INSTALLATION AND SERVICE OF AUTO RADIOS AND FARM RECEIVERS

44RH-1

NATIONAL RADIO INSTITUTE

ESTABLISHED 1914

WASHINGTON, D. C.

PIONEER HOME STUDY RADIO SCHOOL

NRI

STUDY SCHEDULE NO. 44

For each study step, read the assigned pages first at your usual speed, then reread slowly one or more times. Finish with one quick reading to fix the important facts firmly in your mind. Study each other step in this same way.

☐ **1. Radio Operation in Automobiles ------------ Pages 1–4**

Auto sets must be designed particularly for operation under the conditions found in cars. They must have high sensitivity, be compact and sturdy, and must be carefully shielded and filtered to keep down the interference level. A discussion of the sources of interference is given, as this has an important bearing on the installation and repair of auto sets.

☐ **2. Installing Auto Sets ------------------ Pages 4–15**

The various types of auto sets, aerials and controls are described, then the proper installation and connection steps are described.

☐ **3. Eliminating Ignition Interference ------------ Pages 16–25**

All eliminating steps are covered, in the order of their importance. Bypass condensers, suppressor resistors, bonding and shielding are all used for interference reduction. A step-by-step localization procedure is given to assist in running down the noise.

☐ **4. Servicing Auto Radios ------------------ Pages 25–34**

How to service auto sets in the car and on the workbench. Vibrators and vibrator circuit troubles, as well as auto set peculiarities, are covered here.

☐ **5. Farm Radio Receivers ------------------ Pages 34–36**

A description of a typical vibrator-powered farm radio and service hints for this kind of set.

☐ **6. Answer the Lesson Questions and Mail your Answers to N. R. I.**

☐ **7. Start Studying the Next Lesson.**

NPC6M149 1949 Edition Printed in U. S. A.

INSTALLATION AND SERVICE OF AUTO RADIOS AND FARM RECEIVERS

Radio Operation in Automobiles

AS FAR as their wiring diagrams show, the use of a vibrator power supply and special filters in the power leads is all that distinguishes the average automobile receiver from the average home radio. But actually, because of the unusual interference and sensitivity conditions it must meet, and because of the physical requirements imposed by use in an auto, the car receiver is a far different set. You must take these special conditions into consideration when you install or service an automobile radio—so let's see, briefly, what they are.

Sensitivity Requirements. The antenna of an automobile radio must, of course, be small and is quite close to the ground. As the antenna effectiveness varies directly with size and height, this means the amount of signal pickup is small, so the sensitivity of the set must be high.

Also, as one drives on the roads between cities, it is desirable to be able to pick up signals from favorite stations as long as possible, or to be able to pick up the stations in the next town as those in the last one fade out. (This is particularly important to truck drivers and salesmen who depend on the radio to relieve the monotony of driving.) Again, high sensitivity is required.

Hence, auto sets use high Q coils and high-gain circuits. Some even introduce a certain amount of regeneration to increase the sensitivity further. Most auto sets have an r.f. stage ahead of the first detector to raise the weak signal input to the point where first detector noise is less of a problem.

► Further, as the car is driven around, the receiver may be at one moment in an area of good reception—the next instant in a section where signal strength is tremendously reduced by some shield (the steel framework of a building or a bridge, overhead trolley wires, etc.)—and, a few seconds later, back in a good reception area. The set must have sufficient reserve sensitivity and a fast-acting a.v.c. network (one with a short time constant) so it can minimize the effect of variations in signal level.

Physical Requirements. Besides having high sensitivity, an auto receiver must be compact, so it can be installed out of the way of the driver and car occupants, and must be rugged to withstand road shocks and bumps. Its controls must be easy to reach and use. And, since the set must operate from an already heavily-loaded car battery, it must draw as little current as possible.

Interference. An auto set must work in the middle of a "hot-bed" of the worst kind of radio interference, caused by the automobile ignition system. Special shielding and filter devices must be used to produce good reception without interfering greatly with the operation of the car or the radio.

► After the auto radio set is designed, there remain three problems: *1,* its installation; *2,* suppression of interference; and *3,* radio servicing. The interference problem affects the other two, as the set must be installed so as to pick up a minimum of interference, and you must recognize the differences between interference and radio troubles for proper servicing. Therefore, as an important first step in your study of auto receivers, let's learn just what can cause radio interference in cars.

LOW-VOLTAGE CIRCUITS

The electrical parts of an automobile, including the starter motor, the ignition system, lights, electrical gauges, heater, etc., all operate from the car battery.

The battery is a 6-volt storage battery in all modern pleasure cars and in most trucks. This storage battery is rather heavily loaded, particularly by the starter motor. As the battery is essential for the car's operation, it must be kept charged, so a generator driven by the car engine is used for this purpose.

Fig. *1* shows what is called the "low-voltage circuit" of a car, including an ammeter *M* (mounted on the instrument panel) that keeps track of conditions in the circuit. The meter has zero at the center of its scale and can deflect either to the left or to the right, depending on the direction of current flow. One side of the scale is called the "discharge" range, the other the "charge" range. A meter reading in the discharge range indicates that the battery is supplying more currrent to the car's electrical components than it is receiving from the generator, while a reading in the charge range shows that the generator is supplying all the current required by the electrical circuits plus an extra amount that is being stored in the battery.

The Cutout. Before the car engine starts to run, the generator must be disconnected from the battery to prevent the battery from discharging through the generator winding. The cut-out (see Fig. *1*) does this. The cut-out is a relay which remains open until the voltage across its operating coil L_1 (that is, the generator voltage) rises to a little more than 6 volts. When it does, the relay closes its contacts and connects the generator across the battery, making the connections through coil L_2. Since the generator voltage is higher than the battery voltage when this connection is made, current flows from the generator into the battery through coil L_2. If the speed of the engine slows down enough so that the generator voltage falls below that of the battery voltage, the battery will start discharging through the generator and the direction of the current flow through coil L_2 will be reversed. This coil then forces the cut-out to open, and it will remain open until the voltage of the generator rises enough for coil L_1 to close it again. Thus, the generator is connected to the battery only when the generator voltage is higher than the battery voltage.

Many cars also have voltage-regulating relays, which close only when the generator gets to the right voltage and will put a resistance in series with the circuit if the generator voltage exceeds a safe amount.

Interference Sources. The generator causes most of the radio interference produced by the car's low-voltage circuit, because of the arcing and sparking which is bound to occur between its brushes and its commutator. As dust and oil collect on the commutator, the sparking becomes worse.

The cut-out may cause a clicking sound as it operates, but this is not usually troublesome. The oil, gas and other indicating circuits are usually resistive in nature and rarely cause trouble unless poor contacts develop in their circuits. However, if the heater has a motor-driven fan, the fan motor commutator and brushes may cause disturbances. Of course, a poor contact anywhere in the low-voltage circuit may cause arcing and so produce radio interference.

When the storage battery is well charged and in good condition, it acts like an extremely high-capacity condenser across this circuit. In other words, it tends to bypass noise ripples by holding the circuit voltage steadily at the battery voltage value. If a poor connection develops at the battery, or if the battery is run down or defective, this action is lost and the amount of interference will rise to rather high levels.

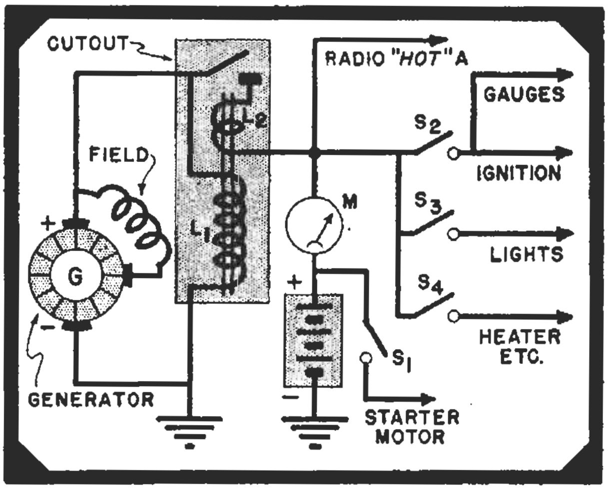


FIG. 1. The low-voltage wiring system of an automobile. The return circuit is through the car chassis, as shown by the ground symbols.

THE IGNITION CIRCUIT

The amount of interference caused by the low-voltage circuit is relatively immaterial compared to that which comes from the ignition circuit. A typical ignition circuit is shown in Fig. *2*.

As you probably know, the spark plugs which ignite the gasoline-air mixture in the cylinders of a gasoline engine must be fed rather high voltages to produce the hot, high-intensity sparks needed to cause proper combustion. Voltages up to 5000 volts are common.

A cam-driven switch — usually called a "breaker"—and a voltage step-up transformer are used to obtain such high voltages from the 6-volt battery. The switch (S_2 in Fig. *2*) is opened very quickly and closed somewhat more slowly, by a cam driven mechanically by the car engine. When switch S_1 (the car ignition switch) is closed and the engine is running, the high-speed opening of switch S_2 causes abrupt changes in the current flowing in the primary circuit of transformer T and so induces a high voltage in the step-up secondary winding of the transformer.

Since the spark plugs in the various cylinders must be fired or ignited in a definite sequence to produce proper engine performance, the secondary of transformer T is connected to the spark plugs by a rotating switch, called a distributor, which is geared to the engine crankshaft. The distributor arm and the primary breaker are geared together so that each time the primary circuit is interrupted, inducing a voltage in the secondary, the distributor rotor arm is at the proper contact to deliver the high-voltage surge to one of the spark plugs.

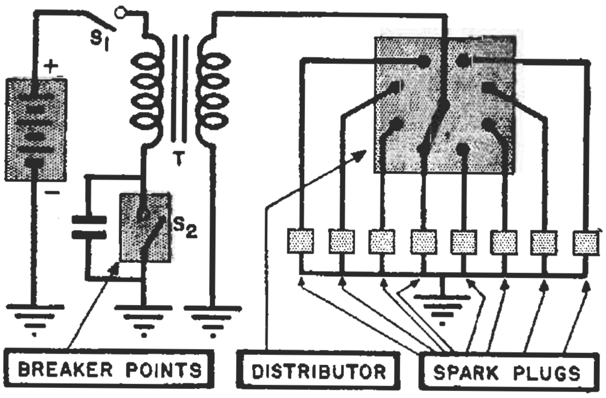


FIG. 2. The high-voltage ignition circuit.

► Thus, there are three arc sources in the ignition system which will produce noise surges whenever the engine is running—the breaker contacts, the distributor contacts and, of course, the spark plugs themselves. (A condenser is connected across S_2 to reduce the amount of arcing here, but even so the primary current surges are sharp, noise-producing pulses.) These surges are fed directly to the radio through its power supply lead, since both the radio and the ignition circuit are connected in parallel across the battery. In addition, and even worse, these sharp pulses and those produced in the secondary circuit cause radiation of noise energy from the ignition wiring itself.

In modern cars the low-voltage wiring is separated from the ignition wiring as much as possible, to prevent disturbances radiated by the ignition wiring from being picked up by the low-voltage wiring and carried about in the car. Some cars even have the ignition wiring in shielding compartments.

In addition, the modern car body is all metal and if the hood over the engine is in good contact with the car body, the engine compartment is rather well shielded. This helps greatly in cutting down the amount of radiated interference.

