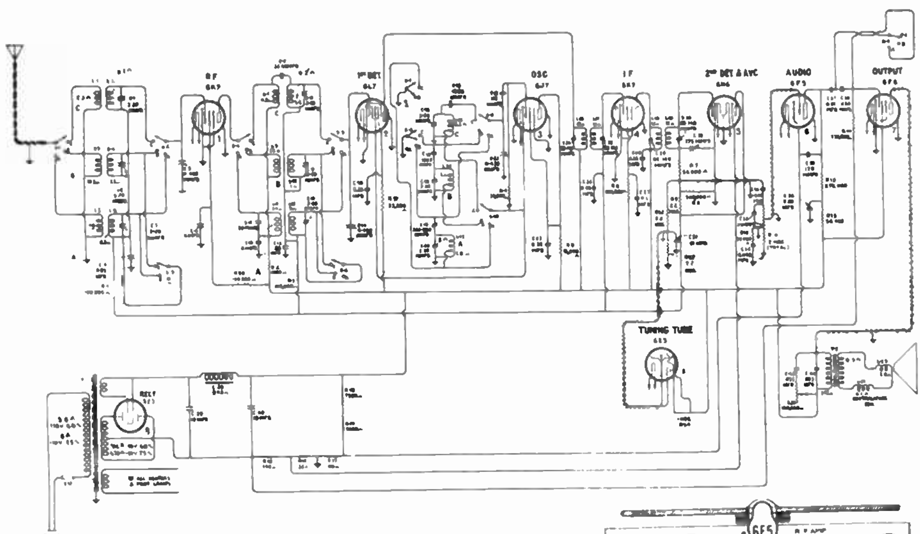
A schematic radio diagram is a shorthand method of showing the different parts used and the circuit connections in simplified symbolic form. If you become thoroughly familiar with the use of these diagrams so that you get a visual picture of how the actual circuit connections appear in a receiver, then you have mastered the symbolic system. To get a complete picture of the operation of the circuits involved is the major reason for using a schematic diagram. You may have a clear picture in your mind of the component parts of the receiver, but the actual function of each circuit may not be so clear.

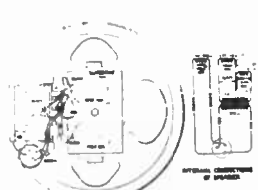
The schematic diagram should give the complete picture of the operation of each and every circuit of the equipment involved. With the use of the schematic diagram, the theory of operation of any circuit can be worked out. To use these diagrams to the best advantage, you must be able to understand the operation of the circuits involved. This you will gradually be able to do from studying your SAR lessons. Even though you may not understand every part of a schematic diagram, much information can be secured from it. The schematic diagram shows every effective connecting wire in the receiver. Then if you are in doubt about a connection, the wanted information can usually be found by tracing the circuit as it appears in the diagram. In many service jobs where someone not qualified to service a radio has tried to repair a receiver, wires may get disconnected and with the complex circuits now in use it is almost impossible to find where they should be reconnected without a schematic diagram. In some cases the circuit of the receiver may have been connected wrong. This type of defect is much more difficult to find than if the wires were just disconnected and without the aid of a schematic diagram it may require much time and experimenting to find and correct the defect.

It is possible to draw a schematic diagram from the receiver itself but this would require that you trace out every wire in the receiver. Tracing out the wiring in some of the larger and more complex receivers would take a great amount of time. Therefore, it is not practical unless it is absolutely necessary. *It is, however, good experience to do this while learning.* You might try tracing out the circuit of some receiver of which you have a diagram and compare your final drawing with the correct diagram.

As most radio service manuals do not come out until sometime after the end of the year, you won't have diagrams of the receivers built during the year. However, current radio service magazines print a few of the newer model diagrams each month. Your best source for diagrams on the very latest receivers is direct from the manufacturers involved. Older receiver diagrams are available in loose leaf manual form from your radio parts jobber.

Figure 1 shows an example of a typical schematic diagram. This schematic diagram, if understood, will tell you a great many things about this particular receiver (RCA Model C9-4 and T9-10). Some of the important features of the receiver which can





Loudspeaker Wiring

I. F. PEAK
460 KC

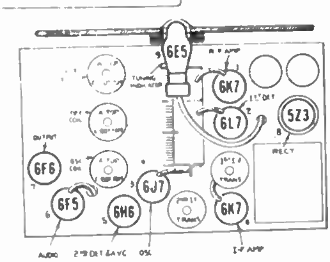


FIG. 1

Coil and Radiotron Locations

easily be seen from the diagram are as follows. It has an electric tuning indicator, automatic volume control, three band operation, a separate oscillator tube, a special type of noise supression control for the high frequency bands, a compensated volume control with a speech-music control, a separate tone control and a neutralizing coil for the speaker to minimize hum. These are just a few of the special features. To give the complete story told by this diagram would require a sizeable book. There are, however, certain things that are not revealed by the schematic diagram.

Referring to Fig. 1 you will see several switches (S1 to S11) located in different sections of the diagram. There is very little indicated on the diagram about these switches. However, an experienced service man knows that these switches are all attached to the same shaft and they are the *band changing switches* (used to change from one frequency band to the other). Information about the number of turns on a coil, the type of base used for the pilot light, and other such facts are not often included, but they are not needed for servicing. Some of this information, if needed, can be found from a parts list or by actual inspection of the receiver.

Other Diagrams

Figure 2 shows a different type of diagram. It is called a *chassis wiring diagram.* It is not used for trouble shooting as much as the schematic, but is a great aid in locating the parts on the chassis. As the parts are numbered the same on both the schematic and chassis diagrams. it is easy to go from one diagram to the other.

A layout diagram of the parts as they are mounted on the chassis is sometimes used. The layout diagram may show an actual

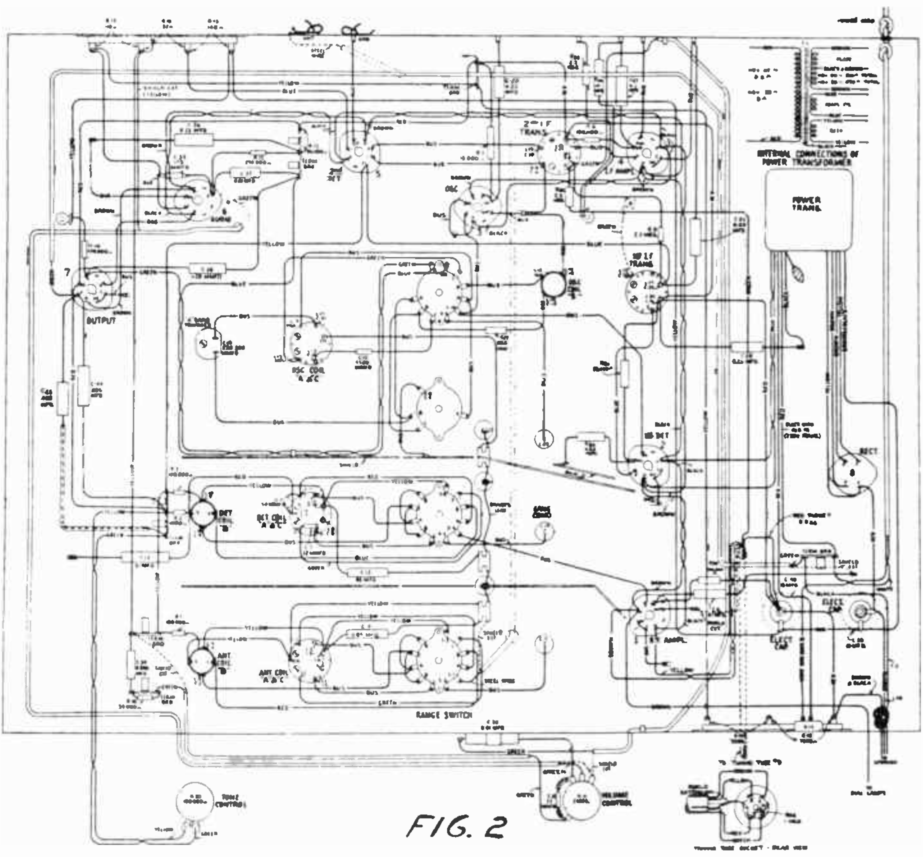


FIG. 2

photograph of the chassis. These layout diagrams help a great deal in the replacement of tubes. In many cases where a receiver owner takes it upon himself to replace the tubes, he may get them mixed and when he puts them back in the receiver, they will be in the wrong sockets. This trouble often happens because most of the newer type tubes will fit in any octal socket; and if you don't know exactly where they go, it is very easy to get them mixed. A quick check of the tube layout diagram will give you the correct position of the tubes.

How Diagrams Can Be Used To Service A Receiver

The information you can secure from these different type diagrams is important. However, how to use this information to service the receiver is of far more importance to the serviceman.

The schematic diagram separates the different stages in such a way that it is easy to refer to a single stage in the receiver without becoming confused with the rest of the circuit. This makes the circuit analysis much easier as the defect is generally in one stage only. This defective stage can be analyzed by itself and any possible trouble that could occur checked. The defect can be found in a very short time by this method.

Looking at the diagram of Fig. 1 you can easily locate the different stages of this particular receiver. What you have learned about superheterodynes and radio tubes in the SAR course up to now should aid you in locating the separate stages of a receiver from the schematic diagram.

Taking the circuit of Fig. 1 as an example, go through the circuit and identify each stage in its turn, starting with the antenna and working back identifying each tube and the stage to which it belongs until every circuit is covered. In this way it should be clear to you how important these diagrams are in servicing receivers and how easy they are to use. In the first circuit, there is the antenna or RF amplifier circuit. As you see, there are three separate sets of coils. One for each of the three bands. The switches S1, S2, and S3 change the coils of the circuit to the band desired by the listener.

The 6K7 tube is the RF amplifier tube. It amplifies the signal from the antenna before it reaches the mixer or first detector tube. The next stage is the first detector. In this stage the signal is amplified more and also mixed with the signal from the oscillator to form the IF. The 6L7 is the mixer or first detector tube. In this stage you see the three sets of coils. One set for each of the three bands. Switch S4, S5, and S6 change the circuit to the band desired.

The next stage is the oscillator. This receiver uses a separate oscillator tube which is the 6J7 tube. You can see from the diagram that a separate set of coils for each band is used in the oscillator stage as well as in each of the preceding stages.

The next stage is the IF stage. It is easy to see that only one stage of IF amplification is used with this receiver. The 6K7 is the only IF amplifier tube.

The 6H6 tube next to the 6K7 is the second detector and AVC tube. Connected to the AVC of this stage is the magic eye tube, 6E5, used as a tuning indicator. The next two stages are very easy to identify and are the audio output tubes—the 6F5 first audio driving the power output tube 6F6. The speaker, of course, is a part of this audio circuit and its circuit is shown in the diagram.

There is one circuit not discussed. This circuit is the heart of the whole receiver. Without it the receiver could not operate. It is the power supply located at the bottom and to the left of the diagram. The 5Z4 tube is the rectifier tube in this power supply circuit.

The identification of each circuit in this manner aids to analyze any defects arising within the receiver, and by making an accurate test of the individual parts of each stage in turn, *the defect can always be found.*

The analysis of a circuit will become clearer as you study in more detail the lessons of your SAR course. This Business Builder points out the importance of understanding the operation of every circuit used in a radio. As there are about 20,000 different makes and models of radios, one cannot possibly memorize the circuits of all these receivers; but if you will master the technique of using the different type diagrams, by their use the job is much simplified.

Radio
BUSINESS BUILDERS
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO IDENTIFY THE SEPARATE STAGES OF A RADIO RECEIVER

BUSINESS BUILDER No. B-25

THE object of this Business Builder is to help you identify the different type receivers and the different stages associated with these receivers.

In some instances it is impossible to locate a diagram of a certain receiver. If you understand the theory of operation of the receiver and can identify the different stages, diagrams are not always necessary. Diagrams, of course, will help in most service problems; but if you can locate all of the different stages without the aid of diagrams your servicing efficiency will increase.

Most receivers of the same basic type have certain circuits that are essential to all of this same type. For this reason if you understand these basic type receivers and the circuit necessary for each type, with the aid of a few pointers, you should be able to identify the stages in the majority of them.

There are three different basic types of radio receivers in use today. They are: (1) The tuned radio frequency receiver (TRF). This type receiver is not used very much anymore. (2) The superheterodyne. This type receiver is used almost universally today. (3) The FM receiver (Frequency Modulation) is somewhat different than the other two. It is relatively new development; and for this reason, it should be easy to identify.

TRF Receivers

The tuned radio frequency receiver was one of the first types of receivers used. The principle of the TRF is discussed very thoroughly in your lessons and will therefore not be explained here. However, reference will be made to its principles of operation, assuming that the student understands them.

As a TRF receiver usually has several stages of radio frequency amplification and each of these stages are tuned, it should be an easy matter to identify one of them. Each tuned radio frequency stage of a TRF receiver must have a variable tuning condenser to tune the stage to resonance. By observing the number of tuning condensers and the connections to these condensers, you will have a good clue as to the type of receiver it is. Usually the RF tubes in the TRF receiver have top caps. These top caps connect to the control grids of the tubes and if it is a TRF these several top caps will be connected by means of a flexible wire to the tuning condenser stator terminals. If there are three RF stages, there will be three tuning condensers ganged together with wires from each to the top cap of the tubes, etc.

The RF transformers of a TRF receiver are similar to those of any other receiver but because of the principle of operation, the TRF is not usually used for more than one frequency band (some few exceptions in older receivers). Therefore, if the receiver has more than one frequency band, it is not likely that it is of the TRF type. As there are no IF stages in a TRF receiver, their absence is a good indication that it is a TRF type. Also the absence of a mixer tube and an oscillator indicates it is a TRF receiver.

The absence of certain types of circuits

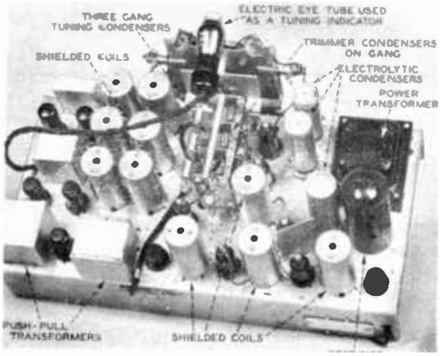


FIG. 1

and parts is probably one of the best clues to identify the TRF receiver. If a receiver has six or more tubes and the tuning condenser has but two sections, you can be reasonably sure that it isn't a TRF type. If the variable condenser gang has one section smaller than the other section, it isn't a TRF receiver.

So by a process of elimination, you can soon identify a TRF receiver.

The Superheterodyne

The superheterodyne as you remember employs an entirely different principle of operation. Understanding this principle and knowing the component parts necessary for the operation of the receiver, should make its identity an easy matter. If you can locate the IF amplifier stages, or the oscillator, or the mixer tube, you should know that the receiver is a superheterodyne.