STATIC DISCHARGES

In spite of the best efforts of the car manufacturer, poor contacts will develop eventually between the car body and chassis and between various pieces of metal in the car. As the car runs, friction between various parts builds up charges of static electricity, which may discharge around these poor contacts (or to the road) and cause interference radiation. We will take up this subject in more detail in a later section of this lesson, where you will learn the various ways of eliminating interference. Right now, since you know how interference can be developed, let us go on to the subject of installing the receiver in a car.

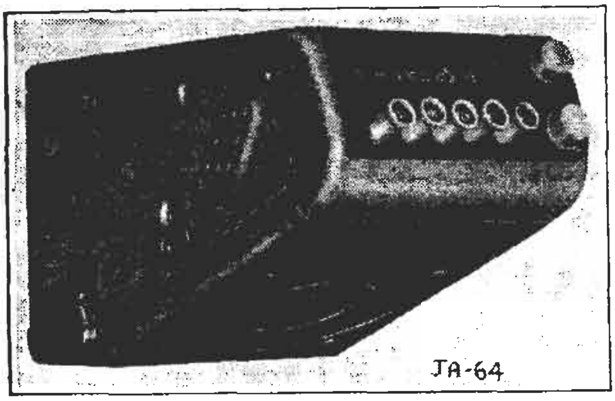
Installing Auto Sets

Installing auto radios tends to be a rather specialized branch of radio work which many servicemen do not attempt. Whether you should take it up depends on the number of probable jobs, your mechanical inclinations, and the facilities available. However, even if you do not intend to install car radios, you must know how they are installed and connected so you can get them in and out of the car for service—so let's run through the procedure.

► First, you need a place to work and a few tools. Most auto radio specialists either work for car dealers or operate from a garage. "Drive in" facilities help you work conveniently and safely on the car's ignition system or on the job of installing or servicing the radio.

► For tools, you will need an electric drill or a breast drill of good quality for drilling holes to mount the antenna and receiver. You should use high-speed, good-quality steel bits, and you will need a center punch. An adjustable end wrench or a set of assorted end wrenches in sizes up to ¾-inch will complete your collection of special tools.

► As the installation must not interfere in any manner with proper operation of the auto, you'll be wise to have an auto mechanic help you on the first few jobs if you are not too skillful about cars yourself. However, the instructions furnished with



Courtesy General Electric

FIG. 3. A standard single-unit auto radio.

new sets are quite detailed and can be readily followed. The next section of this lesson gives general information which will help you get started properly.

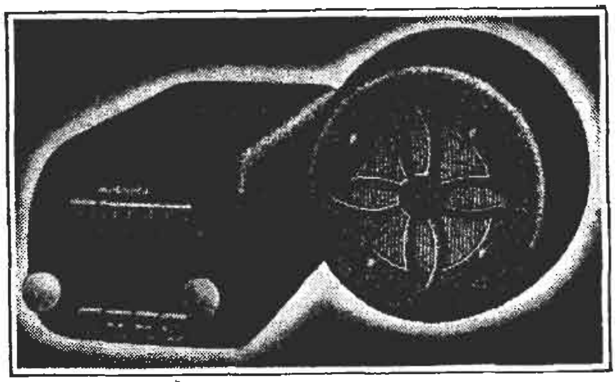
SET TYPES

Modern automobile receivers divide automatically into two general types. One type is a general-purpose radio (available from radio supply houses or distributors) which can be mounted in almost any automobile by providing the proper mounting facilities. The other type is a custom-built set, made for a particular make and model of car, and usually sold by the distributor for that car. The majority of both types are single unit radios like that shown in Fig. 3. All early models, and some present ones, have separate speakers (see Fig. 4). Better tone quality is claimed for these latter by their manufacturers. However, space limitations often force the choice of a model with a built-in speaker.

The exact method of mounting will depend on the type of set and the provisions in the car for the radio controls.

Many custom-built receivers are compact models designed to mount in a space behind the dash or instrument panel itself, so that their controls protrude through an aperture in the instrument panel. In such cases the controls are a part of the radio itself.

If the receiver is not custom-built, it will probably be mounted high behind the instrument panel. It may have extended controls which come out underneath the instrument panel at a convenient location, or may be provided with a remote control system. Usually, in the latter case, the control head will be mounted in an opening in the instrument panel, or even mounted on the steering wheel column, and flexible cables will be used to operate the receiver from this control head. Commonly, such remote controls will operate the receiver



Courtesy Motorola

FIG. 4. An auto set with a separate speaker.

tuning condensers, on-off switch and volume control. Sometimes the tone control will also be operated from the control head, but more often it will be right on the receiver cabinet.

Remote control heads designed to be mounted as a part of the instrument panel of a car are usually available in several styles to allow selection of a head which will blend in nicely with the other instruments of the car involved and will fit the space allotted for this purpose. Therefore, anyone buying an auto set should be sure to specify the make, model and year of the car in which it is to be used, so he will be furnished with the proper matching control head.

Whenever you undertake to install

an auto set, be very certain to read carefully all instructions furnished by the manufacturer. The receiver manufacturers furnish very complete installation data and, if you follow them carefully, you will usually experience little trouble. Before starting, check the material you received to be sure you have the correct control head for the particular automobile.

POLARITY

Before installing the radio, check the set diagram and read the manufacturer's instructions carefully to see if polarity matters. If the set is modern and has a *tube rectifier*, polarity will not matter at all. On the other hand, if the set uses a *synchronous vibrator* (which acts as a mechanical rectifier), *polarity is important*. The following thus *applies only to sets using a synchronous vibrator*.

The storage battery must be connected to the car generator with such a polarity that current will flow in the proper direction for charging. Therefore, the polarity of the generator (which may be different in different cars) determines which terminal of the storage battery can be grounded to the car frame, and determines the connections of the electrical equipment. Hence, the storage battery polarity will differ in different cars, having the negative grounded in some cases and the positive grounded in others.

► If the receiver is designed for a particular make and model car, it probably will be already adjusted for the polarity found in that model. However, if the receiver is a universal type which can be used in any car, you may have to make this adjustment. To do so, determine from the manufacturer's instructions the polarity used in the car in which you are interested. If the car is not listed in your service information, check the polarity by measuring with a voltmeter between the car frame and one of the terminals on the ammeter. Reverse the test probes if necessary, until you get an up-scale deflection of about 6 volts. If the negative probe of the voltmeter goes to the car frame, the negative battery terminal is grounded (and vice versa). With that information, you can proceed to make the required adjustments on the receiver.

SET INSTALLATION

Before making an installation, try the receiver on your workbench—because even a new receiver can be defective. (Details on how to do this will be given when we take up receiver servicing.) If the receiver operates properly, and you have the proper control head for the particular make and model car, you can now proceed with the actual installation.

Study the recommended positions for mounting the receiver. Usually there will be several possible positions, but your choice may be limited by the fact that a heater or some other accessory has been mounted so it will interfere with one or two of them. Other things being equal, you should, of course, choose the position in which installation is easiest.

The exact mounting of the receiver will depend on its type. The kinds which mount up behind the instrument panel are frequently rather easily mounted on a bracket assembly furnished with the receiver. Another type has bolts on the back of the receiver which are used to secure it to the fire-wall (the partition separating the engine compartment from the driver—it is also sometimes called a bulkhead or dash). With still another type, a mounting plate is mounted on the fire-wall and the receiver is hung on the plate.

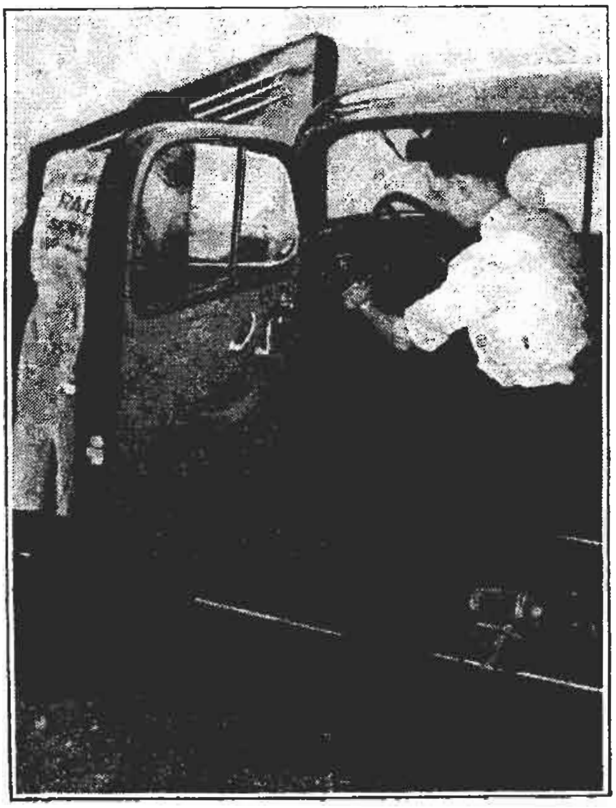
► If the radio is to be mounted on the bulkhead, a drilling template will usually be furnished. This consists of a piece of cardboard about the size of the back of the radio, marked with the location of the holes to be drilled. If a template is not included, make one. To do this, get a piece of cardboard about the size of the back of the radio. Place the radio with the bolts facing upward, put the cardboard on top, and press it against the bolt ends. Then draw small circles on the cardboard around the end of each bolt, thus showing the bolt size and its location.

Move the template to the recommended position in the car and use it as a guide for making the mounting holes in the fire-wall. If dimensions for mounting are given, use a ruler to check the accuracy of your positioning of the template. Then, as a further check, open the hood and examine the fire-wall on the engine side to be sure no ignition coil mounting, vacuum tank or similar object is in the way of the installation. You should also make sure there is enough room for the receiver in the position chosen, particularly if it is one of the bulkier sets.

Mark the location of each hole by driving a steel center punch through the center of the bolt-locating circles on the template. The punch will both mark the steel fire-wall satisfactorily and provide a slight indentation which will help prevent the drill point from slipping. Since the fire-wall is usually rather tough steel, it will be hard to drill unless you use high-grade drills which are in good condition.

► If the speaker is separate, its location should be determined in a similar manner. Usually the speaker is held by a single bolt, so only one hole is necessary. Be careful to choose a position where the speaker will be well out of the way of the feet of passengers in the front of the car, and check again on the engine side of the fire-wall to be sure you will not drill into some vital part of the car.

After the bolt holes are drilled, sandpaper, scrape, or file the area around them on the engine side of the fire-wall so the washers or nuts will make a good ground to the fire-wall.



Two men working together make installation easier, particularly when mounting the set.

► If the mounting bolts are on the back of the radio, you will need a helper. One of you must hold the set in position and force the bolts through the fire-wall, while the other must place the washers and start the nuts on the bolts after they have come through. Tighten these nuts, with an end-wrench or heavy pliers, enough so they will not loosen even when jarred by the car travelling over rough roads. Be very sure that a good contact is made to the fire-wall, because the electrical circuit from the grounded side of the storage battery must be completed through the frame of the car and through the fire-wall to the radio.

If a mounting plate is used, hold it in position and force the bolts through the holes. This plate will usually stay in place while the nuts are started. Draw the plate tightly into position by tightening the nuts, then hang the receiver on the hooks provided on the mounting plate.

Remember, complete instructions are furnished with all new receivers. *Read them carefully.*

ANTENNA TYPES

Once the receiver is mounted, the next step is usually installation of the

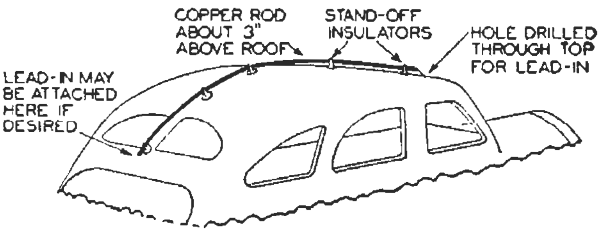


FIG. 5. An antenna mounted on top the car.

proper aerial. The kind of aerial used depends upon the recommendations of the receiver manufacturer and the desires of the set owner. Many automobiles have provisions for certain special types of antennas.

Top Types. A very satisfactory aerial could be had in early cars by connecting to the wire mesh in the fabric top of the car. The all-steel tops of modern cars has made this impossible but, since the roof is an ideal location—as it lets the antenna be fairly high and well away from most interference sources—a number of different antennas have been developed to go on top of the car. A typical one is shown in Fig. *5*. Several more decorative types have

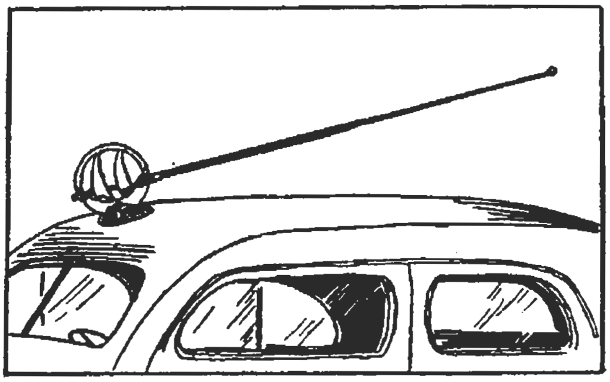


FIG. 6. A typical modern top-type antenna.

been developed, like those shown in Figs. *6* and *7*.

The antenna shown in Fig. *7* may be rotated by a knob within the car so that it is in a downward position in front of the windshield. This more or less removes it from sight and safeguards it from low obstructions, such as overhanging tree limbs. The pickup in this position is sufficient for local conditions. When increased pickup is desired, the knob is turned to bring the antenna to an upright position above the top of the car. Often, antennas of this type are extensible (can be made longer, with one section telescoping within

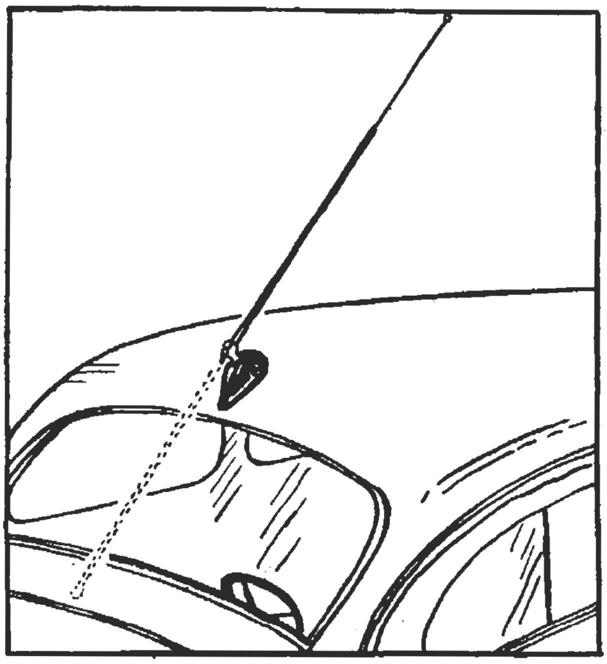


FIG. 7. This antenna is raised for distance reception. It can be turned down to the position shown by the dotted lines if only locals are desired.

another). Some have to be pulled out by hand, while others operate from the knob within the car.

You may wonder why antennas are made so that their lengths can be changed. In cities, the signal strength is usually high enough so that a relatively short antenna will give sufficient input energy for the modern high-sensitivity auto set, so you can make the antenna practically invisible when driving about town. However, as you go out on the road and get away from stations, increased pickup is necessary. Here, a longer antenna is quite helpful.

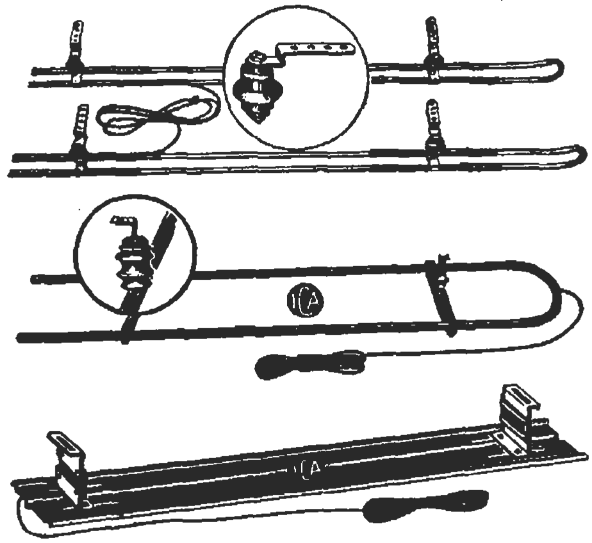


FIG. 8. Several typical antennas intended to mount under the car's running board.

Under-Car Types. Fig. *8* shows several different types of under-car antennas which are designed to be mounted under the running board. A number of others have been used which run between the axles.

These under-car antennas are subject to breakage when the car runs against the curb or strikes obstacles in the road; they speedily become fouled with dirt, and they are in a poor location insofar as noise pickup is concerned. Brake and wheel static, and interference carried by the low-voltage wiring under the car, are picked up more readily with the antenna in this location. A more thorough interference elimination procedure is always required for such antennas. In some cars, it is impossible to eliminate interference enough to use them. However, they have proved quite popular with car owners who do not want the antenna visible.

► Some car manufacturers, realizing the desire of the customer to conceal the antenna as much as possible developed cars with insulated running boards which could be used as an aerial in a manner similar to the regular running board antenna. In some of these cars, all you need do is attach a shielded lead-in to the running board. Such an aerial has mechanical advantages over the other under-car types, but it is still subject to considerable interference, especially when out-of-town reception is desired.

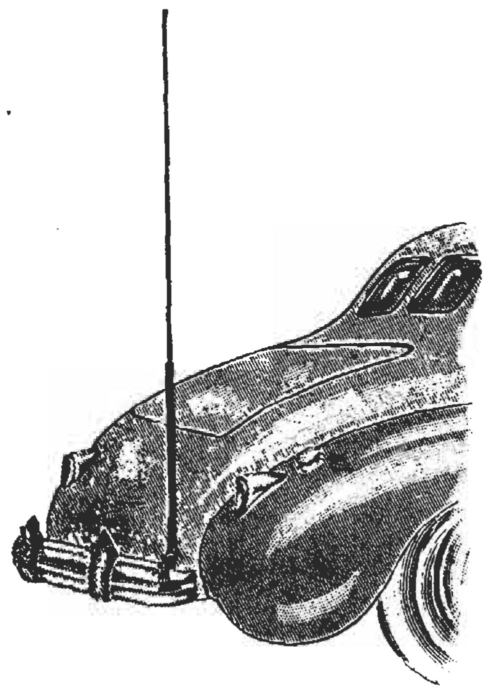


FIG. 9. A rear bumper whip-type antenna.

Bumper and Cowl Types. The whip antenna, which mounts on the rear bumper of a car (Fig. *9*) can be extended to be six or eight feet long and gives rather good pickup. Its length and appearance do not add to its popularity, however.

Today, the antenna mounted on the side of the cowl is by far the most popular. There are many types, one of which is illustrated in Fig. *10*. Such an antenna gives a reasonable amount of signal pickup and is so positioned that only a relatively short shielded lead-in wire is necessary from the antenna to the receiver. The antenna

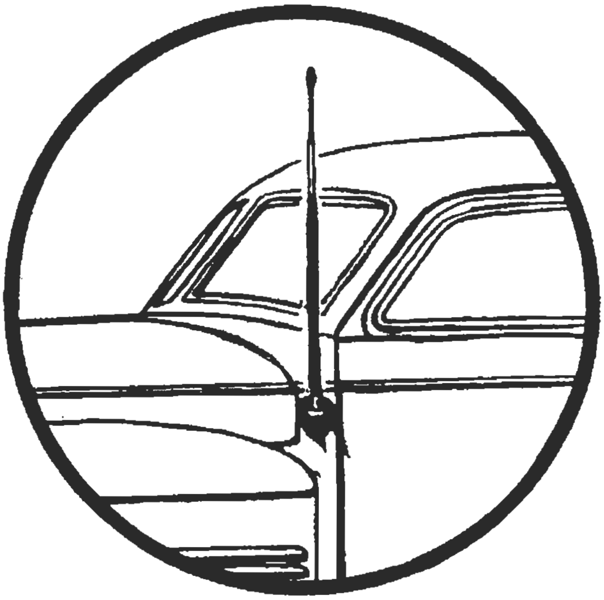


FIG. 10. A side-cowl mounting.

is made from hollow sections which fit inside each other and can be pulled out to increase the effective length.

Some cowl antennas are mounted on brackets which are placed under the edge of the hood, while mounting others requires the drilling of two holes. Typical examples are shown in Figs. *11* and *12*.

► Some antennas are made even more inconspicuous by being mounted so they disappear into the cowl or fender. Fig. *13* shows an installation in which a hole is drilled through the cowl and the antenna is mounted in a tube inside the car. Some antennas of this type are manually extended, while others are operated by compressed air obtained from the engine. Fig. *14* shows a fender-mounted type.

These antennas are popular because they are out of sight except when extended and are "gadgets." They must be mounted carefully, however, to prevent a leak from developing around the seal.

► You have probably noticed a knob or ball on the end of all auto radio antennas. This knob is not just a decoration. Any pointed object which can collect static electricity, such as a pointed antenna, will have a large discharge from its end and this discharge will cause noise. The amount of discharge is reduced if a ball is put at the end of the antenna. Remember this, because a missing ball

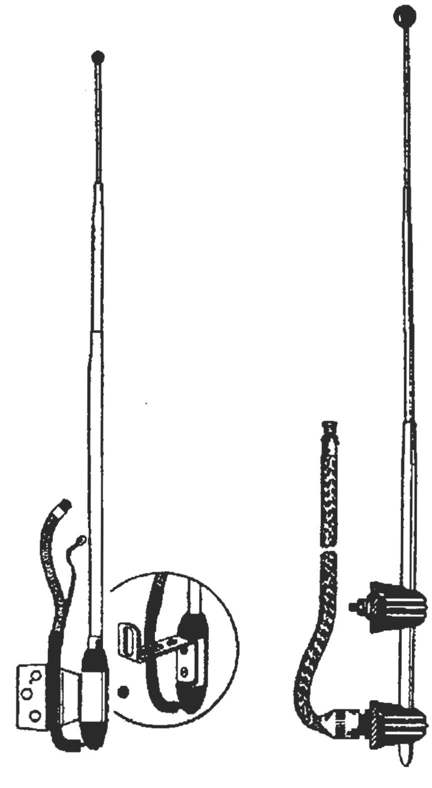


FIG. 11. FIG. 12.