From your studies of the superheterodyne in several of your lessons, you will learn about the shape and general appearance of the IF transformer and the layout of the superheterodyne circuit with its oscillator, mixer and second detector. Remember most of the present day receivers use the superheterodyne principle so that the majority of the receivers you will have to service will no doubt be of the superheterodyne type.

Frequency Modulation Receivers

The FM receiver has several very distinctive features which make it easy to identify. The RF section of these receivers is of the high frequency type. Therefore, the coils and condensers are considerably different from those used in ordinary receivers. Figure 1 shows typical stages of a radio receiver.

The FM receiver has more separate stages than an ordinary receiver. Figure 2 shows a block diagram of a typical FM receiver with each stage represented. From this diagram you can see that the FM receiver has RF, oscillator, IF and audio stages — the same as a superheterodyne but it also has a limiter, discriminator and de-emphasizing stages in addition. These additional stages will help to distinguish it from a superheterodyne receiver.

There are, as you see, many factors concerning an FM receiver which make it easy to identify. Not only are they easy to identify because of the receiver circuit, but they are usually labelled very well, making a positive identification obvious immediately. You will learn more about these FM receivers in your SAR lessons. So no further discussion will be given here.

AC and DC Operated Receivers

There are many battery operated receivers in use today. These receivers are very easy to identify for the wire leads coming from the chassis indicate immediately battery operation. If the receiver has more than one battery, it will have several leads. These leads will be labelled or coded in some way for identification when replacing the batteries. If there is just one battery, two leads with special type connections will give the clue to its identity. In the case of a 6 volt battery operated receiver, these leads will be quite large and will have large battery clips labelled with the correct polarity.

Some receivers are of the combination AC-DC type. These receivers are easy to identify. Although they operate on AC, there will be no transformer but there will be a rectifier tube. This rectifier tube is a good clue to the identity of these receivers. It is usually of the high voltage filament type such as the 12Z5, 35Z5, 25Z5, 117L6, etc. The power

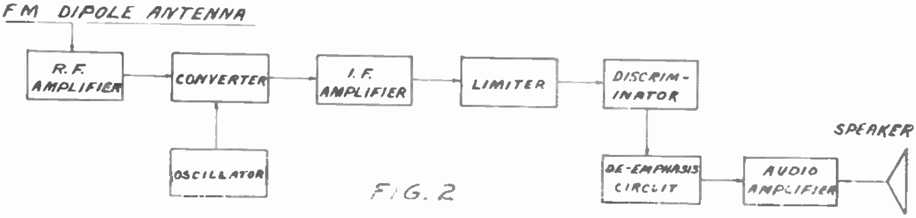


FIG. 2

line cord sometimes helps in the identity of this type of receiver. It may have an extra or third wire used as a line cord resistor and it will get quite warm when the receiver is in operation. In the case of a straight 110 volt DC operated receiver there will be no rectifier tube.

When the receiver is to be operated from the 110 volt AC line only, there will always be a rectifier tube and a power transformer. The transformer is usually mounted on top of the chassis with the rectifier tube and filter condensers near by. If there is no power transformer some of the other clues mentioned should be looked for.

Separate Stage Identification

In the identification of the different stages of a radio receiver, the most valuable guide is the tubes used. There are certain types of tubes designed for each type of circuit and if you know the characteristics of the tubes used, this will be a valuable clue as to the identity of the stage in question.

The RF stages are identified by the tube and the type of coils and condensers used in these circuits. The IF stages are identified by the tubes and also the IF transformer. The audio stage can be identified by the type of tubes and the size and type of components used in the audio circuits. The oscillator is identified not only by the tube and the components of the circuit but it is also identified by its position on the chassis. The oscillator stage is located very near the tuning condenser or, in the case of an all-wave receiver, near the band switch. The oscillator tube is usually combined with the mixer tube. Both, mixer and oscillator tubes are often sealed in one tube envelope. A more thorough discussion will follow concerning the components used in each of these separate stages. As you gain experience by working with receivers, the indentification of the different stages will become easier to you although at first they may seem very confusing. It is important to be able to identify these separate stages in order for you to make a routine service check and also to align the receiver after it has been serviced.

Locating the Stages of a Superheterodyne

The power supply is no doubt the easiest stage to identify. However, there are some cases where the components in the power supply are scattered, making the components hard to identify as a complete unit. The power transformer is very easy to find. After it has been found, the rectifier tube, which in most cases, is located near the power transformer, can be found with little difficulty. The filter condensers and choke (if one is used) are not always easy to find. There are so many different kinds of condensers that it isn't always an easy matter to locate them. There may be two or three separate condensers in one container, but with practice you will be able to identify them. The filter choke in a good many cases is the *field coil of the speaker*. The rectifier tube is very easy to identify for it is usually one of the largest tubes in the receiver; and as it has so few elements, the structure of the tube can often be seen through the glass tube envelope. Even if the tube number isn't visible, you can identify it. You should become familiar with all types of rectifiers. See your SAR lessons on rectifier tubes for a complete discussion of this type of tube.

The next stage to identify is the audio power output stage. The output tube is usually about the same size as the rectifier tube but has a more complex structure. Some of these output tubes are metal but the shape is different than other metal tubes. There are quite a number of these output power tubes, but they all are somewhat similar in appearance. A list of these power output tubes with a description of the physical size can be obtained from any tube manual. Some of the more common types are listed as follows: 42, 43, 45, 47, 2A3, 6A3, 6L6, 6F6, 6V6, 25L6, 35L6, 117L6, etc. Most of these tubes have glass envelopes. Some types of rectifiers are made in both the metal and glass style. A "G" is added to the tube type number when it has a glass envelope such as the 6L6G, 6F6-G, etc. The power output stage is usually near the speaker or near the outlet for the speaker. There are fewer components in the output and audio section. This is one way they can be identified. If all of the easier stages are identified first, the other more difficult stages will be made less difficult to locate.

The next stage to identify is the input RF amplifier. This is easy to find because it is usually connected to the tuning condenser. If there is just two sections on the variable condenser, it is reasonable to assume that there is no RF amplifier. However, in some cases there are untuned RF sections and these require no variable condenser.

If there is no RF amplifier, the mixer or first detector, and oscillator stage may employ the same tube. Some of the tubes that will serve this multiple function are 6A7, 2A7, 6A8, 1A6, 1C7, 1C6, 12SA7, 6K8, 6D8G, 7B8, 7J7, 7J8G, etc. This type of tube is called a converter. It may be a pentagrid, a triode hexode converter, or a triode heptode converter. When this tube is located, you will have identified the first detector and oscillator stages. Ususally the top cap (not used for all of these tubes) of this type of tube is the RF or input signal grid and it is connected to one of the tuning condensers by a flexible lead. If there is only two tuning condensers, then the other condenser must be for the oscillator stage. Sometimes it will be easier to find the oscillator stage first, then locate the mixer or first detector. In a good many receivers, the oscillator tuning condenser is smaller in size making it easy to identify. The oscillator tube in some cases is a separate tube usually a triode. Therefore, if a converter tube is not used, look for a triode tube near the tuning condenser. If there is one, it will more than likely be the oscillator for triodes are never used in modern receivers as RF amplifiers. To make sure that the tube is the oscillator, trace the wiring of the tube and by so doing you can soon see if it is connected to the tuning condenser. If so, it is the oscillator.

After the oscillator is found, the other variable condenser of the gang will be for the RF input condenser if there is a stage of RF amplification ahead of the mixer tube. If not this other section of the gang will be for the mixer tube. In some receivers there is a tuned band pass circuit ahead of the mixer to improve the selectivity. In this case, there will be no grid cap (or control grid lead) connected to the first variable condenser of the gang.

The remaining tubes on the superheterodyne chassis will be for the IF stages, the second detector, and probably an audio driver stage. The IF stages can be identified with the aid of the IF transformer. These transformers are usually made from aluminum cans and may have one grid wire coming out of the can to an IF tube. These cans will also have holes drilled in them to permit tuning and adjusting the trimmer condensers. Sometimes the IF tuning condensers are located outside the can but close to it. There is usually at least two IF transformers in a superheterodyne receiver, and there may be more than two in large receivers. After the IF stages have been located, the next stage to identify is the second detector.

In the older receivers, triodes were used but in the more modern receiver diode tubes are usually used. The second detector may be a simple diode such as the 6H6 or it may be a triode such as the 27 or 56. In many receivers it is a combination tube consisting of a duo-diode and a triode. The diode section is the second detector whereas the triode section *is the first audio tube.* Such tubes as the 75, 7B6, 7C6, 6Q7, 6SQ7, 7E7, 7B7 are typical examples. The AVC circuit is also associated with the second detector, and it may be identified by the circuit wiring under the chassis. AVC circuits are discussed in your SAR lessons. Refer to them for further discussion on AVC identification.

The next stage, of course, is the audio section. The output tube has already been mentioned. Another stage which might need identifying is the audio driver between the second detector and the output stage. Sometimes this audio stage is just the triode section of the duo tube used as a detector and audio amplifier. All the usual stages have thus been identified. If there are other tubes not incorporated in the identified stages, they are special tubes used in a special way. A cathode ray tuning indicator tube (Magic Eye) can, of course, be identified by its appearance; but there are other circuits not so easy to identify. In these cases, reference to the diagrams of the receiver will be necessary.

The stages of a TRF receiver are much easier to locate as there are only four different stages—the power supply, the audio amplifier, the RF amplifier, and the demodulation (detector) stage.

In the case of the TRF, start with the rectifier as before and so on to the RF stages which, as stated at the beginning, will all be connected to the tuning condenser unless one of the stages is untuned. The detector is usually a triode or a diode and is the next stage after the last RF amplifier. There is usually more than one RF stage in a TRF receiver.

Radio
BUSINESS BUILDERS

SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO LOCATE SOURCES OF RECEIVER HUM

BUSINESS BUILDER No. B-26

A COMMON complaint of the receiver owner is receiver hum. Sometimes this hum may become so loud that the signals cannot be heard through it.

Hum then being a very common service problem, knowing how to locate and correct it, will no doubt prove to be a good Business Builder for you. The purpose of this Business Builder is to discuss the common causes of hum and how to cure it so that you will be able to service receivers which develop this type of defect.

In general there are two different types of hum. (1) A steady low pitched hum. (2) A modulated hum appearing only when the receiver is tuned to a station. Either type is very annoying to the listener.

Sources of Hum

It is important to know just where this hum could originate and then by a process of elimination, locate the exact source. Many times it has been found to be caused by some outside source and not due to any fault of the receiver. This must be determined before making any test for internal trouble in the receiver.

There are a few definite circuits where hum often originates. Hum in general is picked up from the AC power lines which supplies power to the receiver. When hum occurs, these AC circuits are the first to suspect. The main AC circuit feeds the power supply which converts the AC to DC. (Any one of the components in this power supply can cause hum.)

The heater or filament is another AC circuit and can cause hum by induction or defects may develop which in turn will tend to generate hum. Moving the filament wiring from its original position may cause hum to be introduced into some high gain stage. When servicing any receiver, it is very important that you do not disturb other parts of the circuit or you may cause other more serious trouble to arise than that which you are correcting.

Hum can be caused by external as well as internal conditions. Causes of external hum may be due to power lines being too close to the antenna or power lines too close to the receiver itself. As hum can be caused by an outside source, it is of special significance when you are testing the receiver in the owner's home.

Isolating the Hum

By a special testing procedure, the hum can usually be localized to one particular stage in the receiver. As stated previously, it is important to know whether the hum is due to the receiver itself or due to some outside cause. The owner of the radio can help you to determine this. If the receiver has been operating properly for some time and then later started to hum, gradually getting worse, you can be reasonably sure that it is an internal defect. If the hum has been present ever since the receiver was installed, you should be suspicious of the installation.

If the hum started all at once, it could be due either to an outside or an inside source.

Inspect the antenna installation, and note whether new power lines have recently been installed. Also check the wall plug reversing the AC cord to see if it is plugged-in right. One side of the line is grounded and in some cases if not plugged in right the receiver will hum.

The next check to make involves shorting the antenna and ground connections of the receiver. If the hum ceases, you may be sure there is trouble in the antenna lead-in and not in the receiver itself. Check the ground wire. This may be the source of the hum in the form of a bad connection.

Making a thorough check at the owner's home may save you much embarrassment. For, if the hum is due to a defect of the installation and not in the receiver, your shop tests will not in any way correct the hum condition. It may be necessary, in cases where you are not too sure about the source of the hum, to set up a receiver of your own that you know has no hum, connecting it to the same power outlet that the receiver in question used. If you find that the hum persists with your own receiver in use, the trouble must be due to an external condition.

When you are sure that the trouble is in the receiver, the hum can be localized by following a definite procedure. If it is a steady hum, start your test with the power supply, checking carefully the tubes. A defective rectifier tube may be causing the trouble.

When the receiver warms up and the hum is so loud and constant that no signal can be tuned in, a complete breakdown of one or more parts is indicated. A careful inspection of the rectifier tube may indicate the source of the trouble. If the elements, particularly the plates, get red hot and a blue glow is seen between the elements (except for a mercury vapor rectifier tube) it is almost a definite indication of a shorted tube or a filter condenser. The rectifier tube and filter condensers are so interdependent that the failure of a condenser in the power unit usually causes the failure of the rectifier tube. It isn't safe to replace the rectifier tube without first checking for a short or heavy overload in the power supply filter.

Mercury vapor type rectifiers, such as the 82, are sometimes a source of hum. This hum condition is produced by radiation from the tube itself.

The complete filter circuit of the power supply should be checked. A filter condenser can be checked by first disconnecting it and then temporarily connecting a condenser known to be good in its place. Be sure that the good condenser has a high enough DC voltage rating to withstand the high voltages in these circuits. Also watch the polarity of electrolytics. If when making this change there is a noticeable decrease of the hum, the original condenser should be replaced. Loose condenser mounting nuts or screws can cause AC hum. Be sure they are all tight. Most hum troubles are caused by defective electrolytic condensers in the power supply. So they should be carefully checked. The filter choke should next be checked for shorted turns. The resistance of most receiver filter chokes varies from 350 to 2000 ohms. If the resistance is much less, the choke may be faulty. If possible try a new choke in place of the one under suspicion and if this does not decrease the hum, the original choke is probably all right. A shorted filter choke can be tested by momentarily shorting its terminals. If no difference in the hum is noticed when this is done, it is probably already shorted. Check it with an ohmmeter to make sure its resistance is within the rated value.

The speaker field in a good many receivers is used as a filter choke. Therefore you cannot easily replace it with a choke to test for hum. However, its resistance or continuity can be checked with an ohmmeter. After a complete check of the filter, the power transformer itself should be checked. Loose laminations in the transformer core can cause hum. Check the windings of the transformer for opens and for improper grounds.

The next step is to isolate the hum to a particular stage in the receiver if checking the power supply does not enable you to find the cause of the hum.