Two more side-cowl types. One uses a replaceable bracket mounting, while the other requires two holes for mounting.

may cause an unusual static-like noise, heard only when driving around.

Lead-in. All auto antennas require a shielded lead-in wire, which may come with the antenna or may have to be purchased separately. *Always keep the lead-in short.* Run it as directly as possible to the radio,

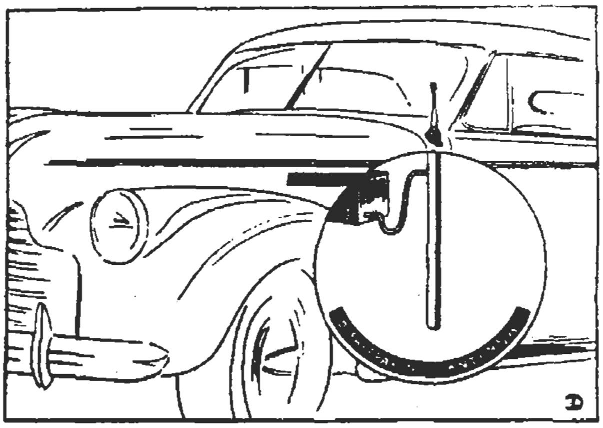


FIG. 13. A disappearing side-cowl type, which can be extended for distance reception.

but keep it away from the auto electrical wiring as much as you can, and of course keep it away from brake pedals or control rods so as not to interfere with the car operation. Remember—even a shielded lead-in will pick up interference if it passes through a high-noise zone.

The shield will ground through the coupling at the radio, but the other end must also be grounded *as close as possible* to the antenna. You may have to drill an extra hole, clean an area about it, and use a bolt or self-tapping screw to provide a good ground connection. Since this ground is sometimes hard to make, careless installation men frequently omit it—and so make the interference problem worse. Remember to check for a poorly made shield ground if the antenna or lead-in picks up interference.

CONTROLS AND CONNECTIONS

After the receiver and antenna have been mounted, you must mount the controls of the receiver. As you've learned, these controls may be a part of the receiver and require no further attention. On the other hand, you may have a remote control which mounts on or underneath the instrument panel of the car, or on the steering column. In addition, some models have separate sensitivity or tone controls which have to be mounted.

The correct method of mounting the control head is usually obvious, but you should again follow the instructions furnished with the head.

Once the controls are mounted, you are ready to connect the radio. You will have the "hot" A lead, antenna connection, control head cables, and possibly speaker connections, to make. Usually a picture like Fig. *15* or *16* will be included in the installation instructions, so there is little chance for error in making the connections if you follow the instructions carefully.

Control Cables. If the set has a control head, it will have flexible cables to drive the tuning condenser

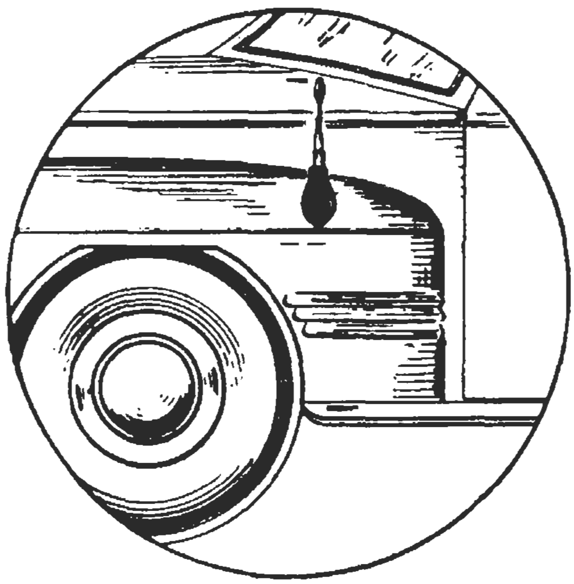


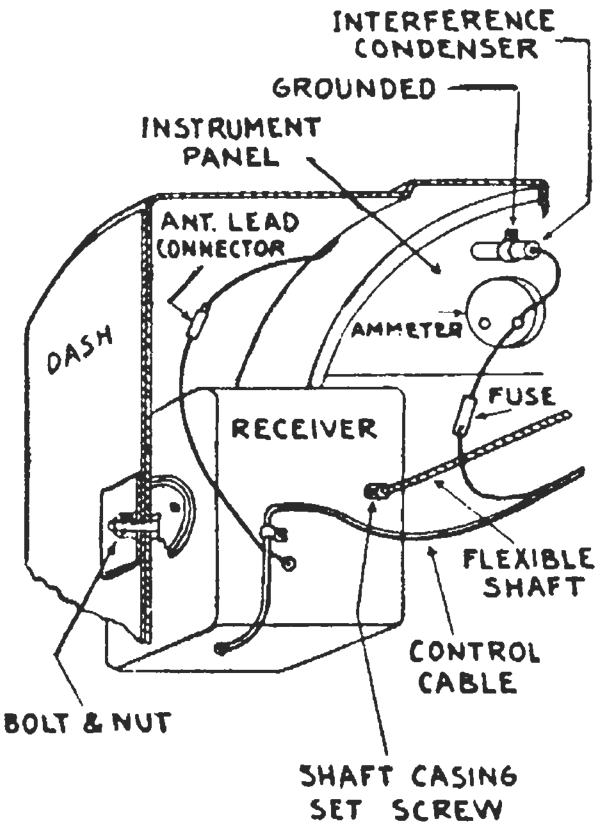
FIG. 14. A disappearing fender-mounting antenna.

and volume control from the remote position. The correct plug-in terminal for each of the control cables must be located by studying the instructions.

The control cables from the control head must be run to the receiver with a minimum of bending or kinking of the cable. Allow the cable to make wide radius turns when it must go around a corner. If you make a sharp bend, the cable will bind inside its housing and will not operate properly.

Of course, these cables must not get in the way of the driver or interfere with any of the control rods coming to the instrument panel.

The control cables plug into sockets on the case of the set. Some are locked in by turning the cable housing a quarter or half turn to engage locking ears in the case; others are anchored by set screws. Before locking into position, be sure the cable it-



Courtesy RCA

FIG. 15. Typical mounting and connecting diagrams, such as you can expect to be with a new auto set.

self is engaged properly. Most have slotted end fittings which slip inside a sleeve and fit over a projection as in Fig. *17*. The control knob should be rotated until the fittings connect together before locking in the cable housing.

► When the control cables have been engaged with the tuning condenser and volume control mechanisms, you must synchronize the tuning dial with the actual rotation of the tuning condenser gang. Some models have a slip mechanism. With these, rotating the tuning control first to one end of the tuning condenser range, then to the other end of the range, will "slip" the dial pointer so that it will indicate correctly. On other models, you must release the dial mechanism by turning a set screw, rotate the shaft until the tuning condenser is at one end of its rotation, set the dial pointer to the proper end of the range, and tighten the set screw. Consult the manufacturer's instructions if you have any doubt as to the method used.

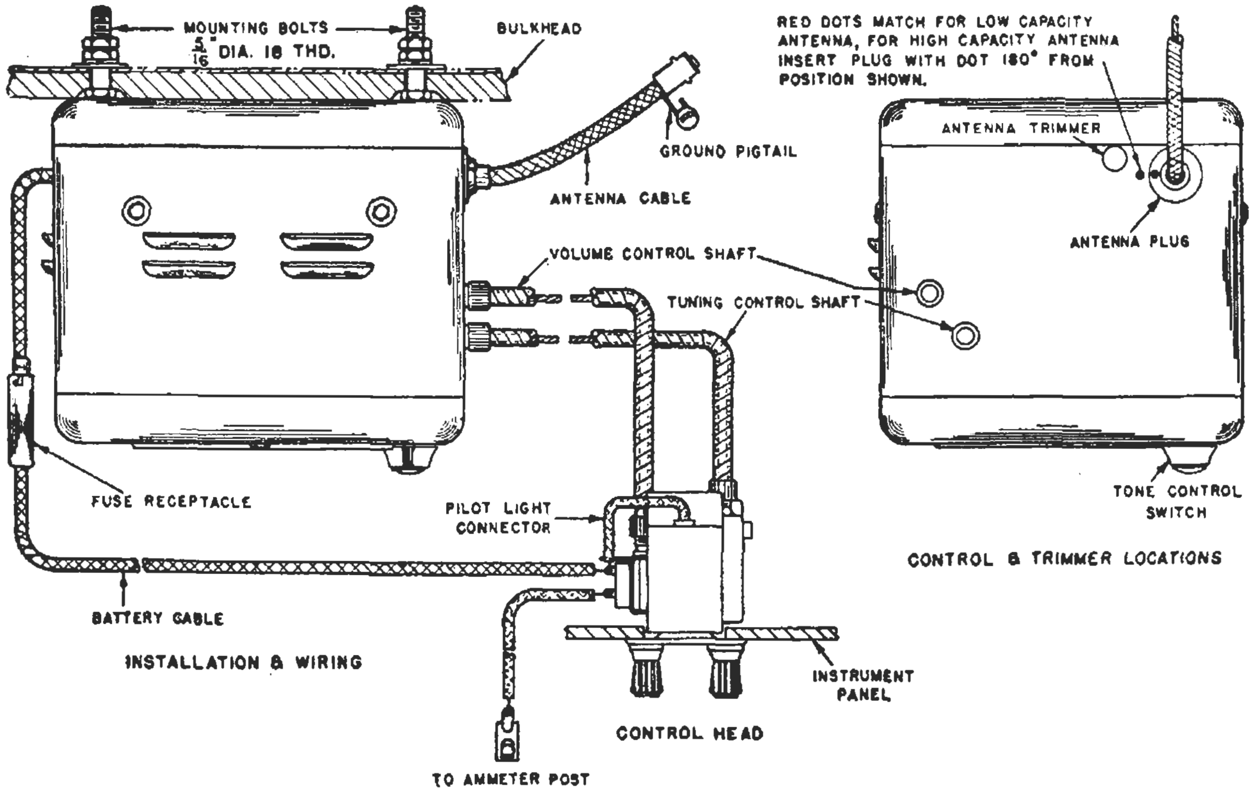
► In addition to the control cables, some control heads will have pilot light leads or other connections which have to be identified from the manufacturer's instructions.

Speaker Connections. If a separate speaker is used, plug in its connections at this point in the installation. There will be a terminal board or a socket-and-plug arrangement for this.

Antenna Connections. Some receivers have sockets for plugging in the antenna lead-in, while others use a short lead and a coupler. Be careful about the latter—it may look like the storage battery lead. However, the antenna will *always* be shielded, and the connector is usually a short affair, frequently with a fastening clamp like the one in Fig. *18*.

Some receivers have two plug-in receptacles for the antenna lead, or a special reversible antenna connector. This is provided to compensate for the widely different capacities of auto radio antennas.

Antennas which mount close to the car body have a very high capacity between themselves and the frame of the car, so the antenna transformer must be of special design. Other antennas which are held away from the body of the car do not have such high capacities. Therefore, so that the re-



Courtesy General Electric

FIG. 16. Another example of mounting and connecting instructions. Notice the figure at the right shows how the antenna capacity is adjusted.

ceiver can be used with either type with equal satisfaction, you will sometimes find both high-capacity and low-capacity terminals provided on the set. Follow the manufacturer's instructions as to which terminal or method of plug-in should be used. Note that Fig. *16* shows one arrangement for adjusting the antenna capacity.