Starting with the audio stages and working back to the antenna, the stage that the hum is introduced in can be found. How this is done is as follows. (1) To find if the hum is introduced before or after the detector, short circuit the input to the audio frequency circuit just after the detector. If the hum persists, it is in one of the audio stages. By shorting the input to each stage in turn until the hum is eliminated, the stage causing the hum or the stage in which it is introduced can be found. If shorting the input to each audio stage does not eliminate the hum, it is possibly caused by the speaker. Many receivers use a hum bucking coil in conjunction with the field and voice coils of the speaker. If this coil has been changed, moved, or short circuited, hum will develop. (2) If the hum is eliminated by shorting the input to the audio system, it originates in some circuit ahead of the second detector. With one end of a wire connected to the chassis, successively touch the grids of the IF, mixer, RF, and oscillator tubes while noting the level of the hum. If the hum is decreased by shorting the input of one of the circuits, the cause is in or ahead of that stage. If the hum continues, it probably originates after the stage under test.

By making such a test from the grid of the output tube to the grid of the tube in the antenna stage, the stage in which the hum originates can be located. Then by checking each part in the stage, the cause of the hum can, no doubt, be found.

How to Find and Correct the Hum

After localizing the origin of the hum to one stage, it then becomes necessary to locate the part or parts in the stage causing it.

As stated previously, the power supply can cause hum. Defective parts in the filter of the power supply is the most common cause of hum. When you find one of the filter condensers at fault, it should be replaced. When replacing a filter condenser, there are several requirements to follow. First be sure that the new condenser has the proper capacity and has the proper voltage rating for the circuit involved. If you are replacing the input condenser of the filter circuit, it should have a higher voltage rating than the DC output voltage from the rectifier tube.

Next be sure that you observe the polarity of the electrolytic condensers. The condenser will be destroyed if connected with wrong polarity. The leads from the condenser are usually color coded with black indicating negative and red indicating positive. In the case of a multiple unit condenser one common black lead may be used for all of the condensers in the unit with separate leads employed for the positive terminals. However, in a good many cases especially with AC-DC receivers, there may be a common positive and several separate negative leads. Be sure you have full information on the circuit or condenser unit you are replacing before installing the new condenser. Another important thing to remember about electrolytic condensers is that they should not be subjected to an excess voltage above their rating. If the condenser you are replacing has a 200 volt DC working voltage, replace it with a condenser of similar voltage rating and not one with a much higher voltage rating. The reason for this is that electrolytic condensers require a certain film forming voltage; and unless they are operated on approximately this same voltage rating they will gradually reduce in capacity.

With many of the small receivers it is not always possible to find an exact replacement of a filter condenser and as the receiver is small, the physical size of it is important. In cases where larger condensers *must be used,* it can usually be done by extending the leads. It may become necessary to place the replacement condensers outside the chassis. When doing this, be sure that you do not place it near a radio tube or any other position where it might become heated. Electrolytic condensers, when subjected to heat, will dry out very fast, losing their capacity.

If the filter choke needs replacing, there are certain specifications to follow. The new choke must have similar characteristics to that of the original. That is, the inductance of the new choke should be the same (10% tolerance) as the old one. The DC resistance should be approximately the same and the current carrying capacity should be the same or higher. If the choke is used as a voltage dropping device for securing grid bias, an exact replacement will usually be necessary. The connections for the choke are simple as there are usually just two leads and in general it makes no difference how they are connected.

When mounting the new choke, be sure that it is mounted with its lamination in the same direction as the old choke. Otherwise, you might introduce hum from this choke to other parts of the receiver. Tighten the mounting bolts so that the choke cannot vibrate or it may cause a hum.

When the power transformer causes a hum due to loose laminations, tighten the bolts that hold the laminations in place. If these bolts cannot be tightened, drive a thin wood wedge in between the laminations until they are tight.

The tubes in the receiver may also cause hum. A thorough check of each tube will determine if they are hum sources. Be sure that an accurate short test is made with a tube tester while thumping the tube lightly with your finger.

As mentioned before, never replace a shorted rectifier tube until you are sure that there is no short or heavy overload external to it. The short may be at any point in the receiver where DC voltage is applied. The easiest test to make for this type of defect is to remove the rectifier tube and check continuity between the cathode of the rectifier tube socket (or filament if a cathode isn't used) and ground. If the ohmmeter shows a very low resistance, a check of all the condensers and all B+ circuits must be made and the short located before replacing the tube.

After the power supply and tubes have been thoroughly checked and the defect not found, the audio frequency stages and the speaker should next be checked. If you find from your tests that the defect is in the audio circuits, it can be found by making a test of each part in the audio circuits. Remember that a hum has as its basic source the AC circuits so this limits the search to parts involving AC. The filaments and the rectified DC from the power supply are the only sources in the receiver where forms of AC can exist. If you have followed previous instructions, the power supply will have already been eliminated as a source of hum. The only other hum source is the filament circuits. These AC filament circuits can cause hum by induction when the filament wires are placed too close to tube circuit wiring, especially grid circuits. Check the position of all the filament leads making sure that the shielded wires of the grid circuits (if shielded wires are used) are well grounded. Poor ground connections of any of the metal shields may cause AC from the filament circuits to be introduced into a grid circuit of an amplifier tube thus causing an audible hum in the speaker.

In some receivers, the volume control which is usually placed in the grid circuit of the first audio stage has the AC on-off switch attached to it. When the volume control is turned completely to the left the switch operates turning off the receiver. As this switch is connected directly to the AC power line hum may rise by coupling from the switch cover to the associated volume control. This condition may readily be detected by removing the switch cover from the control. The hum is usually due to solder, paste, or grime creating an AC current path between the switch points and the resistance strip of the control or its terminals.

Cleaning all exposed surfaces with carbon tetrachloride should clear up this trouble. If not, the volume control should be replaced or a separate on-off switch installed. In some cases the tone control is used in conjunction with the AC power switch. The same procedure should be followed if it is under suspicion.

Modulated hum which occurs when a signal is tuned in can be caused by coupling between an AC line and the grids of RF tubes. By checking the wiring in the RF stages very carefully, eliminating any possible coupling you should be able to correct this type of hum. As stated before, hum can be caused by an outside condition and as modulated hum is definitely brought about in the RF circuits, it may be due to pick-up from the antenna. Because of this, it gives you a clue when checking the receiver in the home.

There are other more complex causes of hum not mentioned in this Business Builder. These will be taken up in your SAR Master Service Course lessons.

SUPERHETERODYNE CIRCUIT ADJUSTMENTS

RADIO SERVICE BULLETIN NO. 11

The ordinary tuning adjustments for a superheterodyne receiver may be divided into three distinct steps: (1) Alignment of the IF amplifier, (2) Alignment of the RF and oscillator circuits and (3) Padding of the RF circuits. The adjustments should be made in the order given.

Starting with the IF amplifier, there are two essentials for its adjustment, a signal generator and some type of output indicator. In some instances the ear may be used as the judge of the relative output of the receiver. For ordinary purposes the intermediate frequency trimmers are adjusted with an insulated tool from the second detector back toward the first detector. The signal generator must be set to the frequency to which the IF amplifier is to be adjusted (determined by the manufacturer), and is coupled into the IF amplifier input at the first detector. The output meter is usually placed across the voice coil of the speaker, but may be placed elsewhere according to the more complete information given in your SAR lessons.

A few of the more important points in connection with the IF alignment are: (1) If there is a fidelity switch it should be in its most selective position, (2) If AVC (automatic volume control) is used the receiver should be operated below its threshold level or the AVC should be made temporarily inoperative, (3) If there is a coupling control in the IF it should be set at or below the critical value, (4) If AFC (automatic frequency control) is used it should be shorted to ground by means of the switch provided, (5) If the oscillator interferes with the signal its grid circuit should be shorted. Anywhere from two to eight circuits must be adjusted from the second detector backward to the first detector.

The second step is to align the RF trimmers. For this job, tune the receiver to 1400 KC and set the signal generator to 1400 KC and attach its output leads to the antenna and ground of the receiver. The shielded test lead or the one marked ground should be grounded, while the other is connected to the antenna input of the receiver. Starting with the oscillator stage, alignment is done as usual. The oscillator trimmer is adjusted for maximum output and next the first detector grid tuned circuit is adjusted for maximum. Almost without exception the trimmers for this work will be found on the gang condenser assembly and often the oscillator tuning condenser has **smaller** rotor plates than the others.

If there are three main tuning condensers, one of them tunes the RF stage and it is the last of the three to be adjusted. Whether the tuning condensers are all alike or not the trimmer adjustment is the same.

Next comes the process of padding. This is done at the low frequency end of the band as near 600 KC as possible for the broadcast band. Tune the receiver to this frequency and also tune the signal generator to this frequency. Locate the padding condenser and adjust it for maximum signal strength. While doing this the setting of the tuning condensers must be varied each way so that the combined maximum of the padder and oscillator tuning condenser may be obtained. This varying of the gang condenser setting simply by tuning it each side of its setting at 600 KC to find the maximum point is called **rocking** the gang condenser and is an essential part of the aligning process.

The remainder of the padding process must be done only with reference to detailed instructions and in accordance with the provisions made in the construction of the receiver for such work. It includes the means by which the other settings on the dial besides the low and high frequency settings are aligned. Such adjustments are far less subject to variation or error and hence rarely need attention. The factory adjustment usually remains throughout the life of the receiver.

Carefully notice the rotors of all of the tuning condensers. If they are all alike, the foregoing procedure should be followed. However, if one of them has smaller rotor plates than the other one or two condensers, the receiver will have no padding condenser on it and the last adjustment for low frequencies will not be possible.

If tuning is attended by an excessive hiss near stations, the adjustment is either too critical or there is trouble elsewhere in the circuit.

For the trimmer adjustment, the total tuning range of the gang condensers from 540 to 1600 KC should be exactly the same length of angle as the 540 to 1600 KC markings on the dial regardless of whether the registration with stations is correct or not. The dial scale may then be shifted for the correct registration.

If the condensers cover a larger range or space than the length of the dial scale, all of the trimmers must be increased in capacity, while if the range of the condensers is shorter than the scale, they must all be reduced. Only after the range of the condensers for the band has been made equal to that of the dial scale, should the latter be shifted to the proper place.

AUTOMOBILE RADIO TESTING HINTS

RADIO SERVICE BULLETIN NO. 12

By far the majority of work done on automobile receivers by servicemen is in connection with the elimination of interference and with troubles in connection with the power supply. It is generally easier to determine the source of a defect in auto receivers than in the home type receiver for this reason.

To test for noise sources within the receiver or its power supply, the car should be parked with its engine stopped. Noise from a faulty vibrator can be determined by the characteristics of its sound. If the receiver is completely dead it is well to have an auxiliary power supply as a substitution test. This may be B batteries or a vibrator-rectifier unit or an AC power unit operated from a convenient AC outlet.

The main B+ lead from the power supply lead is located in the receiver and a voltage of from 180 to 250 is applied to it. If a rectifier tube is used in the receiver it should be removed while under test. The negative lead of the B supply is connected to ground. Voltages at the filaments should be determined by test and by observation when the tubes are of glass (lighted filament shows).

With this substitution B supply, if the receiver is still inoperative there is either a power supply short or trouble in the signal circuits of the receiver. Any such condition may be tested by making use of continuity tests.

Any breakdown within the circuit proper must be traced and located in accordance with the regular procedure for any other receiver.

Vibrators should be tested in regular vibrator testers or by substitution and there should be more than 5.5 volts at the vibrator terminals while in operation. Sometimes a receiver will not operate because it is connected to the car ammeter rather than directly to the battery. Always check the fuse in the **hot** (ungrounded) lead if you fail to find voltage at the vibrator or filaments.

A good vibrator tester tests both the input and output of a vibrator. Without an oscilloscope a vibrator should be filed and adjusted for **minimum arcing** at its terminals. (Requires very careful work). This can be determined more exactly by means of an oscilloscope where an actual graph of the arc voltage is produced. Although not essential, an oscilloscope is very helpful. See that the spacing of the vibrator contacts are all equal and amount to as nearly .005 inch as you can judge or by actual measurement with an auto valve feeler gauge.

In testing for sources of ignition interference, the engine of the car should be idling but the car should not be in motion. As it is best to avoid using suppressors, each dash control member of the car and its wiring should be bypassed, while the receiver is tuned to a position of high sensitivity so that the interference sources may be identified. They are then bonded, by-passed or completely filtered. Electrical circuits must be filtered, while non-electrical parts of the car are preferably bonded (electrically connected to the frame of the car). Your Service Course lessons treat this in detail.

Some of the parts which must be tested with a .5 to 2 mfd. condenser by-passed to ground are the hood, the bulkhead, the dash board, the muffler, steering column, clutch housing, differential housing, heater, feeders, windshield wiper, gas line, speedometer cable, choke cable, brake rods and in fact any part which is essentially separate from the chassis and engine of the car.

The rear light, dome, head and dash lights are also tested (by-passing them temporarily with a .5 to 2 mfd. condenser), and if interference reduces any or stops when the test is applied, these must be filtered. A regular dome light filter is used for each interferring device. In some cases the primary ignition lead (low tension) must be filtered. Only when all of these methods fail to stop interference should you add ignition suppressors. First, one should be placed in the main center distributor lead and if this fails to stop the interference an additional resistor suppressor should be placed in each spark plug lead.

When these sources of interference have been located and corrections have been made, the next test is the driving test. Careful note should be taken of the noises during various driving operations such as when the clutch is disengaged, when the brakes are put on, the type of road and whether it is wet or dry. By this means, it will be possible to determine very definitely the sources of interference due to static charges which build up in various places in the car. There is wheel static, tire static, clutch static, brake static, and other types of static from doors, differential housing, etc., each of which has a special method of treatment. The method of elimination is described in detail in your Service Course lessons on this subject.

Such things as alignment, tube testing, resistor testing, etc. are exactly the same for car receivers as for home receivers. Usually, however, the receiver must be removed from its mounting for this work. This is quite simple as the receiver is usually supported on the bulkhead by means of three or four bolts. Its wiring need not as a rule, be detached. If it must be temporarily detached to remove the receiver, it must be replaced before a complete test can be made.

Radio
BUSINESS BUILDERS
Which help you build a growing business
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO GET PRACTICAL RADIO EXPERIENCE

BUSINESS BUILDER No. B-31

SOONER or later every SAR student comes to the point where he wants to actually begin working with radio parts with his hands—to put into practice some of the things studied in the lessons of the Course. This Business Builder is designed to fulfill that need. It provides a plan whereby the student *may get actual radio repair experience on an old receiver.*

Around many radio shops, stores, and in homes there are hundreds of old receivers lying around, collecting dust in store rooms —not serving a useful purpose for anyone. They have very little retail sales value in their present condition and can, therefore, be purchased for a very reasonable sum—usually from about $3 to $10. You, as a student, can purchase one or more of these old receivers, get some good practical experience with them and then later sell them at a nice profit, after making whatever repairs are necessary.