One manufacturer uses a tubular condenser which fits in the antenna connector to reduce the capacity of a high-capacity antenna. Be sure not to confuse the antenna connector for this type with a fuse holder, which it closely resembles.

Battery Lead. To provide power, the battery lead (called the "hot" A lead) of the receiver must be connected somewhere to the ungrounded side of the storage battery circuit. (The other half of the power circuit is completed through the set mounting bolts to the frame of the car and thus to the battery.) The terminals of the car ammeter (which is mounted on the instrument panel) provide a convenient mounting point for this A lead from the receiver. You should connect to the ammeter terminal which does not connect directly to the battery, so the discharge produced by the radio will appear in the ammeter indication.

Sometimes connecting at the ammeter will allow a considerable amount of interference to be fed into the receiver. If so, run the A lead from the receiver directly to the storage battery. As you've learned, a storage battery in good condition acts as a large condenser, so a minimum of

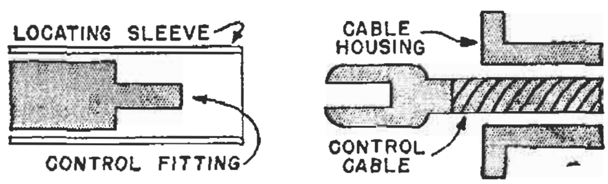
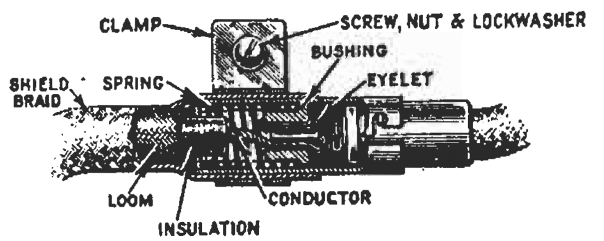


FIG. 17. How the control cable is engaged within the radio.

interference will be found directly across the storage battery itself. Once in a while you'll find interference can be reduced by running a ground lead from the radio case to the grounded terminal of the storage battery.

The battery circuit is completed by placing a fuse in the holder (Fig. *19*). Use a 10- or 15-amp. auto fuse. Some servicemen use a 20- or 25-amp. fuse



ANTENNA CONNECTOR

FIG. 18. The antenna connector is longer in diameter than a fuse holder and is in the shielded antenna lead.

because they happen to have it, but this is bad practice—it does not sufficiently protect the radio.

Tuck the A lead and lead-in up behind the instrument panel, out of sight and out of the way. Fasten them with tape if there is any chance of their falling down in the way.

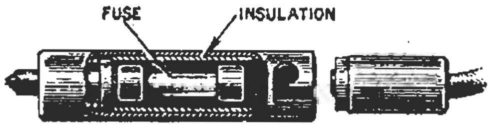
CHECKING THE RECEIVER

Now, with the receiver installed, you are ready to try it and make the necessary adjustments for best operation.

Since you have not yet suppressed the interference (we will take this up later in this lesson), do not have the engine of the car running when you try the set. Turn on the receiver and tune to the frequency of some local station. Check the operation and calibration of the tuning dial, and make sure the volume and tone controls work properly.

After assuring yourself that the set is working, locate the antenna trimmer from the manufacturer's instructions. In practically all cases, this trimmer is so placed that it can be adjusted on the outside of the radio to compensate for the effects of the particular aerial used. In some instances a small cover may have to be snapped out of the side of the set, or unscrewed, to reach the trimmer. Once you've located it, tune in a signal at the frequency indicated in the manufacturer's instructions and adjust the antenna trimmer for maximum output. Some are adjusted for maximum at the low-frequency end of the band while others are adjusted at the high-frequency end.

Push-Buttons. Many modern auto sets have push-buttons, which may be mechanical, electromechanical, or electrical. In general, the method of



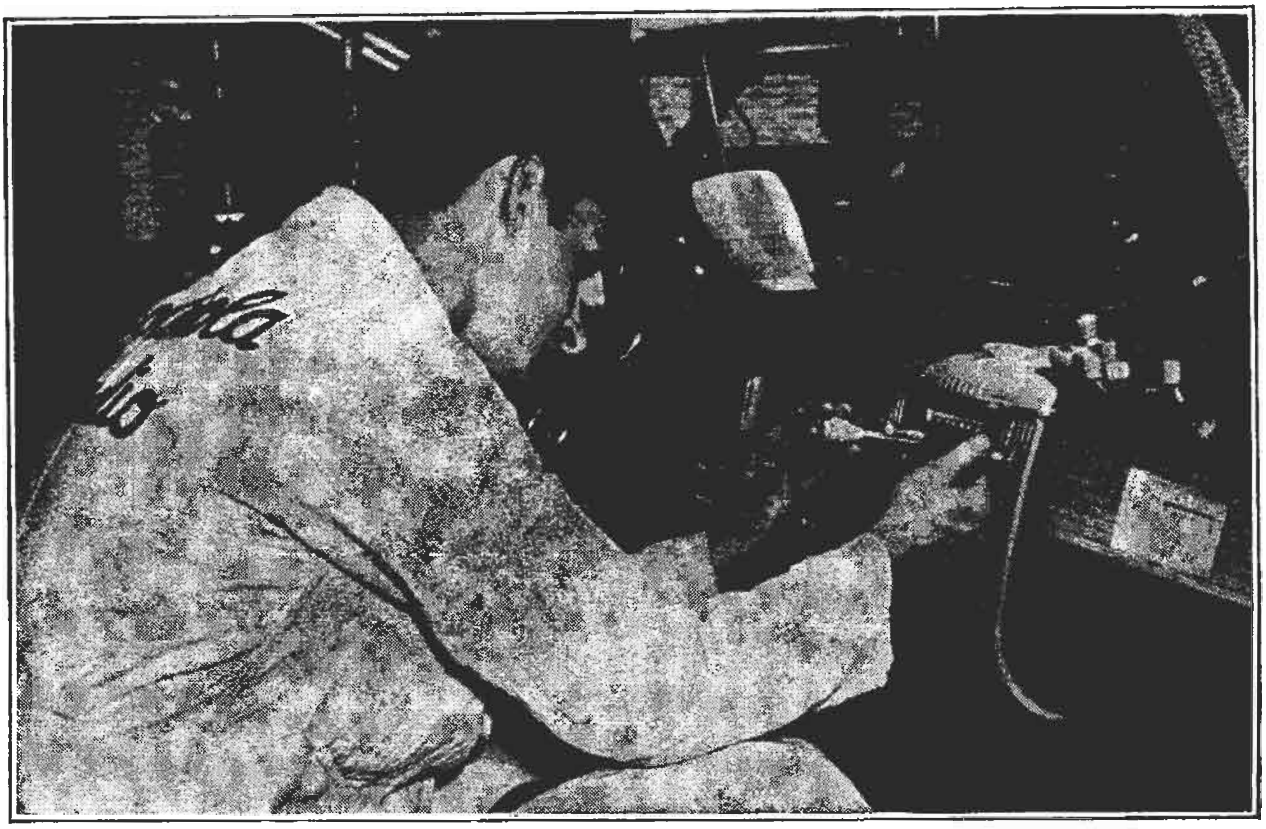
FUSE RECEPTACLE

FIG. 19. The fuse holder can be recognized by its shape and by being in the A lead.

setting the push-buttons will be the same as that for a home receiver (given elsewhere in this Course). Of course, you should refer to the manufacturer's instructions to make this adjustment in the quickest possible manner.

ADJUSTING THE GENERATOR CHARGING RATE

The radio represents an additional drain on the storage battery of the car. Since the battery is already heavily loaded in many cars by defrosters, lighters, lights, electric oil and gas gauges, heaters, clocks, etc., it is sometimes necessary to advance the charging rate of the generator. This is particularly true if a great deal of night driving is done—especially in wintertime, when the engine



Setting mechanical push-buttons after the installation.

is hard to start, and the consequent longer use of the starter motor puts a severe extra drain on the battery.

The charging rate should not be made so high that the battery is overcharged, however; the usual range is up to 15 or 20 amperes. Here again, the advice of a good auto mechanic will be helpful.

Some cars have automatic means of adjusting the charging rate, but in most cases it is necessary to adjust the third brush on the generator. If you remove the commutator cover, you will see this third brush located between the two main brushes—in contact with the commutator, of course. You can usually move this brush holder by loosening a screw or clamp. Moving the holder *in the direction of armature rotation* will increase the charging rate, while a reverse movement will cause a decrease. After you've made the adjustment, run the automobile engine and watch the car ammeter to make sure the charging rate has increased, but has not increased too much.

It is well to caution the receiver owner that the condition of the battery should be checked frequently with a hydrometer. If the battery is somewhat low, it should be brought up to full charge by a service station and then frequently checked to see that it stays reasonably well charged.

Eliminating Ignition Interference

An important job in any installation is cutting down the interference generated by the car's electrical system. This is always necessary in a new installation and, because of loosening of chassis bolts in the car and general deterioration in the ignition circuit, additional elimination steps may become necessary after six months or a year of operation.

You've learned that interference comes from the ignition circuit, the generator and low-voltage wiring, wheel and tire static, electric gauges and indicators, and from special appliances such as heaters, electric lighters, etc. Regardless of the source, the interference must enter the set through the antenna and lead-in, the A lead, the control cables, or by direct chassis pickup. To some extent, the method of entry depends upon the installation. For example, an antenna on top the car will be much less subject to wheel static than one underneath or on the side of the car.

There are two general methods of reducing this interference—we can suppress it at the source, or we can introduce shielding between the source and the point of entrance into the radio.

Suppression is usually the easier method, but since we must not affect the operation of the automobile adversely, there are definite limits on the kinds of suppression which can be used.

For this reason, we usually take advantage of the fact that the engine of the car is more or less completely enclosed in metal which can be made to act as a shield if all of it is properly bonded (electrically connected together). For example, if we bond the radiator, engine hood, oil pan and fire-wall together, we cut down very effectively the amount of radiation from the engine compartment. This is not a perfect shield, however; some radiation may still escape through various openings in this compartment, in addition to the interference which is conducted out over the low-voltage wiring and through control rods, gear shift levers, brake and clutch pedals, steering gear column, etc.

Almost never can you take out every last bit of interference. When tuned between stations, it will almost always be possible to hear some noise. However, you can consider the job is finished if you can tune to relatively weak stations and hear programs without noticeable interference.

Now, let's take up the interference eliminating procedures. We'll start first with the basic elimination procedures—the steps that are practically always taken regardless of the car's make and model.

BASIC ELIMINATION PROCEDURES

Practically all the equipment necessary for eliminating or minimizing auto radio interference is readily available from the wholesale supply houses. In most cases, the apparatus is made specifically for auto use—some parts being made for specific makes and models of automobiles. You won't have to worry about condenser capacity or resistor values either; you just purchase the parts needed according to their location and the car model. Thus, a distributor suppressor has a different resistance than a spark plug suppressor, but they are sold for their particular use and look different so you won't have any trouble telling them apart.