The type of receiver you select for this purpose will depend on the type of power you have available to operate the receiver. If AC 60 cycle power lines are available to you, then you should try to purchase a well known make of receiver with a power transformer. Do not at first get a small AC-DC receiver with a series wired filament circuit because ofttimes the circuits are *tricky* and for many of these receivers no diagrams are available. If you have 110 volts DC available, then try and get a receiver designed to operate on this type of power line. If no power line is available to you, then you should get a battery operated receiver. Regardless of the type of operating power available to you, this plan may be put to full use because all radio receiving circuits operate on the same basic principles. That part of the circuit which actually has to do with the signal is basically the same for all receivers. Any differences in the various types of receivers will be in the power supply circuit and not in the signal circuits. So the fact that you may have an unusual type of operating power available will not prevent you from putting this plan to full use.

Obtain A Well Known Receiver

In buying your old receiver try and get one of the popular makes. Receivers made by one of the following companies will be suitable and we are very likely to have diagrams and full service information for it—RCA, Philco, General Electric, Silvertone, Zenith, Spartan, Crosley, Airline, etc. Once you have selected and purchased your old receiver for use in getting practical experience, write to us giving its name and model number. If you cannot find the model number, give us the total number and type number of tubes the receiver employs. With this information we can probably locate a diagram and service information for you. *When this is received you should make a large drawing of the circuit for your own use and return the original to us.* The reason for this is two-fold. (1) It will give you experience in drawing complete circuits and it will make you fully acquainted with the receiver on which you are going to make your experiments. (2) It is necessary that the original diagram be returned to us for it may be a *rare diagram* of which we only have one copy and further it is necessary that the original diagram be returned to us for some other student may need it and we don't want to keep any student waiting for a period longer than 10 days.

First Correct The Defect

Your first task on obtaining an old receiver will be to correct the defect or defects it will have and it surely will have them else the receiver would not have been discarded in the first place. In doing this a definite procedure should be followed which should lead you to the exact source of the defect or defects. It is suggested that you use a lamp controlling circuit as a protective device as explained in Lesson 1R-1. Connect this to the power line and connect your receiver to the lamp circuit. In this way no fuse will be blown and no additional damage will be done to the receiver. In trying to find the defects in your receiver, use the test system as outlined in Lesson IR-1.

In brief here is what you will have to do. First see that all the tubes are in good condition by having them tested on a good tube tester. Replace all tubes that are defective. Connect your lamp circuit and receiver to the power line. See Fig. 1. Then check the condition of the power transformer, the rectifying action and the filter condensers as explained in 1R-1. Then check all resistors and coil windings for opens and all by-pass and coupling condensers for shorts. Tubes may be added to the receiver as you make your tests as referred to in 1R-1. If this general check is made very likely you will have by this time located the defect and will know what you will have to replace or correct to get normal operation. Thus it will be assumed that you now have your old receiver ready for operation and experimenting. First you should clean the entire chassis and speaker. Remove all the dirt and dust that you can find. Remove all shields and give them a thorough cleaning. With a smokers pipe cleaner, insert it between the rotor and stator plates of each tuning condenser, removing all dust and dirt. Examine all trimmer and padder condensers. If dust has accumulated, carefully take the condensers apart removing all dust and dirt. Be especially careful and do not break or crack the insulation between condenser plates.

Force Parts To Develop Defects

As you know there are many parts in a receiver which can become defective and thereby cause abnormal operation. You can select almost any part in a receiver and purposely cause it to simulate a breakdown or to put it another way you can choose any part and force it to have a defect if you will properly control the flow of current to the circuit. This may be done, of course, by making proper use of your lamp protective circuit as explained in Lesson 1R-1. The most common defects in a receiver are opens, shorts, and grounds and represent a high percentage of all receiver defects. To simulate these defects for a condenser disconnect one of its leads from the circuit for an open and for a short merely connect a short wire across its two terminals. To simulate a ground connect a wire from the high potential side of the condenser to the chassis of the receiver. Note in most cases a short and a ground of a condenser means the same thing depending on the way the condenser is connected.

For resistors connect a short wire across their terminals to simulate a short and for an open merely disconnect one of the resistor terminals from its circuit—the same connections apply for coils whether they be AF filter chokes, RF filter chokes, speaker field windings, AF transformers, IF transformers or RF transformers.

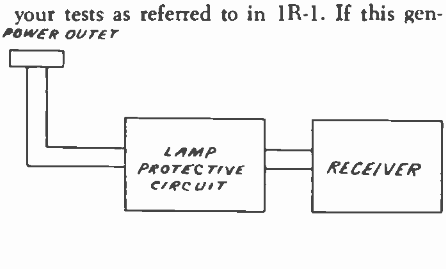


FIG. 1

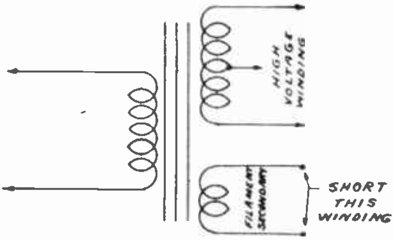


FIG. 2

Use Lamp Circuit For Protection

For your experimenting, it is suggested that you start with the power transformer. Connect your lamp protective circuit to the power line and connect your receiver to the lamp protective circuit. Turn on the receiver and allow it to come up to operating temperature—in this connection use a lamp in your protective circuits which lights to a dull glow while the receiver is operating normally. For small receivers, this will be about a 50 to 75 watt lamp and for larger receivers a lamp rated at from 100 to 200 watts will be required.

With this done use a short length of wire and connect it across the terminals of a filament winding on the power transformer. See Fig. 2. This is equivalent to a shorted filament winding on the power transformer—note how it affects the test lamp—it should increase in brilliance. Could you use this same set-up to determine a shorted winding on another receiver? Short the high voltage winding in the same way you shorted the filament winding. How does the lamp react? Does it indicate to you that the winding is shorted? Next with the power turned off unsolder a filament winding lead. Turn the receiver power on again. How does the receiver and lamp react? Do you get an indication that a very vital part of the receiver is not functioning? Reconnect the filament winding lead and unsolder one of the leads to the plates of the full wave rectifier tube. How does the receiver and lamp react? In what way is this type of defect indicated to you? How can you prove that a transformer winding is open or shorted? For answers to these general questions refer to Lesson 1R-1.

Experience With Filter Condensers

Next consider the filter condensers. There should be at least two of these and there may be more either of the paper or electrolytic type. Regardless of the type of filter condenser, the same general tests and experiments may be made. In practice these may develop two types of defects. These are an open and a short. Both of these conditions may intermittently develop—that is, for a period of time an open may occur and the same thing is true for a short. The more common defect, however, is for a full short or open to occur in the filter condensers. If an open occurs the effect is the same as if no filter condenser were present. Hum level as reproduced by the speaker will be high—a connection of a good condenser across the one suspected will restore normal operation which will not be true for a shorted filter condenser. If a good condenser is connected across a shorted condenser it does not remove the short and hence the test has little significance. If you use a protective lamp, a shorted condenser will cause it to light to greater brilliance while you purposely short an input or output filter condenser. You can simulate a partially shorted condenser or one with a high resistance internal short by externally connecting resistors of various values across the filter condenser terminals. Start with a resistance of about 50,000 ohms and successively connect lower value resistors across the filter condenser terminals in steps of 10,000 ohms down to 10,000 ohms. From 10,000 ohms down to 2000 ohms use separate resistors in steps of 2000 ohms. Note as the resistance is lowered the test lamp increases in brilliance. Note too a full short of an input filter condenser will cause the gas in the rectifier tube to ionize (blue glow within the tube) signifying a heavy overload on the tube. By making these filter condenser experiments, you can simulate practically all defective conditions which may occur for filter condensers. In this way you can study the effects of partial and full shorts and opens and thus will be able to recognize these same conditions in other receivers.

Coupling Condensers

Throughout a given receiver you will find various by-pass and coupling condensers. The by-pass condensers will be found to be connected across plate, screen grid, and cathode circuits. The coupling condensers will be connected between grid and plate circuits to couple one stage to another—the latter being used more often in AF circuits. To simulate an open in either a by-pass or coupling condenser, disconnect one of its leads. For a by-pass condenser in the RF or IF stages, an open will cause howling and oscillation depending on the effectiveness of the unit in question in by-passing RF energy. An open condenser in detector and AF circuits will cause distortion and possible oscillation. Check these conditions in your receiver by purposely causing an open condition for several by-pass condensers. For coupling condensers an open condenser will interrupt the passage of the signal through the receiver. This you can prove by tuning the receiver to a signal and then purposely causing an open in a coupling condenser. A short in either a by-pass or coupling condenser will usually ground a B+ circuit. The result of this will be to lower DC voltages throughout the receiver and signals will be weak or there will be no signals at all. To become familiar with this action purposely cause one or more by-pass or coupling condensers in your receiver to be shorted by connecting a short wire across the condenser terminals. Be sure to use your test lamp circuit while doing this and note what action occurs as various condensers are shorted. Study the action and note how you can apply this same test to other receivers.

Tube Load Tests

All the tubes in the receiver will have plate and grid circuit loads in the form of coil windings, resistors and condensers. These are subject to opens, shorts and grounds. A good way to prove the effectiveness of a plate or grid load is to short it with a short length of wire. This same test will also indicate if the coupling medium between stages is passing a signal. Try this test on the output stage of your receiver while the receiver is tuned to a signal. Locate the output transformer and temporarily connect a wire across the primary terminals. Note that just as soon as this connection is made signals will be no longer reproduced. The mere fact that a wire is connected across the primary winding, does not mean the plate circuit of the output tube is interrupted . . . plate voltage will still be applied to the tube and it will still draw current. What happens is the short circuit removes the inductive reactance from the plate load thereby preventing signals from being transferred to the secondary circuit. The same test can also be made on the secondary side of the transformer. If it is shorted the voice coil of the speaker is also shorted which prevents it from moving the cone and thus no sound waves are created. Note this condition will produce the same effect as an open—in either case there will be no signal. To make sure whether an output transformer secondary or speaker voice coil is open or shorted (in case you suspect it) a continuity test is recommended. Simply open the circuit and test both windings for continuity.

To return to plate and grid circuit load tests and assuming you have checked the output circuit as directed, make the same type of shorting test on the grid circuit load of the output tube. This load may be in the form of a resistance or it may be a coil winding. In either case short the grid load and note signals are no longer reproduced. What does this suggest to you? It suggests you can make the same general test on other receivers provided they will reproduce a signal of some kind. If shorting a grid or plate load as directed prevents the passage of signals, it at least proves the defect you are looking for is *not in the circuit under test* (grid or plate load).

The foregoing type of test need not be confined to an output stage. You can make it with equal effectiveness on input AF stages, detector stages, IF stages, oscillator stages, and on RF stages. Where a plate or grid load is made up of a combination of coils and condensers short and open each one of them separately. This will give you good experience on checking the effectiveness of unit parts in a circuit. Each time you open or short a part, note how it affects the signal reproduction.

Radio
BUSINESS BUILDERS
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

COMMON TROUBLES IN AC-DC AND BATTERY OPERATED RECEIVERS

BUSINESS BUILDER NO. B-30

THERE are several types of receivers in use that differ considerably from the ordinary AC receiver. These receivers are usually table models or portable type receivers. Some are battery operated, while others are combination battery and AC or DC operated. The majority, however, are power line AC or DC operated.

As these receivers are somewhat different in construction as well as design, there are certain defects common to these receivers only. Because of their size and also the voltage from which they operate, many of the components in these receivers are widely different from those of ordinary AC receivers. The tubes used in these receivers are considerably different. Because of the tube difference, it is easy to identify these receivers. In general these receivers can be classified as follows: AC-DC operated AC-DC and battery operated, and battery operated (6 volt operation and high voltage operation). The 6 volt battery operated receivers may be placed in two classes—automobile and battery operated home type receivers. The high voltage battery operated receivers may also be classified in two types—portable and home type receivers. There is one other type that should be mentioned and that is the 32 volt DC receiver. This type is not so popular but there are a few in use today.

AC and DC Operated Receivers

There are a greater number of AC-DC operated receivers in use than other types, and also the defects encountered with these receivers are more numerous, therefore, more information will be given for this type receiver in this Business Builder than for other types.

The AC-DC operated receiver is designed to sell at a low price. Therefore the number of components is kept at a minimum. With this type receiver there is no power transformer. The DC voltage for the plates is secured by rectifying the AC direct from the line. In case a voltage higher than line voltage is needed *voltage doubling* circuits are used.

The filter circuit in many of these receivers is of the RC type instead of the familiar LC filter. This is to eliminate the cost of a filter choke which is bulky and more expensive than resistors. Where a filter choke is used, the field winding of the speaker is usually used as the choke. The filter condensers, because of the use of resistors instead of chokes, must be very large, running as high as 200 mfd. in some receivers. The voltage rating of these condensers is not as high as in other receivers because the voltage, even with a doubling circuit, can never exceed twice the peak line voltage and in practice it will always be less than this amount.

Figures 1 and 2 show some of the typical power supply circuits used with modern AC-DC receivers. The resistor and the two condensers shown in Figs. 1 and 2 are the filtering system. These circuits use half-wave rectification.

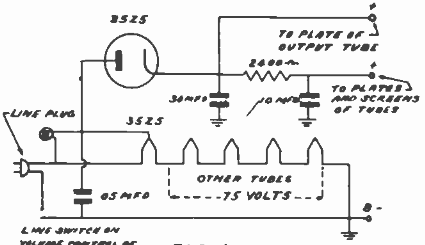


FIG. 1

The circuit of Fig. 1 is typical of receivers using a 35Z5 or similar tube as a rectifier. The filaments are connected in series. The pilot light is connected across part of the 35Z5 filament. The 35Z5 is a special tube made so that the pilot light can be connected as indicated. The size of this light, however, is important and the value specified should be used when it is replaced.

Figure 2 is somewhat different from Fig. 1. Circuits similar to this are used where the receiver is a combination AC-DC and battery operated. The tubes use the filament as a cathode. Therefore DC is required to heat these filaments. The diagram shows how this is done. The rectifier is used for two purposes—one to provide current to heat the filament and second to rectify the AC line voltage for the DC plate and screen grid voltages for the other tubes. The filament cannot be connected direct to the same B+ point as the plates. Therefore, the second half of the 50Z7 is used to isolate the plate circuit from the filament circuit. The same filter is used for both circuits.

Figure 3 shows a complete circuit for a combination AC-DC battery operated receiver. The filament switching from AC-DC to battery operation is fairly complicated. This is due to the fact that the tubes are operated in series when used as an AC-DC receiver and connected in parallel for battery operation. With this type receiver, to use the battery, the AC-DC power line plug is plugged into a specially made socket in the back of the receiver. Plugging in this automatically switches the tube filaments and plate circuits for battery operation. When the plug is removed, the switch returns to its original position for AC-DC operation. Using this method of switching, there is no danger of burning out parts in the receiver or damaging the battery by connecting to the power line while the batteries are still in the circuit. There are a great number of circuit combinations for wiring the filament circuits and each radio manufacturer uses different methods.

Because of this, it sometimes becomes necessary to trace out the filament circuits before the defect in a receiver of this type can be found. The type of tubes used for AC-DC operation have high voltage filaments. They can be connected in series across the power line or some type of voltage reducing resister may be used in series with them. The line cord is sometimes used for a line voltage reducing resistor. When the cord is used in this manner, it will be warm to the touch when the receiver is in operation. If the cord is used for a line reducing resistor, the cord will have three wires instead of two. When repairing line cords with the extra line reducing resistor, be careful you do not change the length of this third wire. The resistance of this wire is proportional to its length and if its length is changed, the resistance will change causing the tubes to be over heated. This will cause them to burn out in a short time.

There are a great number of special made tubes for use in this type of receiver. The high voltage filament type and for both battery and AC-DC, the low voltage filament type. Because these tubes are made for a special purpose, their cost is sometimes quite high and in many cases they do not last as long as an ordinary tube. This is especially true of the rectifier tubes with a high filament voltage—such as 35Z5, 117Z6G, 50Z7G, etc.

Many of these small AC-DC receivers are TRF receivers. When servicing these small receivers, make sure about its type. Many small receivers are built for portable use and employ a built in antenna or have a length of wire attached to the receiver to be used as an antenna. When the antenna is of the built in type, there is usually a directional effect due to the employment of the loop antenna. By rotating the receiver, one best

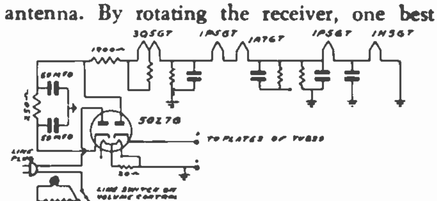


FIG. 2

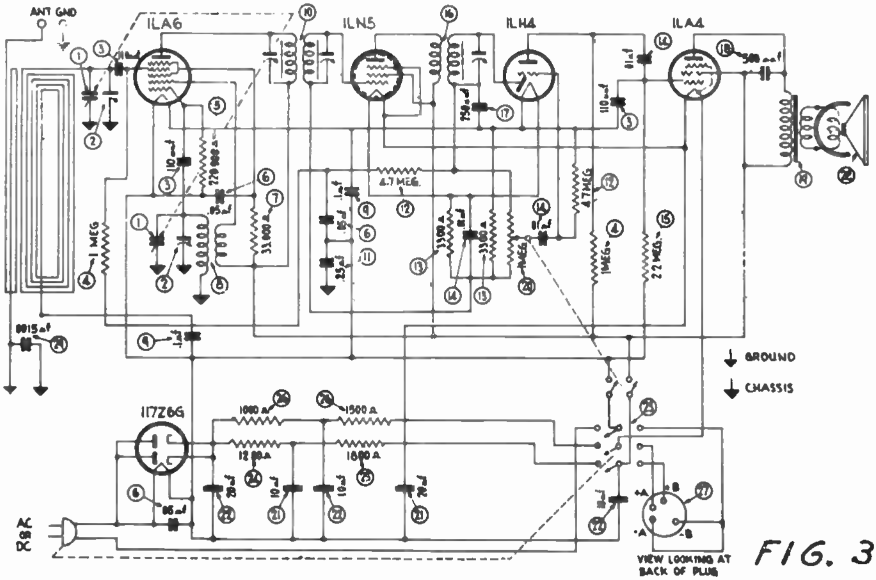


FIG. 3

position for it will be found for a given station. Volume levels for many stations can be increased considerably by changing the position of the receiver. An external antenna can be used if desired. The receiver will usually perform better if an outside antenna is used. Never ground these receivers direct to ground. Always use a condenser between ground and the chassis of the receiver. One side of the power line entering into a building is grounded. The other side is above ground in potential. As one side of the power line is usually connected to the chassis, if the plug should be put in wrong, the chassis will be 110 volts higher in potential than ground; and if the chassis is then connected to ground, the line fuse will blow due to this direct short of the 110 volt AC line. This condition can also damage many parts in the receiver.

Pilot lights are sometimes placed in series with the tube filaments. Care in the selection of replacement pilot lights for these receivers must be exercised. If the wrong rated light is used, the life of the tube may be shortened or the pilot light itself may be damaged.

A list of common troubles encountered with AC-DC receivers and how to cure them is given in the following table:

Trouble Symptoms

NONE OF THE TUBES LIGHT

Cause:

1. Burned out tube.
2. Burned out series connected pilot light.
3. Open Ballast Resistor.

Cure:

1. Make continuity test to reveal which component is open and replace it.

HUM

Cause:

1. Rectifier tube weak or defective.
2. Power output tube defective (type 43 tube causes this trouble very often).
3. Cathode–Heater leakage in any tube.
4. Line cord plug reversed in AC outlet.
5. Open line by-pass condenser.
6. Filter condenser open or otherwise faulty.

Cure:

1, 2, and 3. Check tubes and replace those at fault.
4. Reverse line cord plug.
5. Check line by-pass condenser and replace if necessary.
6. Replace faulty filter condensers.

FADING

Cause:

1. Loose element in tube causing internal shorting.
2. Wrong type tube.

Cure:

1. Tap tubes while checking and replace defective tubes.
2. Check tube types.

WEAK

Cause:

1. Cathode-Heater leakage within one of

the tubes.

2. Filter condenser shorted or leaky low filament voltage.
3. Antenna not adequate.

Cure:

1. Check tubes for shorts. Replace defects.
2. Replace shorted filter condensers.
3. Use outside antenna.
4. Check filament voltage on each tube.

NOISE

Cause:

1. Faulty tubes, loose element, etc.

Cure:

1. Use tap test on tubes and replace defects.

DISTORTION AND RATTLING

Cause:

1. Antenna has insufficient pick-up causing weak distorted reception.
2. Antenna signal pick-up too great—overloading the tubes—causing distortion.
3. Filter condenser (open) or dried out.
4. Bias resistor shorted or open.
5. Resistor by-pass condenser shorted.
6. Rattling caused by loose screws on speaker.
7. Voice coil of speaker off center.
8. Voice coils out of round, warped, or torn. Broken spider.
9. Speaker overloaded.
10. Receiver not properly tuned.
11. Two stations interfering.

Cure:

1. Use a better antenna.
2. Connect a .0005 mfd. condenser in series with the antenna leadin.
3. Replace faulty unit.
4. Replace faulty unit.
5. Replace faulty unit.
6. Tighten all loose screws.
7. Use shims and recenter.
8. Replace speaker or speaker cone. (With small sets replace the speaker.)
9. Reduce volume.
10. Tune receiver properly.
11. Try other stations.

Battery Receivers

There are many places where power lines do not reach, making it essential to use a battery operated receiver. There are several different types of battery operated receivers. The most common type operates from the following type DC or battery source: (1) A 6 or 12 volt battery. Automobile receivers also come under this classification. (2) A low voltage A battery for the filaments and one or more high voltage batteries for the plates and screen grids of the tubes. (3) A 32 volt DC power plant. Receivers operating from 6, 12 and 32 volt DC sources all must use some system for increasing the voltage for the plates of the tubes. This is usually done by one of the following two methods: (1) A dynamotor which changes the low voltage DC to a high voltage DC. (2) A vibrator which changes the DC to AC or pulsating DC which can be stepped up by means of a transformer to a high voltage AC and then rectified just the same as in any AC receiver.

The dynamotor operates as a low voltage DC motor and turns a high voltage DC generator. Both motor and generator armatures are wound on the same shaft and they both use the same magnetic field. These units are very small and dependable and as altitude has no effect upon them, they are used considerably in aircraft work.

The simple type vibrator just changes the DC to pulsating DC. This pulsating DC is fed to the primary of a power transformer and the low voltage is stepped up to the value desired. Then it is rectified and filtered. The main trouble with vibrator type power supplies is the failure of the vibrator to operate. The vibrator, when operating, produces an audible sound. If no sound is heard when the receiver in question is turned on, the vibrator isn't operating. Sometimes a slight jar will start or stop the vibrator. These vibrators are sealed in a metal shield and are not meant to be serviced. If one becomes defective, it must be replaced by a new unit.

Battery operated receivers are free from the usual AC hum found in ordinary AC receivers but the vibrator type may cause an AC hum at the frequency of the vibrator.

The automobile radio is the most popular receiver of this type. Due to the many shocks and jars encountered while the car is traveling, the receiver must be installed firmly so it will not vibrate of itself. Any loose component or tube element will cause the receiver to be noisy while the car is running. However, noise can be developed from the car itself. As the power supply to the automobile receiver is directly connected to the ignition system of the car, the ignition of the car may generate RF noise and unless properly shielded and surpressed, noise will be introduced into the receiver. The proper installation of an automobile radio is, as you see, very important. (The installation of automobile receivers will be taken up in detail in your SAR course.)

Radio
BUSINESS BUILDERS
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO REPAIR AND REFINISH RADIO CABINETS

BUSINESS BUILDER No. B-29

IN this Business Builder another avenue of profit which, in a sense, is closely related to radio service work will be presented. It is repair and refinish of radio cabinets—a work that may readily be extended to include various articles of furniture, should that be your inclination.

While at first thought this may appear as a thing apart from that of radio servicing, nevertheless it is not a difficult type of work to master. The tools and materials required are few, and the serviceman who has mastered the ability to perform this work will find his services in greater demand than the man not prepared for it.

For example, suppose a radio distributor or radio dealer has run an ad in a local newspaper for a radio serviceman, and upon making application for the position, you find a number of men have likewise applied for the job. Now these business men have various trade problems which at times prove to be very annoying and expensive. Consider one of their problems.

Once a receiver has been turned over to the express or other transportation companies by the manufacturer for shipment, he is no longer responsible for the chassis or cabinet. If, for example, a cabinet is damaged during transportation, the distributor or dealer is compelled to either file claim for damage with the transportation company involved or hire a furniture refinisher to restore the cabinet. The matter of collecting a damage claim usually develops into a lengthy, annoying process while repeated hiring of a furniture refinishing man to remove damages, which in most cases are scratches of minor nature, proves to be an expensive item. Also the demonstrator receivers must be considered. There is always a number of the current models on the floor of the distributor or dealer showrooms, and the cabinets of these receivers are bound to receive scratches, become marred in other ways or develop a worn appearance.

In order for the distributor or dealer to sell these floor samples and realize his profit from them it is usually found necessary to have the cabinets refinished. From this it becomes very clear that if you have the ability to do this work efficiently, your services will be more desirable to the distributor or dealer. This extra knowledge then gives you an edge over the other applicants for the position.

Or perhaps you may open a store of your own, in which case, the knowledge of cabinet repair and refinish will serve you in good stead, for no matter how careful you may be in handling cabinets there will be times when damage will result. Then, too, the buying prospect often has an older type of receiver he desires to trade-in on a new one. To make the sale you have to give a certain trade-in allowance for the old radio and attempt to make up this allowance by the re-sale of it. By carefully cleaning the chassis and refinishing the cabinet, dollars may be added to the resale value of the old receiver.

Still, as a radio serviceman, a number of further opportunities arise for added profits.

The housekeeper naturally desires that the radio cabinet maintain its original appearance. However, constant fingering by the members of the family in tuning, moving about in house cleaning, the desire to place it in a new position or setting ornamental objects on top of it such as small vases or radio lamps often develops scratches and blemishes. Then, too, the finish may gradually become dulled or some portion of the cabinet chipped or broken.

To carry on this work proficiently you must learn how to fill in a simple scratch as well as a deep one, how to restore a marred surface, how to fill gouged holes, how to repair or restore broken off ornamental woodwork and finally, how to correctly polish the entire cabinet when the repair work has been completed. The secret of the entire task is one of practice and after you have obtained the materials and tools required for the work, it is a good plan to practice on some old discarded articles of furniture. After a little practice you will be surprised how the *knack* develops and how simple it really is to turn out a job—the workmanship of which rivals that of the factory.

The tools required are few and usually may be purchased in any ten cent store. First you will need an alcohol lamp. This can be made from a small machine oil can. Simply cut off the snout at a point where it will be about one quarter inch in diameter. Then roll up about a foot of cheese cloth between the hands to form a round wick. After the wick has been fashioned pull it up through the snout, allowing the remainder of the wick to rest in the base of the can which is then filled with alcohol. Other tools necessary are a putty knife and a scalpel. Undoubtedly you are familiar with the design of the conventional putty knife as used by painters and glazers. The scalpel is similar to a putty knife and is used by cabinet makers and furniture refinishers for burning-in the transparent stick shellac.

It would be unwise to purchase a large amount of supplies before actually becoming engaged in practical cabinet work. The following list may be obtained in half pint quantities. Care should be used in obtaining the mahogany and walnut stain to ascertain that they have an *alcohol base.*

Mahogany stain; Walnut stain; Wood alcohol; Furniture polish of good quality; Varnish remover; Quick drying clear varnish.

Other needed materials will be: 1 small can of rotten stone powder; 1 stick of transparent, burning-in shellac; 1 small can of 0000 pumice stone powder; 1 tube of furniture glue; 1 small camel hair artist's brush; 1 paint brush one inch wide; 5 yards of cheese cloth; 1 pint of rubbing oil; 1 package of fine sandpaper.

The rubbing oil may be made by mixing one-third benzine with two-thirds linseed oil. It is a very good idea to purchase a metal box with a hinged lid similar to those which are used for fishing tackle. This may be used for storing and carrying your tools and materials in a handy, compact kit.

Removing A Simple Scratch

First consider how to remove an ordinary scratch – that is, one which is not deeply etched but sufficiently pronounced that it cannot be covered and removed with ordinary furniture polish. Assume that the scratch is on the top of the radio cabinet. First a newspaper or an old blanket should be placed on the floor under the cabinet to protect the hardwood or floor covering. A piece of cardboard or several thicknesses of newspaper should next be laid on the top of the cabinet upon which is placed tools and materials to carry on the job. The cardboard or newspaper serves not only as a convenient tray but also as a protection against drippings which would affect the finish of the rest of the cabinet if allowed to come in contact with it. The scalpel, alcohol lamp, rubbing oil, pumice powder, burning-in shellac, brush, stain and a piece of cheese cloth are the materials that may be needed for the removal of the scratch and these are placed upon the tray.

If the scratch does not show white at any point of its length proceed to burn-in the transparent shellac. Light the alcohol lamp and with the scalpel held in the right hand place its tip in the blue portion of the flame. Be very careful not to get the scalpel too hot, as only enough heat is required to allow you to melt off a little of the burning-in shellac when the scalpel tip is applied to the stick.