The bypass condensers used are metal-clad. This metal case keeps heat from affecting the condenser, protects it from dirt and moisture, and also acts as a shield.

► Installing bypass condensers is the first step to take. A bypass condenser should be installed at the point where the receiver A lead connects to the ammeter. Typical installations are shown in Figs. *15* and *20*.

Next, a condenser should be installed at the generator to reduce the interference produced by the commutator. Regardless of the generator type, you will always find a convenient screw for mounting the condenser so that the lead can be properly connected to the hot or ungrounded generator terminal. Several examples of such connections are given in Fig *21*.

These two condensers minimize the interference produced in the low-voltage circuit and also take out much of that which is radiated to the low-voltage wires from the ignition circuit.

►Practically all installations will also require some sort of suppression in the ignition system high-voltage circuit. The most effective device is a distributor suppressor which damps out or dissipates the sharp current changes (noise impulses) in the spark discharges. For this reason, a resistor or an r.f. choke coil is always placed in series with the distributor arm. The impulse energy developed in the ignition circuit must flow through this resistor or choke coil, and much of it is dissipated.

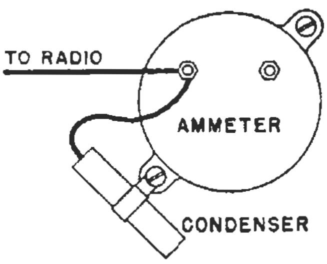


FIG. 20. The condenser should be installed right at the ammeter and must connect to the same terminal as the radio A lead.

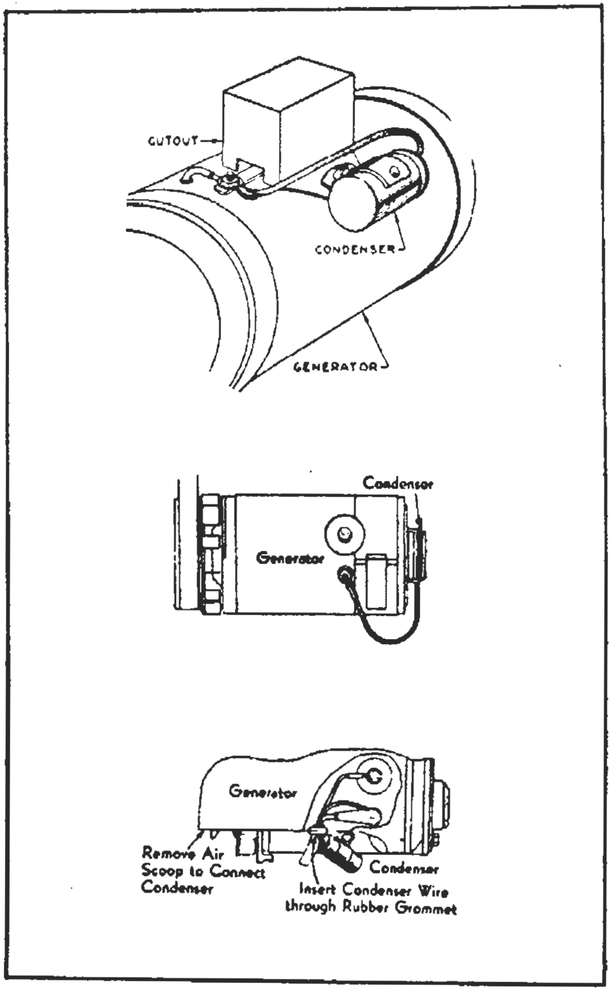


FIG. 21. Examples of installations of condensers at the generator.

Fig. *22* shows some of the many kinds of distributor suppressors available. On the usual distributor head, the high-tension wire from the coil comes to the center terminal. If the high-tension wire plugs into the distributor head, it is unplugged and the special resistor inserted as shown in Figs. *22A* and *B*. If it cannot be unplugged, the wire itself is cut and a special screwtype suppressor is put in series with the wire, as shown in Figs. *22C* and *D*. Several others are shown in the remaining illustrations.

► The three steps we have just described—installing a condenser at the ammeter, installing a condenser at the generator, and installing a suppressor in the distributor circuit—must be taken on practically every automobile. These might be called the basic suppression steps. You will often find that these three are the only steps necessary, particularly if the car is new and the receiver is a better quality set with built-in interference eliminating features.

SECONDARY PROCEDURES

If the basic procedures do not reduce interference sufficiently, however, then several secondary steps must be taken.

Spark Plug Suppressors. When auto sets first came out, most servicemen installed suppressors at each

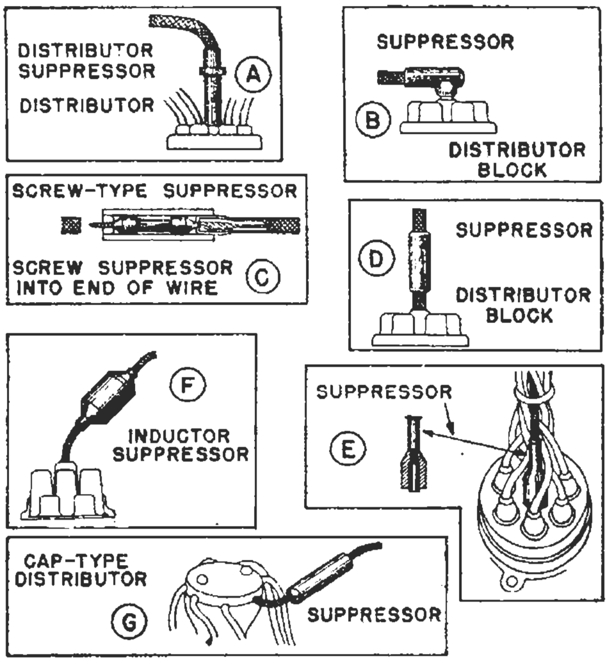


FIG. 22. **Types of distributor suppressors.**

spark plug. A typical suppressor is shown in Fig. *23* and a typical installation in Fig. *24*.

Today, however, spark plug suppressors are not installed unless absolutely necessary, because they tend to interfere with the efficiency of the engine. When the spark jumps the gap, the current flow through the resistor reduces the voltage at the spark gap to such an extent that the spark is no longer as hot as it should be for best combustion. A trained mechanic can reduce the spacing between the spark plug points and so produce a hotter spark, but this cannot be carried too far. If the spacing is made too small, the initial voltage may cause a spark to jump more quickly than normal, thus upsetting the timing and again interfering with the operation of the car. You should make every effort to

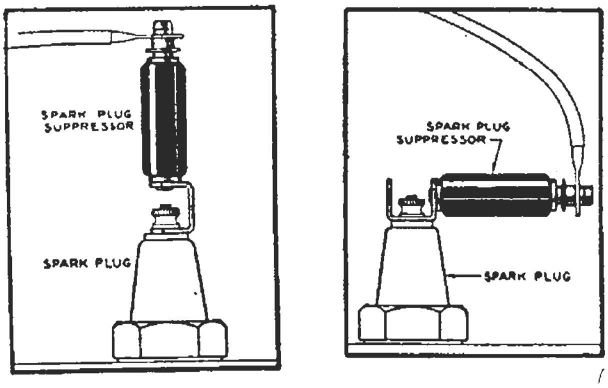


FIG. 23. **Typical spark-plug suppressors.**

exhaust other possibilities before trying spark plug suppressors.

Other Steps. The manufacturer's literature on the radio will tell you steps which may have to be taken for various makes and models of cars. Further information can usually be obtained from the firm selling the automobile. Make full use of this kind of information, for many of the suppression steps may not occur to you otherwise.

Bypass condensers are generally necessary on the leads of the oil pres-

Courtesy Erie Resistor Corp.

FIG. 24. **Spark-plug suppressors installed.**

sure, gasoline, and water temperature gauges. In some installations, it is even necessary to bypass the electric clock. Always use the location suggested in the service notes for the bypass condenser, as sometimes it is better to put the condenser at the end of the cable which comes to the instrument panel, while in other instances it is better to bypass the other end of the cable. Condensers with mounting brackets specially designed for specific cars are available; using them will make installation much simpler. Several typical examples of such condensers are shown in Fig. 25.

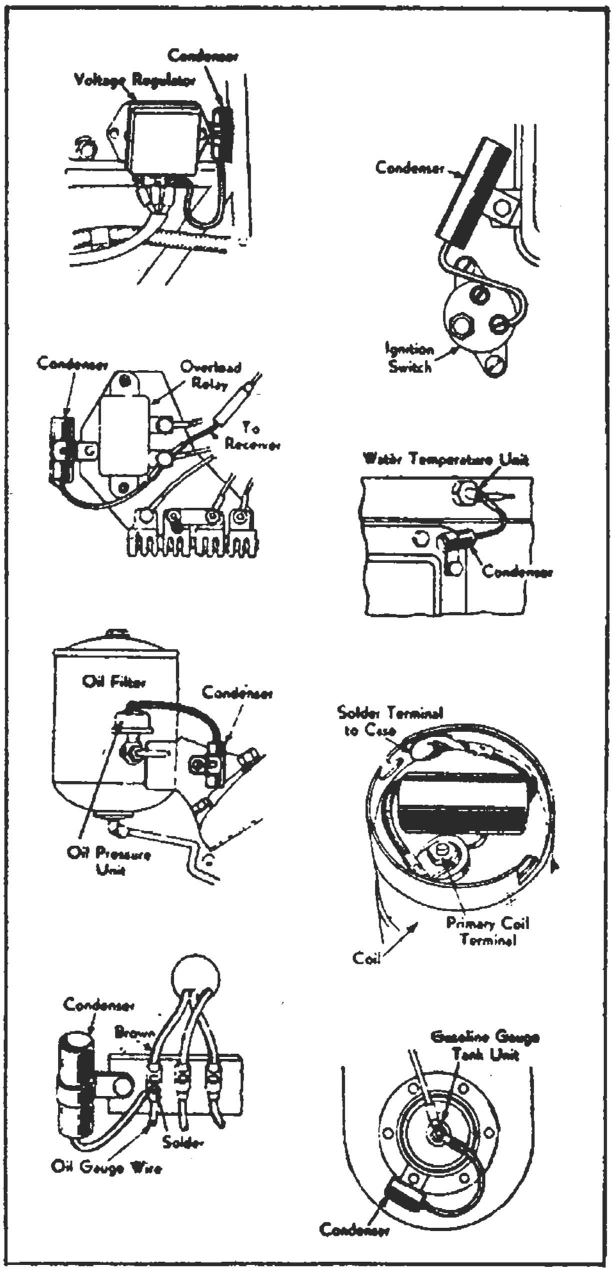


FIG. 25. Several examples of condenser installations for noise suppression. Diagrams like these come with receivers or are obtainable from auto dealers or from manufacturers of suppressors, showing the proper installations for the particular make and model receiver and car.

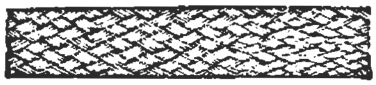
BONDING

An important secondary step necessary in a great number of installations is bonding—making good electrical connections between various parts of the car. In most cars, for example, the engine is mounted on rubber blocks so its vibration will not be transmitted to the frame. This means that the only electrical contacts between the engine and the frame are those obtained through the wiring and through such grounds as the car manufacturer may have felt necessary. These are rarely sufficient—so one of the most common bonds needed is between the cylinder head and the firewall.

You should first make the bonds directed in the installation data, then, if interference still persists, check to see if further bonding is necessary. For test purposes, use a length of copper bonding or shielding braid (Fig. 26) about two feet long, with large battery clips soldered to each end. The braid should be the wide, heavy type, like that used to ground the car battery. In fact, these grounding straps can be purchased and used for bonding. Make tests by starting the car and turning on the radio, then clipping together various metal parts of the car with the braid to see if interference can be reduced. Check particularly between the car body and the chassis, instrument panel and body, chrome trim (decorative grills) and body, transmission housing and chassis, steel floor boards and chassis, brake rods and chassis.

When you find points where your bond helps, either clean away paint and grease from under the bolts holding these parts together or install a piece of the bonding braid between these points. Be careful to make good contacts and use short bonds, but leave enough slack so vibration does not break the braid.

► Fig. 27 shows several examples of bonding. To make the cylinder-head-to-fire-wall connection, remove one of the bolts in the cylinder head and carefully clean around the bolt hole. Punch a hole in the braid, then slip a washer and the braid on the bolt, reinstall the bolt, and tighten it. Fasten the other end of the braid similarly to some convenient point on the frame or fire-wall of the car. Be sure enough slack is allowed for engine vibration, but don't use excessively long pieces of braid—they may get in the way of controls or have



Courtesy Lenz Electric Mfg. Co.
FIG. 26. A copper braid, useful for bonding or for shielding wires.

sufficient resistance to be ineffective.

► Fig. 27 also shows how to bond control cables with flexible braid. You should fasten one end of the braid to the fire-wall by drilling a hole in the wall and passing a self-tapping screw through the braid into the hole. Solder the other end of the flexible braid to the control cable. Be careful to allow enough slack so that the control cable can be moved throughout its range without interference.

► It is frequently necessary to bond the hood of the car. The hood is separated from the frame of the car by a strip of felt or fabric to prevent the rattling that a metal-to-metal contact would cause. Therefore, the only grounding of the hood is that obtained through the catch holding the hood closed and through its hinges. Usually, a great amount of interference can be eliminated by using little spring contactors to improve the hood grounding. These contactors are flat strips of spring brass, made with a roughened, jagged surface which will make a good contact through grease, oil, and paint. To install one, loosen one of the screws holding the felt in place, and insert the metal strip *under* the felt so the strip is in contact with the cowl of the car. Put the screw back through the felt and through the metal strip to hold them in place, then bend the metal strip back over the top of the felt, so that the roughened metal surface is outermost. Now, when you close the hood, it will be firmly grounded to the car cowl and frame through the U-shaped strip. You should install one of these on each side of the cowl.

SHIELDING

Ordinarily, you should avoid installing shielding on the car electrical system unless you are sure that it will not affect the operation of the car, and unless the manufacturer recommends it. Usually, it will be all right to shield low-voltage wiring, but shielding on the ignition circuit is to be avoided unless absolutely necessary. It is true that many modern automobiles are now manufactured with shielding over the ignition wiring, but this has been carefully placed by the manufacturer; it will not cause trouble by reducing the efficiency of the ignition system, nor will it trap heat and result in the ignition wiring being destroyed. This is an important consideration, as it becomes quite hot in the engine compartment of a car.

► It may be necessary to shield water hoses going to heaters. Remember that signal noise energy will flow over any path that is even semi-conductive. Some cars have heaters under the front seat with long hose connections from the engine. These water paths carry ignition interference inside the car. A shield may be necessary (see Fig. 28) over such water hoses.

► Sometimes screen wire must be installed over the flooring of the car between the front seat and the fire-wall. Put this screen under the floor mat, cutting it to fit around the brake and

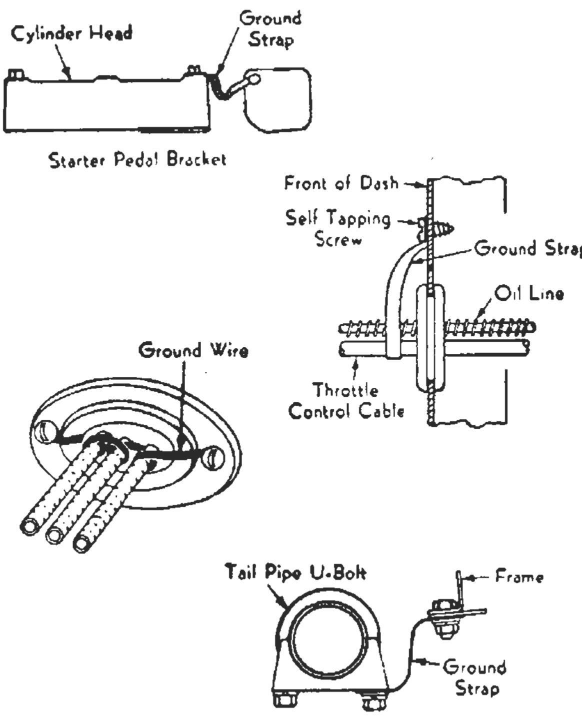


FIG. 27. Examples of bonding.

clutch pedals, etc. It must be bonded to the fire-wall and fastened to the car body at the sides.

STATIC DISCHARGES

Annoying amounts of interference can be caused by discharges of static electricity developed in the brake system and about the wheels.

Brake static is commonly caused by metallic particles in the brake lining touching the revolving drum connected to the wheel, by dragging brakes (where the brake lining is partially in contact with the brake drum), or by improper adjustment of the brakes.

Usually, brake static can be cleared up by having a mechanic check over and readjust the brakes. Sometimes bonding the brake control rods will prevent this interference from being carried to other parts of the car.

► Wheel and tire static are interesting examples of conditions which can arise when poor contacts develop between metal parts. The sounds produced may be an intermittent rasping or clicking noise, with the time intervals varying with the speed of the car, or may be a steady hissing developed after the car reaches a certain speed. The trouble will occur only when the auto is in motion and will usually be worse when going over asphalt or cement pavement, although it may be noticed in some cases on brick pavements or on dry gravel roads. It will frequently disappear during periods of high humidity or when the pavement or wheels are wet but will reappear as the road or wheels dry out. Driving off the

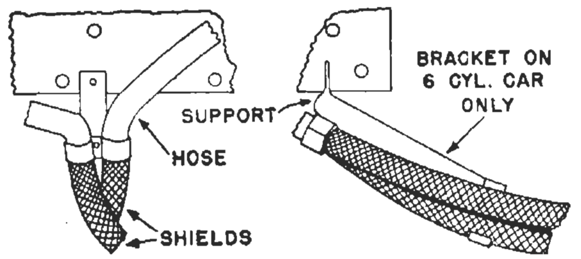


FIG. 28. Shields must sometimes be placed over the hose going to heaters located under the seat.

pavement onto the dirt shoulder or on to dirt side roads will usually stop the noise.

Apparently this noise is produced by friction between dry pavement and the rubber tires, which generates static electricity. This electricity collects on isolated conductive substances in the tires or on the metal wheels (which may be insulated from the body of the auto by grease or oil). The charge builds up, then discharges to the car body or road bed from time to time. If the application of brakes causes the noise to disappear, we attribute the noise to wheel static; otherwise, it is tire static.

► Since wheel static means metal portions of the wheel are insulated from the car body by grease and oil, the obvious solution is to apply some contacting means. Special static collectors, which are installed under the decorative hub caps, are made for this purpose. There are several types, and the recommended type for the particular car wheels should be used. Typical installations are shown in Fig. *29*.

► Tire static is harder to explain. Apparently it is sometimes caused by metallic paint spots inside the tires. (Some manufacturers use such paint inside tires to balance them.) In such cases, cleaning the inside of the casing with a wire brush and then wiping the casing thoroughly with benzine and a cloth to remove this paint will clear up the trouble. Sometimes a special paint available from the maker of the tire can be used to coat the inside wall of the tire.

The difficulty may also be caused by vulcanized patches if a metallic-base glue has been used on the tube or casing.

Often (particularly if the wheel has wooden spokes) the trouble can be minimized by running a bonding wire between the metal rim and the hub of the wheel to make better contact. We refer, of course, to the removable metal rim, which paint and rust may have insulated from the rest of the wheel.

SPECIAL TROUBLES

With older cars, you can expect deterioration to raise the interference level higher than normal. A crack on the spark coil or on the distributor head will provide a leakage path which will affect the operation of the engine somewhat and will create a terrific amount of interference. Also, dirty and worn spark plugs, cracked spark plugs, leaky ignition wiring, and loosened body bolts will all raise the interference level. The services of a good mechanic may be required to put the ignition system in first-class order.

► Frequently excessive noise will be produced if the rotor arm of the distributor is spaced too far from its contacts. Because it turns at high speed, this rotor arm must not strike any of the contacts, but it should be equally spaced from all of them and should just barely miss them as it rotates. A good mechanic, if he finds the spacing too great between the end of the rotor arm and the contacts, can take out the rotor and (with a peening hammer) flatten out the contacting tip to make it somewhat longer. Then, he will reshape it and make a check to be sure it does not actually strike any of the contacts.

If the spacing between the contacts and arm is erratic, a new distributor head should be obtained for the car.

DETERMINING THE SOURCE OF INTERFERING NOISES

It is usually rather easy to determine whether noise originates within the receiver or is caused by ignition interference. Here are some logical step-by-step procedures which will identify the source by the sound of the noise and the conditions of operation.

Case 1. *First try the receiver with the car standing still and with the engine not running.* This condition eliminates mechanical vibration from the engine, the ignition circuits are not working, the generator is not working, and brake or tire static is not a problem. Any noises heard must be caused by defects within the receiver, by a loose connection or partial ground in the antenna circuit, or by a poor connection to the low-voltage circuit in the car.

If the set is noisy, or striking the set sharply with your hand causes noise, you can be sure the noise source is within the receiver. (We will go into internal receiver noises later.) Wiggling the antenna lead will show if the antenna circuit is faulty.

Listen carefully to see if the noise actually comes from the speaker. Often the speaker will be vibrating a loose plate, ashtray, or some control cable from the instrument panel.

► While the car is standing still, try operating the brakes. You may hear a loud click when the stop-light (at the rear of the car) turns on as the brakes are applied. A condenser between the stop-light lead and the car chassis will eliminate this.

If you find a noise is not present under these conditions, go on to Case 2.

Case 2. *Turn on the engine and let it idle or run slowly. The car should remain standing still.* You will now get electrical interference from the ignition system and also a certain amount of mechanical jarring from the engine. Frying or crackling noises are very likely ignition noises. Presuming you have already carried out the basic elimination procedure (or you find this has been done if someone else installed the receiver), check to see that all the manufacturer's recommendations have been carried out. It is quite possible that the basic procedures were sufficient when the automobile and the receiver were new, but that aging has increased the interference level.

► Next, disconnect the antenna lead-in from the receiver. If the noises cease, the antenna or its lead-in is picking them up. Be certain the antenna lead-in is thoroughly shielded and that the shield has a good ground where it first enters the car.

In some instances it is advisable to try other aerials at different locations, to see if the position of the aerial is poorly chosen. For example, an under-car aerial is always subject to more interference than one on top of the car.

► On the other hand, if the noise continues with the antenna lead-in disconnected, the noise is coming in over the A battery lead to the set, or the set is picking the noise up directly, or the mechanical jarring of the engine is producing the noise in the radio.