Then work into the scratch the shellac which has melted on the scalpel and repeat the process until the scratch has been filled. As the scalpel cools it must be reheated to the correct temperature. The procedure which must be developed in this phase of the work is simple in its requirements. The scalpel must not be allowed to become too hot, a small amount of shellac only must be used at one time and speed must be attained to prevent a *messy* filling of the scratch.

After the scratch has been filled there will probably be a surplus of the shellac lapping over the edges of the scratch. Reheat the scalpel and wipe off any shellac which may still adhere to it and with the scalpel still at the proper temperature, trim off the surplus shellac until the fill-in of the scratch is even with the cabinet surface. A piece of cheese cloth is next folded into a small pad and dampened with rubbing oil. The oily pad is then dipped lightly into the pumice powder and the shellac filled scratch is polished until it blends with the rest of the cabinet. In carrying on this polishing operation with the rubbing oil and pumice powder the strokes should always be made with the grain of the wood. After this has been accomplished, the excess pumice powder should be wiped from the surface with a clean piece of cloth, and then the entire cabinet should receive a polish with furniture polish thus completing the job.

Filling A Deep Scratch

There are times when a scratch will be encountered where the white wood shows. This means that the scratch has cut through the thin coating of veneer and has exposed the body or supporting wood. If you fill a scratch of this type with the transparent stick shellac alone, the white wood will continue to show through. Therefore, you must first stain the white area before applying the shellac. If the walnut or mahogany stain you have on hand is darker than that of the cabinet, it may be thinned to the correct shade by pouring a small amount of stain into a glass or other container and then adding small quantities of alcohol until the desired match is obtained. The stain should then be applied to the white area of the scratch with the small artist's brush and allowed to dry after which you should proceed to treat the scratch as in the case of a simple scratch. Each time you finish working in stain with your brush, it should be washed in alcohol. Thus it will always be ready and clean for the next job.

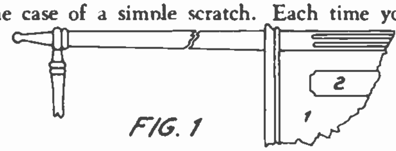


FIG. 1

The Application Of Plastic Wood

Sometimes a deep gash will be made in the cabinet or part of the ornamental design may be broken off, leaving a defect of such nature that it would be impractical to fill-in with burning-in shellac. In these cases plastic wood is used, but before this composition is applied, care must be taken to have the surface absolutely clean otherwise it will not adhere. If any varnish, dirt or furniture polish is in evidence, the gash should be thoroughly cleaned with alcohol.

Plastic wood is a putty-like compound and therefore is very pliable. It can be easily worked with the fingers or scalpel, and if the gash is in a flat, smooth area of the cabinet, plastic wood may be worked in with the fingers and then trimmed even with the scalpel. If working in an ornamental portion of the cabinet, the plastic wood should be shaped with the fingers to match the rest of the design as closely as possible.

After the plastic wood has been allowed sufficient time to thoroughly dry, a piece of sandpaper should be used to smooth out any rough spots which may be present. Stain which blends with the cabinet surface is then applied by means of the small brush to the plastic wood. The final stages of the job are then concluded by polishing the plastic wood with a piece of cheese cloth folded into a pad and moistened with rubbing oil which is in turn dipped in pumice powder followed by a furniture polish treatment of the entire cabinet.

Breakage Repairs

During periods of house cleaning or moving it often occurs that some portion of the cabinet may be chipped off or a leg broken. Breaks occuring to legs are never a smooth fracture for the grain of the wood in this case is vertical and the break has a tendency to follow the grain. Fig. 1 shows a break of this nature.

If the two broken sections are placed together it will be noticed they mesh perfectly and the leg appears cracked but unbroken. However, if a shattering has taken place thus preventing a perfect mesh, the shattered pieces or splinters should be removed carefully until a perfect mesh of the two broken

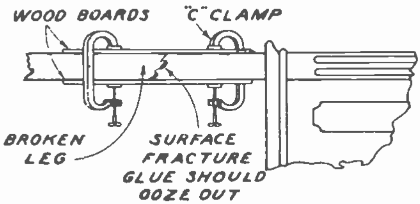


FIG. 2

parts is obtained.

When a snug mesh of the two sections is assured apply glue to both broken surfaces of the break and allow to stand a few minutes until the glue dries to a tacky condition. The two sections are then pressed tightly together in mesh and nailed with small finishing nails. These nails must be punched below the surface of the wood by means of a nail punch. The holes later to be filled with plastic wood or shellac. Small wood screws may take the place of nails if holes are drilled for them.

A small C clamp as in Fig. 2 may be obtained in most any hardware store which will greatly assist in this type of work. In Fig. 2 is shown how C clamps are utilized. After the two glued sections have been placed in position, two wood cleats are placed parallel with the leg to prevent injury to the finish when pressure is applied by the clamps. The clamps should be tightened until the glue *oozes* from the break. The cabinet must then be allowed to stand until the glue is thoroughly dry and hard. This hardening process usually takes from twenty-four to thirty-six hours. C clamps should be used whenever possible and nailing resorted to only in cases where the clamps cannot be applied. When the clamps are removed the excess glue which seeped from the fracture should be cleared away by cutting with a sharp knife. If the exposed portion of the break is rough it should be sandpapered and then treated as if it were a scratch in the final completion of the repair.

Refinishing A Surface

Receivers are sometimes placed in a position near an open window and a sudden rain squall may beat in, wetting one side of the cabinet. This moisture may mar the finish, causing it to take on a dull, spotty appearance or the veneer may crack or warp—in many cases—lifting or curling away from the bodywood. Continued exposure to the direct rays of the sun are also a contributing factor to a dull, lifeless finish. Then too, an accidental spill of hot liquids or cleaning preparations may cause serious damage to surface finishes. In cases of this type it will be necessary to refinish the entire surface. However, if the cabinet contains sectional panels, and one of these panels become disfigured, it will only be necessary to refinish the panel so affected.

In Fig. 1 it will be observed that the body of the cabinet is designated by the number 1 while the panel is shown by the number 2. If a panel of this type should become marred it could very easily be refinished without affecting the body of the cabinet.

If the wood veneer is found to be away from the main body of the cabinet, this must first be reglued. This operation can be accomplished by forcing glue between the veneer and the bodywood. Then place a heavy weight upon the veneer to hold it down until the glue hardens. In cases where the veneer has warped it should be steamed soft by placing hot cloths (which have been dipped in hot water and twisted as dry as possible) upon it until the wood is pliable. Then lay a flat board upon the veneer and set a heavy weight upon the board and allow it to remain until the veneer has thoroughly dried. After the veneer has dried, it is treated with a filling of glue and the weight replaced until the glue hardens.

To make a satisfactory job of refinishing, the old varnish must be removed down to the bare wood. This can be done by using varnish remover. The best method of procedure in removing the old finish is to work on one section or panel of the cabinet at a time. With a paint brush apply the varnish remover to the surface and allow it to remain until the varnish begins to lift or curl. Then with the aid of a putty knife or a brush having fairly stiff bristles, scrape or rub off the varnish. If a putty knife is used be careful not to gouge or scratch the veneered surface with the tool.

Sometimes it will be found necessary to use two or three applications of the varnish remover before the cabinet will be entirely free of varnish. When the old varnish has finally been removed, soak a cloth in alcohol and wash the panel clean. The surface of the cabinet must now be allowed time to dry thoroughly.

Radio
BUSINESS BUILDERS
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO ADJUST THE TUNED CIRCUITS OF A SUPERHETERODYNE TYPE RECEIVER

BUSINESS BUILDER NO. B-28

THE readjustment of the tuned circuits of a superheterodyne type receiver becomes necessary for several reasons; aging of the parts, vibration causing trimmer screws to turn, temperature fluctuation causing movement of trimmer plates, and because trimmer condensers are sometimes tampered with by incompetent hands.

The tuning alignment procedure for a superheterodyne is more complicated than for other types of receivers and it requires more precision in making the adjustment. For these reasons the alignment or adjustment must be right to get maximun selectivity with good tone quality. If for any reason the tuning becomes out of adjustment, it will greatly affect the receiver's performance.

When a superheterodyne is out of alignment, there are certain symptoms that will indicate the need for alignment. As with the TRF receiver, if the RF amplifier needs adjustment, the receiver will have poor selectivity and poor sensitivity. If the oscillator is out of alignment, usually the receiver will have good selectivity and sensitivity at one or two positions of the dial. When the IF stages are out of alignment, the noise level of the receiver is much higher and a very loud high pitched hiss will be noticed, which with experience you will be able to identify.

The signal strength will be low, or in the extreme case of non-alignment there will be no signal at all. There may be undue interference from unwanted stations if the IF amplifier is not properly tuned. Also the audio response may be poor due to possible cutting of sidebands in the IF amplifier.

Circuit To Be Aligned

The superheterodyne is much more complex than any of the other types of receivers. Therefore, the alignment procedure is not so simple but with practice you can make it a simple job. A thorough understanding of the operation of this type of receiver and the alignment procedure is necessary before attempting to align a superheterodyne. It will be assumed in this Business Builder that the student is thoroughly familiar with the theory of operation of this type of receiver. See your SAR lessons for more detailed information on the operation of this type of receiver.

There are three main circuits which must be adjusted in a superheterodyne before the receiver will operate properly. (1) The RF section—if there is one. (2) The oscillator and mixer. (3) The IF amplifier.

The RF section is adjusted in the same manner as for a TRF receiver. Most of the smaller receivers do not have an RF amplifier other than the mixer. In this case, there is no RF alignment other than for the mixer circuit.

The oscillator stage is so adjusted that the oscillator frequency will remain at a value higher than the received signal by an amount equal to the frequency of the IF amplifier. An example will make this principle clear. If the received signal is 840 KC and the IF operates at 456 KC, then for this condition, the oscillator stage will have to be adjusted to 840+456 or 1296 KC. In other words the oscillator stage is 456 KC ahead of the RF or mixer stage and this difference in frequency must remain the same throughout the frequency band. For other receivers, the IF frequency might be different but the principle would remain the same in that the constant frequency difference must be maintained depending on the value of the IF. Thus tracking of the oscillator is very important, for the operation of the entire receiver depends upon how well the oscillator tracks or maintains the frequency difference. The proper alignment of the oscillator and mixer was no doubt done at the factory so usually only minor tracking trouble will occur (except in the case of tampering). Before attempting to make any adjustment of the oscillator tracking, make sure that it is really necessary.

The IF section of the superheterodyne is tuned to the intermediate frequency by adjusting the primary and secondary of each IF transformer so that each will resonate to the intermediate frequency. The IF transformers are not always tuned to peak. In some *high fidelity* receivers, the IF transformers are tuned with a flat top resonance curve the technical details of which will be found in your SAR Service Course lessons.

The alignment of the three circuits mentioned is in general all that is necessary. However, in some cases the receiver may have automatic frequency control or a band-pass filter, or a special wave trap, etc. which may require adjustment. These special circuits are usually different for each receiver involved. For this reason the factory service manual for the receiver in question should be consulted for information concerning these adjustments so that the proper adjustment as outlined by the receiver designer can be made, In the absence of such a manual, refer to your SAR Service Course lessons.

Preliminary Preparations

A good accurately calibrated signal generator should be used for superheterodyne tuning adjustments. It should have frequency ranges to include all the commonly used intermediate frequencies and it should include all of the radio frequency bands—usually from 600 KC to 18 or 20 megacycles or higher. It should have both a modulated and unmodulated output and for flat top broad band IF alignment, a frequency modulated output.

Turn the signal generator and receiver on for at least five minutes before attempting to make any tuning adjustments. This will allow them to heat to standard operating conditions.

A careful study of the circuit diagram and the receiver chassis should reveal what special circuit (if any) are used and at the same time you can locate and identify the trimmer adjustment screws for the IF, RF, and oscillator circuits.

The RF and oscillator trimmers are usually very easy to find as they are connected in parallel with the main tuning condensers. For receivers, employing the broadcast band only, the RF and oscillator trimmers are usually located on the frame of the variable condenser. For receivers having more than one tuning band, the trimmers may be a little more difficult to locate and identify. However, if you follow the procedure given here you should be able to locate and identify all trimmers. The service manual will, of course, give you the right information as to where they are located; but if a service manual is not available, other methods will have to be followed. In practically all of the multiband receivers, the trimmer and padder condensers for all bands are located very near to each other —often on the same insulating strip. It is sometimes hard to trace out the wiring to find which trimmer adjusts which band. An easy way to tell is to turn the receiver on and touch each trimmer and padder with a screw driver blade. Those causing a distinct pop or other unusual sound in the speaker are the trimmers for the band in question. Doing this for each position of the selector switch, the trimmers and padders can be identified for each band.

The trimmer condensers are not hard to distinguish from the padder condensers as the capacity of a trimmer is so much smaller than that of a padder. A trimmer condenser is usually connected in parallel with a tuned circuit whereas a padder condenser is always connected in series with an oscillator circuit. Some receivers employ no padder condensers and some of them employ fixed padders, particularly for the short wave bands. The capacity of a padder is of the order of 1000 mmfd. whereas a trimmer is usually around 10 mmfd. or less. A careful inspection of the

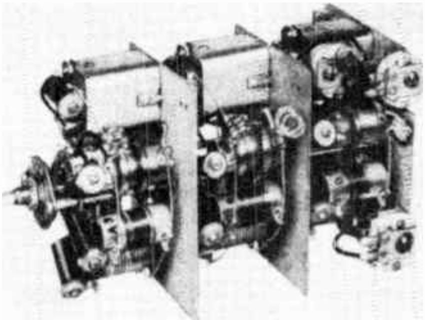


FIG. 1

physical size of the condensers should enable you to identify them.

If there is still a question, the connection of the condenser should be traced. The padder condenser is in series with the variable tuning condenser for the oscillator stage whereas the trimmer is in parallel with it. Thus RF and IF stages do not employ padder condensers. Figure 1 shows a typical multiple band receiver including the trimmer and padder condensers.

When using an output meter for an alignment indicator and the receiver has an AVC circuit, the AVC action must be prevented from coming into action. The reason for this is that if the AVC is allowed to act, it will tend to keep the output constant. Therefore, you cannot find the maximum output point indicating resonance. See your Master Service Course lessons on tuning adjustments.

In receivers where the AVC originates in a diode-triode, detector-amplifier, the simpler way to interrupt the AVC is to use a weak signal from the signal generator so that the AVC action does not take place.

Another method is to disconnect the lead which picks off the AVC voltage from the detector circuit. The lead which feeds the grids of the RF and IF tubes should then be grounded directly to the chassis. As this places a low bias on the tubes, they will operate with maximum sensitivity, necessitating a reduced signal from the signal generator. This method is recommended where 6Q7, 6B6, 7C6, 6B8, 75, 55, 85, 2B7 and 6B7 type tubes are used as second detectors.

If the receiver has automatic frequency control with a switch for manual operation, turn the switch to the manual position so that the AVC will be inoperative.

The local oscillator of the receiver should be stopped from operating during the IF alignment. This can be done by connecting a small piece of wire between the stator and rotor plates of the oscillator variable tuning condenser or by shorting these plates in some other way. If there is a DC potential across the oscillator variable condenser, connect a .05 to .1 mfd. fixed condenser between the stator and rotor of the oscillator variable condenser.

The IF amplifier in most receivers is tuned to peak at the intermediate frequency and as each IF transformer is designed to operate at a given frequency, this frequency must be known before the IF amplifier can be aligned properly. The intermediate frequency used by a receiver is usually stamped on the can that shields the IF transformer or it may be given on a diagram of the receiver. In quite a number of receivers, the manufacturer pastes a diagram of the receiver inside the cabinet. This diagram usually gives the intermediate frequency of the receiver. Any good up-to-date service manual or manuals put out by parts manufacturers will give the intermediate frequencies of practically every receiver built.

The IF trimmers are usually very easy to find. In most receivers the IF transformers are located on top of the chassis and are inside of a metal can. This can is the transformer shield and it usually contains the trimmer condensers. The adjustments are usually made through small holes drilled in the can. However, this is not always the case. Some of the earlier receivers employ the trimmers outside of the can but near enough so that their leads can be traced for identification. In some of the smaller receivers, the IF transformers are not shielded and are located under the chassis. By tracing out the wiring of any receiver, the IF transformer and their trimmers can be located. It, of course, would be quicker with the aid of a service manual.

After the intermediate frequency has been determined and the IF trimmers for each IF stage have been located, the alignment of the IF can be started. Before starting the alignment, be sure that all the tubes, shields, and connections are all in their proper places. Disconnect the antenna from the receiver; but if the receiver is grounded, leave the grounded wire connected to the receiver. The alignment is usually done with the chassis removed from the cabinet because, with most receivers, all of the adjustments cannot be made while the receiver is in the cabinet.

Next connect the output leads of the signal generator from the mixer tube grid to ground. If you do not know which tube is the mixer, refer to the Business Builder "How To Identify The Separate Stages of a Receiver" or refer to a service manual.

Allow time for the signal generator and receiver to come up to operating temperature. Then turn the dial of the Signal Generator to the intermediate frequency of the receiver; and, with the output meter connected to the output of the receiver as shown in the Business Builder "How To Align a TRF Receiver" and the modulated-unmodulated switch of the Signal Generator turned to modulated, turn up the gain of the Signal Generator until a reading is indicated by the output meter.

Special alignment tools must be used to make the adjustment. These tools can be bought from your radio parts jobber. They consist of special shaped screwdrivers and wrenches made to adjust the trimmers of most receivers. The reason special tools are necesary is that if an ordinary metal screwdriver were used the capacity between the screwdriver blade and the shield of the transformer would be so great that you would be unable to make the proper adjustments.

The next step is to adjust the secondary of the last IF transformer (the one nearest the 2nd detector) until the output meter reads maximum, using the special aligning tools. When the secondary has been peaked, adjust the primary. Go back and check the secondary after the primary has been adjusted. Tuning one may affect the tuning of the other slightly. Therefore, it is important to recheck each time one trimmer is tuned until the maximum resonant point is reached, repeating this process for each IF transformer until they are all properly adjusted. While making the adjustment, keep the reading of the output meter near the center of the scale by continually changing the meter range and adjusting the output of the signal generator.

Oscillator Tracking

Before starting to align the oscillator and RF circuits, remove any short you may have placed across the oscillator tuning condenser. Now connect the signal generator to the Ant. and Gnd. terminals of the receiver. Tune the signal generator to 1400 KC and tune the receiver dial until the 1400 KC signal comes in (Broadcast Band only). The signal may not come in at exactly 1400 KC as indicated by the receiver dial. However, with the receiver tuned to 1400 KC, adjust the RF trimmers until the output meter reads maximum. Next turn the receiver dial until it is near 1400 KC and adjust the oscillator trimmer to maximum. Then readjust the RF trimmer to maximum. Keep moving the receiver dial pointer closer to 1400 KC, adjusting the trimmers each time until the 1400 KC signal comes in at 1400 KC, on the dial with maximum output. Go over the oscillator and RF trimmers once more to make sure you have them set at the highest output as indicated by the output meter.

If a low frequency tracking padder is provided on the receiver, tune the signal generator and receiver to 600 KC. With the signal generator and receiver set at 600 KC, adjust the padder condenser of the oscillator until the output meter indicates the highest output. This should be done while the receiver dial is being turned back and forth slightly above and below the 600 KC setting on the dial.

Recheck the high frequency setting at this point making any necessary adjustments. Then return to the low frequency and recheck it. Some receivers do not have a low frequency padder. In this case no padder adjustment is necessary.

Receivers having more than one band are adjusted in the same way. Remember, however, the IF requires no adjustment for the short wave bands as one adjustment for it is good for all bands. The RF and oscillator trimmers of each band are adjusted separately —first at the high frequency end of the dial and then at the low frequency end for the oscillator. The exact frequencies to use are given in Service Manuals. These frequency values vary, depending on the frequency bands involved.

The instructions given in this Business Builder should enable you to make accurate tuning adjustments on the average receiver. For more complex cases refer to your SAR lessons on Tuning Adjustments.

Radio
BUSINESS BUILDERS
SPRAYBERRY ACADEMY OF RADIO CHICAGO, ILLINOIS

HOW TO ADJUST THE TUNED CIRCUITS OF TRF AND NEUTRODYNE RECEIVERS

BUSINESS BUILDER No. B-27

THE adjustment of the tuned circuits of a receiver frequently becomes necessary due to several reasons. Continual movement of the receiver may cause the non-alignment of the tuned circuits. Temperature changes may affect the tuned circuits, causing non-alignment. In many instances the receiver owner will try to make his own repair and in so doing will non-align all the tuned circuits so that a complete realignment becomes necessary.

There are several things to consider before attempting to align the tuned circuits of any receiver. The first thing is to make sure the receiver needs alignment. If there is some other trouble with the receiver and the alignment is changed, it will be much harder to locate the real cause of the trouble. Don't, under any circumstance, make a tuning adjustment on any receiver without first finding out exactly what the adjustment is for and what effect it has upon the receiver. Many a beginner in radio servicing often becomes too hasty in his diagnosis and starts to make tuning adjustments before the real defect is ascertained and as a result cannot get the original adjustment back again. This, of course, is a very embarrassing situation and doesn't make a very good impression upon a new customer.

The theory of operation of the different type receivers is thoroughly discussed in your SAR Lessons. Therefore, it will be assumed in this Business Builder that you understand the operation of these receivers.

Aligning a TRF Receiver

There are two instruments necessary to properly align a TRF receiver, a Signal Generator (Test Oscillator) and an Output Meter. The signal generator is a radio frequency generator. It takes the place of the radio signals, giving a constant signal at any desired amplitude with a frequency range to cover the tuning range of the most common types of receivers. The calibration of this generator must be accurate or the alignment of the receiver will be inaccurate.

It is desirable to have a modulated output from the signal generator and most of the standard models have an audio oscillator incorporated within the generator to modulate the output at an audio rate. This audio oscilliator is controlled by a switch so that the output of the generator can be either modulated or unmodulated.

The output meter is a sensitive AC meter usually with a condenser in series with it. AC will pass through the condenser with little opposition, but DC will not pass through the condenser. Therefore, the condenser stops the DC from interfering with the AC output.

If an output meter is not available you can use an AC meter with a condenser in series. This condenser should have a capacity from .5 to 1 mfd. with a DC voltage rating high enough to withstand the highest peak·value of voltage to be expected in AF plate circuits. Never use an electrolytic condenser with an output meter for the electrolytic condenser cannot withstand the revers-

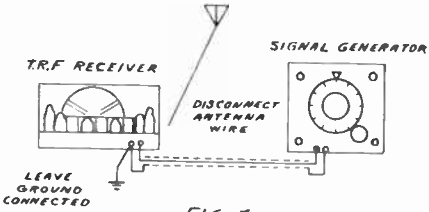


FIG. 1

ing voltage.

To use the signal generator for aligning the TRF receiver, connect the output of the signal generator to the antenna and ground terminals of the receiver, connecting the outside shield of the generator cable to the ground of the receiver and the center wire of the cable to the antenna terminal (See Fig. 1) after the outside antenna has been disconnected. Leave the external ground connected to the receiver. If a loop antenna is used clip your signal generator output lead to a few turns of the loop. No ground connection is required in this case.

The output meter can be connected in several different ways. Figures 2, 3, and 4 show the common methods. Any of these methods will do. Use the one most convenient for the receiver on which you are working.

The object of tuning adjustments on a TRF receiver is to get each separate tuned circuit adjusted to exact resonance with all the other tuned circuits. This is necessary because most receivers employ a ganged condenser. Each separate condenser of the gang tunes a different radio frequency amplifier. All of these amplifiers must be tuned to the same frequency at any one point of the dial or the receiver will not have good sensitivity or selectivity. The non-alignment of a TRF receiver will usually cause the same station to come in at two different settings of the dial.

To tell if a receiver needs aligning, all

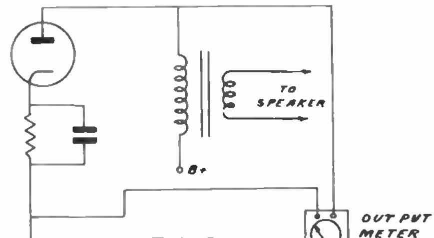


FIG. 3

you need to do is to rotate the dial, tuning in different stations. If the receiver has good selectivity, that is if you can easily separate signals 20 to 30 KC apart without one interfering with the other and if the volume level of each nearby station is satisfactory, the receiver is properly aligned. Poor sensitivity (low volume levels) alone is no indication of non-alignment except in the case of strong local or nearby signals.

After you are sure the trouble involved is due to non-alignment, attach the signal generator to the receiver as mentioned, turning the on-off switch of the generator to on and the modulated-unmodulated switch to modulated. Connect the output meter as mentioned and turn the dial of the receiver to 1400 KC. If the receiver is not calibrated in kilocycles, adjust the signal generator to 1400 KC. As the generator is accurately calibrated, it will give you a strong 1400 KC signal. Now with the output of the signal generator turned on part way, turn the dial on the receiver until the signal from the generator is picked-up and a reading on the output meter is indicated. Watch the output meter while tuning. To begin with have it set at a high range. Then as needed, reduce it. It is a good idea to keep the output meter at a rather high range until you are sure that the output is within the lower ranges. Otherwise, you may damage the meter. If the receiver is far out of align-

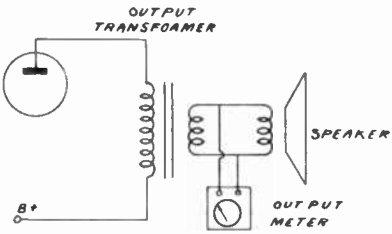


FIG. 2

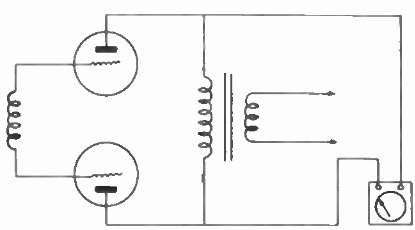


FIG. 4

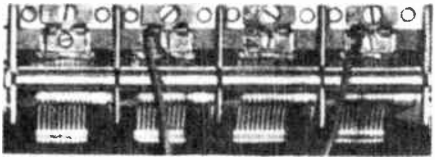


FIG. 5

ment, it may be necessary to set the output meter to a low range in order to get a reading. If so, watch the meter very closely while making any adjustment or the needle of the meter may be damaged by throwing it off scale as you come closer to the proper alignment.

Before you can align a TRF receiver, the trimmer condensers must be found. These small trimmer condensers are usually mounted on the larger tuning condensers (See Fig. 5). These trimmer condensers must be so adjusted that each RF amplifier stage will be tuned to the same frequency when the receiver is tuned to a frequency of 1400 KC.

Special tools are used for these adjustments. They consist of insulated wrenches and screw drivers. This is to avoid unnecessary hand capacity from interfering with the alignment procedure. Figure 6 shows a group of typical alignment tools.

Other receivers have trimmer condensers for aligning at a high frequency and slotted end rotor plates of the large tuning condensers which can be bent slightly for the low frequency alignment (at about 600 KC). There are some few TRF receivers which have no trimmer condensers. They are adjusted by decoupling each rotor of the gang and turning it alone until the stage containing this condenser is tuned to the proper frequency; then without disturbing the setting, it is refastened to the common shaft of the gang. This method is very tedious and usually quite difficult to accomplish. For this reason only the very old receivers employ such an arrangement. A thorough inspection of the receiver will usually reveal what type of tuning adjustments are provided.

Before attempting to make any tuning adjustment, be sure that the dust and dirt that has accumulated in the receiver is removed and the whole chassis is clean. After the chassis is clean and all of the dirt between the plates of the tuning condensers is removed, see that all tube shields and shielded connections are tight and in their proper place. The receiver is then ready for alignment. If the receiver uses trimmer condensers start with the detector tube trimmer and work back towards the antenna stage, adjusting each trimmer until the output meter reads maximum. While doing this, try to keep the range of the output meter adjusted so that the maximum reading will be near the center of the meter scale.

If the receiver tuning condensers have slotted end plates, turn the signal generator to 600 KC and adjust the end plates by bending in or out *slightly* until the output meter gives a maximum reading. Some receivers employ tuning condensers with screw adjustments for bending the slotted plates so that a more accurate alignment can be made. After the segments in the end rotor plates have been bent, aligning the receiver at 600 KC, tune the signal generator and receiver back to 1400 KC and check the alignment. Make a slight adjustment if necessary after which recheck at 600 KC again, repeating this process until you are sure the adjustment is right at both ends of the dial.

For TRF receivers not using trimmers or slotted plates, loosen the set screws, allowing the condenser rotor involved to swing free of the rest of the gang shaft. While the condenser is free rotate it until the output meter reads maximum with the signal generator set at 1400 KC. After you have the maximum setting, hold the condenser rotor firmly so that it cannot turn and tighten the coupling screws. When you have tightened the screws without making any changes, make sure that the signal strength as indicated on the output meter remains the same after tightening. If the reading is not the same repeat the adjustment. This should be done for each condenser rotor in the gang. The method by which the condensers are ganged varies. Some are coupled

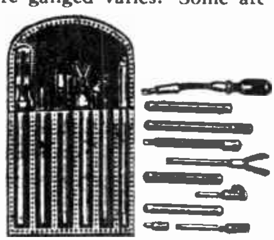


FIG. 6

by belts, others by set screws. With a particular receiver, the mechanical construction will have to be ascertained before starting the tuning adjustments.

Aligning TRF receivers is an easy job. The alignment can be done by ear with a strong signal tuned in, but it takes practice to do this; and to begin with, until you have become accustomed to aligning, you will do a much better and quicker job with a signal generator and output meter.

How to Make Neutralizing Adjustments

The neutrodyne receiver is one of the oldest types of receivers. There are still a few complete neutrodyne receivers in operation even today and some few relatively new receivers employ one stage of neutralized RF amplification.

The neutrodyne receiver usually uses triode tubes in the RF amplifier stages; and, as you will learn from your lessons, triode tubes used as RF amplifiers will oscillate unless the feed back causing the oscillation is controlled. The cancelling of the feed back is called neutralizing. Figure 7 shows how an RF stage using a triode tube can be neutralized. The neutralizing condenser feeds a voltage of *opposite phase* back to the grid, neutralizing the feed back within the tube which causes oscillation.

Before trying to neutralize a receiver, be sure that it is of the neutrodyne type. This can be determined by locating the neutralizing condensers and noting how they are connected. These neutralizing condensers will be located near the stage to neutralized. Do not confuse them with trimmer condensers. Tracing out trimmers—noting the condenser connections—will enable you to identify them. If

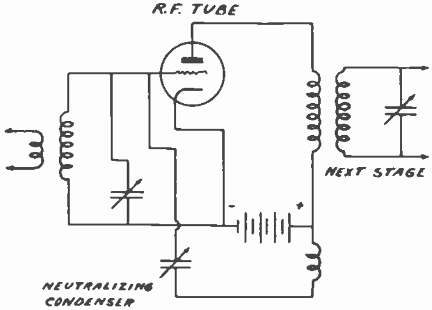


FIG. 7

the condenser is connected between the plate circuit of the tube and the grid circuit as shown in Figure 7, it is a neutralizing condenser, but if it is connected in parallel with a tuning condenser it is a trimmer condenser. The neutralizing condensers are generally made about the same as trimmer condensers. However, some receivers use two metal rods mounted a short distance apart in a glass or fibre tube with a metal sleeve fitting over the tube. The position of this sleeve is changed in order to vary the neutralizing capacity.

After you have located the neutralizing condensers, tune in a station near 1400 KC or use the signal generator as explained tuned to 1400 KC. Next open the filament lead to the last RF tube (the one nearest the detector). This can be done by three or four methods. Either disconnect the lead to the tube socket, or place a soda straw or a pill capsule over one of the tube filament prongs, or use a standard neutralizing adapter. If a signal is heard in the speaker when this is done, the stage is not properly neutralized. If it was neutralized with the tube filament open, no signal could get through to the detector. Receiving a signal with the filament open, indicates the signal is passing through the grid-plate capacity of the tube which is what neutralizing is supposed to prevent. Adjust the neutralizing condenser of this stage until no signal is heard from the speaker or no reading is obtained on the output meter. Do this for each preceding stage until all of the RF stages have been neutralized.

When you have completed the neutralizing, check to see if the receiver oscillates at other settings of the dial. If so repeat the neutralizing procedure at these frequencies and again check until the receiver is free from all oscillation.

If it is impossible to completely neutralize, the feed back voltage will have to be reduced by some other means. Reducing the plate voltage is one easy way to do this. This can be done by moving the AC power line connection to a higher voltage tap on the power transformer. Most of the older receivers have several taps on the primary of the power transformer to take care of any input line voltage from about 105 up to 125 volts. By moving the line connection to a higher voltage tap, it reduces the output voltage of the power supply of the receiver.

BATTERY OPERATED RECEIVER TESTING

RADIO SERVICE BULLETIN NO. 13

The most important test of the condition of the batteries for a battery operated receiver is the load test. This consists in measuring the voltage of the B batteries, while the receiver is operating. There is no value in measuring the voltage of batteries that are not in actual use or not loaded in some way unless they are almost completely reduced in voltage.

With a voltmeter of reasonably high resistance (1,000 ohms per volt) as in common use, the load on the batteries by the voltmeter alone is not sufficient to give a good test. Any batteries which have decreased in voltage more than 20% of their rated values **under load** should be discarded.

The C battery is the only one which need not be loaded while under test, as it is not required to supply current even while in operation. If its voltage is near normal with a high resistance voltmeter test, it will be satisfactory for operation.

The dry cell type A battery should be tested under full load, that is while lighting all filaments in the receiver with which it is operated. Voltage measurements only are needed. However, there is almost always a resistance between the A supply leads and the actual filament connections so a further test for voltage at the tube filament terminals is needed. Not more than 10% variation from the proper rating should be tolerated here. If the voltage cannot be regulated by means of a series rheostat or voltage regulator in the filament supply circuit, the batteries must be replaced.

There are some very important considerations where the air cell type of A battery is in use. The current drain of the air cell must not be allowed to exceed its rated maximum value under any condition. It must never be tested with a shunt current meter and it is essential to use a series ammeter in one of the A supply leads to determine the current which it is delivering. If the receiver is drawing 5% or less current than that for which the ammeter is rated, the voltage at the filaments may be tested with a high resistance voltmeter, not less than

1,000 ohms per volt. The voltage for the air cell tubes must be very near to the specified value. If it is as much as 5% either above or below this value, some correction must be made. All air cell type receivers are fitted with a fixed resistor in the filament circuit, which limits the current to the correct value within the air cell rating. If it draws more current than this, even for an instant, the battery will be ruined.

Symptoms of either a low B battery voltage or low filament voltage are motorboating, noise and lack of sensitivity. Failure of the grid or C battery is evidenced by low volume and muffled distortion of tone with a considerable loss of high frequencies. Open of a grid circuit will cause hum and motorboating or blocking of the circuit which is simply very slow motorboating.

If a shunt type plate circuit voltage divider is used for screen, bias or other voltage supply, be sure that there is a plate circuit switch as well as a filament switch to open the circuit when not in use. Be sure that the switch opens the circuit by measuring the current if any, in the negative B supply when the receiver is turned off.

From tube literature and from manufacturers information, determine what total current should flow from the plate supply batteries and measure this current. If it is excessive, that is above 10 or 20% of that specified, look for a shorted by-pass condenser, a resistor which has reduced in value, a tube short, a coil short or a defect in any of the wiring or parts which could cause this excessive current. The same information applies to a C battery bias circuit of the shunt type used with many receivers to obtain several voltages not available at the C battery terminals. The C battery should supply no current when the receiver is off but when on it must supply current for the voltage divider resistance only.

In most battery receivers the polarity of the A battery is important because of the wiring of the grid returns in the circuit. With an incorrect polarity the bias will be improper and the operation of the receiver will be noticeably inferior.

Where a storage battery is used for filament supply some method should be used to keep it charged with a constant trickle charge supplied by a rectifier, a resistor voltage drop from a DC line, or windcharger. If this is not possible the storage battery must be taken to a charging shop every few weeks, depending on how much it is used.

The liquid electrolyte should be kept ¼ inch above the plates by adding distilled water regularly and the battery must be located in a cool dry place with provision made for good air circulation. The battery terminals should be cleared of corrosion with a bicarbonate of soda solution and wiped dry. Vaseline or cup grease should then be applied to the terminals to prevent further corrosion. Connections should be made to storage battery terminals with screw clamps not thumb clips. Hydrometer readings should be taken regularly of each cell, and if it is not possible to get the proper voltage from the battery it may be necessary to give it a load test. This consists of drawing 300 to 400 amperes from each cell while measuring its voltage. If the voltage drops to zero during test, the cell must be replaced or reconditioned, since a charge will not be effective.

HOW TO MAKE A RADIO CHASSIS WORK BENCH HOLDER

RADIO SERVICE BULLETIN No. 14

Radio shop work is greatly aided by using some means of supporting a receiver chassis so that it may be turned in any direction instantly. Thus tests at the tube top caps or connections to the condenser gang or upper part of the receiver may be made and immediately it may be turned over for examination beneath the chassis. Only in very rare cases can a chassis be placed in various positions without complete artificial support.

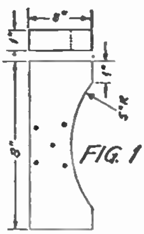


FIG. 1

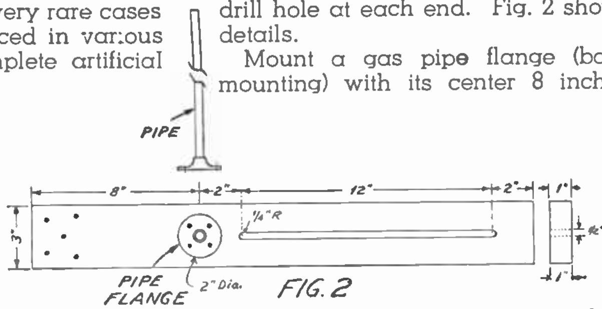


FIG. 2

Although there are several types of receiver chassis holders on the market we have designed one that may be easily built in the home workshop. As in the drawings included herewith it consists of a slide and cross arm base section and two vertical sections cut to admit the **pipe** bearings. The chassis clamps are curved "T" arms 24 inches long with an adjustable wood end clamp. The two chassis clamps are alike each consisting of a wood section next to the chassis, a bolt, an angle iron and a bolt with a wing nut. For its construction 13 feet 2 in. of 1 x 3 inch lumber will be needed. The board is sawed as follows:

1 length 30 inches.
2 lengths 15 inches each.
2 lengths 8 inches each (end clamps).
2 lengths 24 inches each.
1 length 12 inches.
1 length 18 inches.
2 lengths 8 inches (base sections).

With the two 8 inch sections, mark out an arc with a 5 inch radius that will extend 1 inch into the wood and cut. This cut is shown in Fig. 1. Then with the two 24 inch sections, saw ⅜ to ½ inch slots in the center 2 inches from one end and 12 inches long. Bore 5 bolt holes as suggested in Figs. 1 and 2 in both the 8 inch and 24 inch sections and secure the two as for a T square. The slots are started by a drill hole at each end. Fig. 2 shows details.

Mount a gas pipe flange (base mounting) with its center 8 inches from the T end of the clamp member. Next insert a 6 to 8 inch length of ⅜ inch gas pipe as illustrated in Fig. 2.

From the end of the wood left over after cutting out the length mentioned, cut out two 6 x 1½ inch sections and countersink a large bolt head in the center of the 6 x 1 inch dimension as in Fig. 3. The bolt should be at least 4 inches long with a ⅜ inch diameter. Next secure two 6 inch lengths of

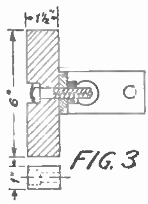


FIG. 3

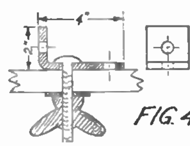


FIG. 4

strap iron 1½ inch wide 3/16 inch stock and bend the ends as indicated in Figs. 3, 4, and 5. Drill a hole large enough for a ⅜ inch bolt to fit in the short leg and a hole large enough for a 3/16 inch bolt in the other. See Fig. 5.

Place a ⅜ inch bolt through the countersunk hole as shown in Fig. 3 and through the hole in the shorter of the two legs of the bent iron. Now insert a round head 3/16 inch bolt in the hole of the other leg and through the slot in the T section as seen in Fig. 2, place a large (2 inch) washer on it and then a large wing nut. See Fig. 4. The completed assembly of Fig. 7 shows the position of the wing nut and the 6 x 1 inch pieces which are fastened to the bent metal.

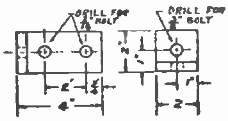


FIG. 5

For the vertical sections, the two 15 inch sections are drilled and cut as shown in Fig. 6 with half-inch holes and one is attached by means of an angle iron to the 30 inch base. The other upright is placed into the center of the 12 inch section in a hole 1 x 3 inches cut to admit it and is then attached by bolts or screws to the two 8 inch sections (making a 19 inch base) on either side of the 30 inch piece as in the end view of Fig. 6. As illustrated in Fig. 7, this entire section slides along the 30 inch base.

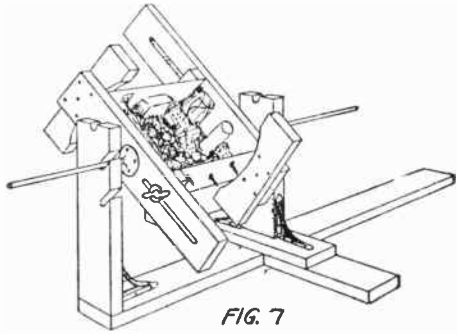


FIG. 7

Each end of any radio chassis in turn is placed over the edge of the work bench and the curved end of the T bar is fitted to one vertical edge. The clamp section and wing nut are moved up firmly against the other vertical edge of the chassis and the wing nut is tightened. The movable vertical section is then moved to embrace the two projecting gas pipe end pivots and the entire assembly is hung in the frame as in Fig. 7 at the desired height. The chassis may now be rotated to any position for easy accessible servicing.

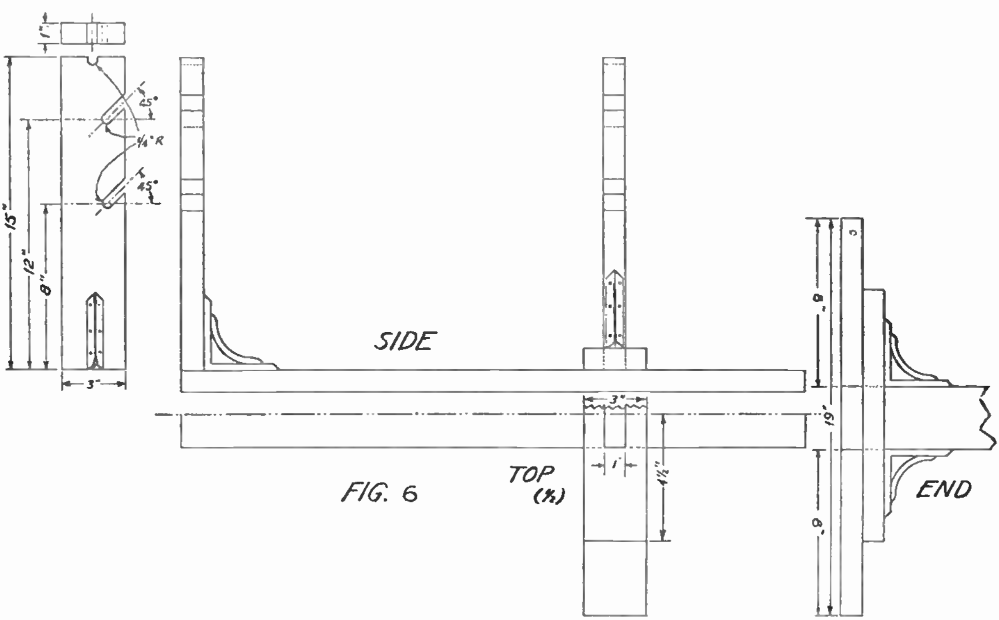


FIG. 6