Usually, in the last case, jarring the set with your hand will change the noise level.

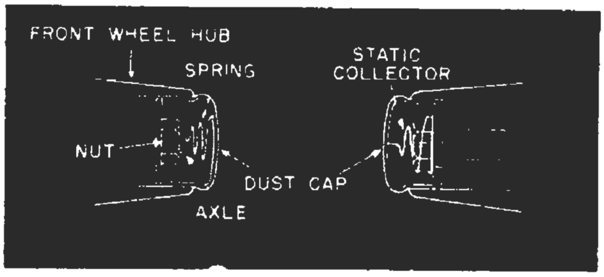


FIG. 29. Wheel static collectors.

Interference coming in over the A battery lead sometimes indicates that a bypass condenser was not used where the A battery connects to the car ammeter. Sometimes it is necessary to run the A battery lead directly to the storage battery to help clear up this interference.

In other instances the noise will enter the radio set directly, probably because some control rod or cable going to the instrument panel of the car happens to run close to some opening on the radio container. Ventilating holes are necessary on the radio, and, when the speaker is built in, holes must be provided to eliminate back pressure on the speaker. If control leads run close to these holes, interference may feed through them. Try moving such cables about to see if this affects the noise level. If so, move them to a position of minimum interference which does not interfere with their normal operation.

Case 3. *After the preceding two tests have been made, speed up the engine but leave the car standing still.* Run the engine fast enough to show a charge on the ammeter. You will now get an increased amount of vibration, generator noises will be more common, and some ignition conditions may show up which were not apparent at lower engine speeds.

► A whining noise, increasing as the speed of the engine increases and decreasing as the engine is slowed down, usually indicates that the generator condenser is improperly installed or ineffective, or that the commutator needs cleaning. The commutator on the generator can be cleaned by holding against it a strip of sandpaper or a lint-free rag moistened with carbon tetrachloride. Sparking, with consequent interference, may also be present if the commutator or the brushes are badly worn or if the springs holding the brushes in contact with the armature have lost their springiness. It is usually best to have these conditions corrected by an experienced mechanic.

► A rattling noise usually indicates something loose inside the car or about the radio. First determine if the sound is coming from the speaker or seems to come from somewhere else. You may frequently find control heads or rods which vibrate. If the noise stops when you touch the vibrating part, the part must be anchored so that it cannot vibrate.

► Again, a buzzing or crackling noise may indicate ignition noise, which is worse at high speeds.

► On some automobiles, the coil is mounted behind the instrument panel instead of in the engine compartment. You may find interference in such cars until the high-tension wire from the coil to the distributor is shielded. Sometimes it is even necessary to shield the entire coil. Use a piece of shielding braid for covering the wire.

The vibration produced by the engine at higher speeds may also cause noises by shaking some defective contact.

Case 4. If the noise complained of does not show up with the car standing still, *drive the car or have it driven, so you can determine the effects of motion.* Any noises which develop with the car in motion, but which are not heard with the car standing still, are usually caused by frictional electricity generated in the brakes or wheels. To prove this condition exists, *coast down a hill with the engine turned off.* When the engine is not running, the ignition circuits are obviously not functioning and there is no engine vibration, so noises must almost certainly be caused by brake or wheel static.

Complete cures for wheel and brake static have been given earlier in this lesson.

SUMMARY

We have given here the general procedures applicable to any car and radio installation. As we have repeatedly mentioned, the manufacturer's instructions accompanying the receiver should be read carefully. If you intend to go into auto radio work, make a habit of collecting tips on various installations. Very good information is frequently available from the automobile distributors. These tips will always save a great amount of time by leading you directly into the proper first steps. You will have trouble only in those older automobiles where the interference level is high and where little information is available. For these, you may have to spend a great amount of time testing interference elimination procedures before you hit upon the combination which does the most good. Remember also, you can't get rid of *all* the noise heard between stations. Try to eliminate as much as you can, checking the level when tuned to local stations.

Servicing Auto Radios

Fundamentally, servicing auto receivers is no different from servicing any other kind of radio; exactly the same principles of effect-to-cause reasoning and localization can be applied as can be used on an a.c. home radio having a power transformer. Except for its extreme compactness, it presents only the special problems of the vibrator power supply.

Before taking up the service procedures, let's see what equipment is required and review vibrator systems.

WORKBENCH EQUIPMENT

There are a few items you will have to provide at your workbench if you intend to do auto radio servicing. One will be a source of power to operate the set. The best device for this purpose is an auto storage battery.

If you intend to do any large amount of auto radio servicing, get a good battery and keep it in good condition at all times. It must be kept filled to the proper level with distilled water and must be kept charged. Therefore, you should have a charger in your shop.

Because of the trouble of taking care of a battery, some service shops use special eliminators designed for auto radio work. They are available from wholesale supply houses and can furnish 6 to 8 volts at currents of from 12 to 25 amperes, depending on whether you get a light-duty or a heavy-duty type.

This high current capacity is necessary. An auto radio in good condition will draw anywhere from 4 to 10 amperes, depending on its type and size. When defective it will draw even more.

► To operate an auto set in your shop, connect one lead of your battery or A power pack to the case of the receiver and the other to the A battery lead. Polarity is of no importance unless the set has a synchronous or self-rectifying vibrator, in which case you must use the same polarity of connections as were used in the car from which the receiver was obtained.

Many servicemen forget that an auto set is extremely sensitive, and make the mistake of connecting a rather long piece of wire or a regular aerial to the set on the workbench. Even an auto set which has lost most of its sensitivity will operate wonderfully from this long aerial, but may be absolutely dead when installed in the car, where it must operate from a small antenna. Use a very short piece of wire or a standard auto aerial mounted on the workbench to try out auto sets properly.

VIBRATOR POWER SUPPLIES

Practically all modern auto sets operate from a vibrator type power supply. Police receivers and a few of the older types may use motor generator sets, but these are not often encountered in regular service work.

Since the vibrator and its power supply systems are common sources of trouble, let's review the basic vibrator types briefly.

Non-Synchronous Vibrator. The circuit of a typical vibrator system is shown in Fig. *30*. When switch *S* is closed, the circuit is completed from the storage battery to the tube filaments through choke L_2. (Tubes having 6.3-volt filaments are used, with the filaments in parallel.) The vibrator supply and rectifier tube filament current flows through L_3.

The vibrator contains a flexible reed *R* which can be made to touch contacts *A* and *B* alternately. When the switch *S* is turned on, current flows through L_1, L_3, P_2 and L_6. This energizes the electromagnet L_6, which

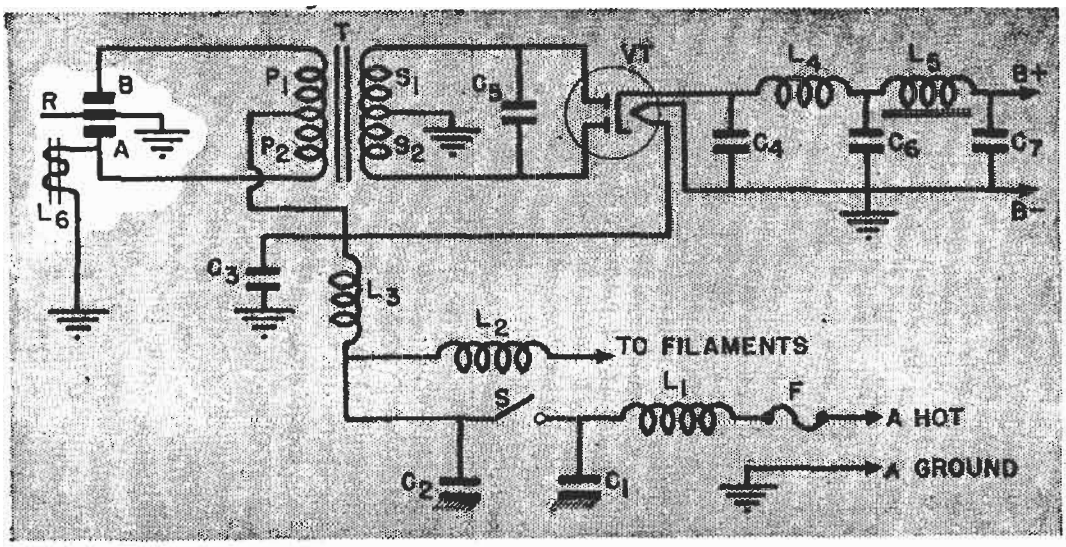


FIG. 30. A typical non-synchronous vibrator type power supply.

pulls the reed down, making contact to *A*. This permits full current to flow through P_2 and also shorts L_6, causing it to release the reed. The reed then flies back, striking contact *B* and completing the circuit through P_1. Then, coil L_6 again attracts the reed, repeating the cycle.

The pulsing current flow first through P_2 and then P_1 induces an a.c. voltage in the secondary of transformer *T*. This voltage is then rectified by *VT* and passed on to the filter.

▶ The rapid circuit openings and closings caused by the vibrator produce current pulses in the primary of transformer *T* which are relatively sharp and square, with a great many harmonics—shaped like noise pulses, in fact. Of course, the voltage induced in the secondary is similar in shape and would have extremely high, sharp peaks except for the buffer condenser C_5. This condenser tends to smooth out the pulses and prevent very high peaks.

Even so, the output of the rectifier tube has considerable "hash" in it. An r.f. filter is normally used in the cathode lead of the rectifier, before the power is fed to the filter, to eliminate some of this "hash" (which would cause interference). R.F. choke L_4, condenser C_4 and the electrolytic C_6 make up this filter.

Similarly, coil L_3, condenser C_3 and the C_1-C_2 combination form a filter in the low-voltage circuit to prevent vibrator interference from feeding back into the filament supply, which is further filtered by L_2.

Coil L_1 and condensers C_1 and C_2 act as a filter to prevent interference from coming in over the "A" battery lead; so do L_3-C_3 and L_2.

It would seem that when the switch is closed, a single condenser would do in place of C_1 and C_2. However, the long leads to the switch are inductive, so the pair of condensers is required for adequate filtering.

As you can see, a vibrator source requires far more filtering than do other power sources, because the interference effects of the vibrator itself must be eliminated. The vibrator must be well shielded; it is often encased in a special compartment with

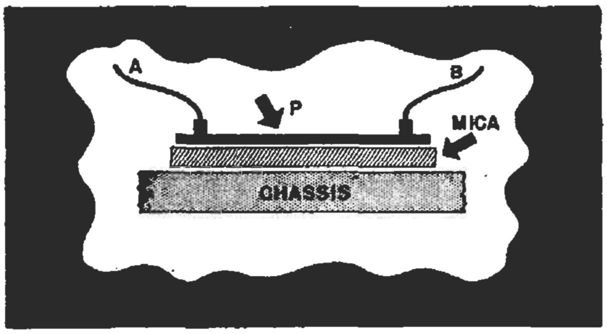


FIG. 31. How a "spark-plate" condenser is made.

the transformer, rectifier tube and the r.f. filter to isolate them from the remainder of the radio and so reduce the amount of noise further.

► Condensers C_1 and C_2 are called "spark plate" condensers and deserve some special mention. The particular symbol used indicates that one plate of each of these condensers is the receiver chassis. As Fig. *31* shows, the other plate *P* is insulated from the

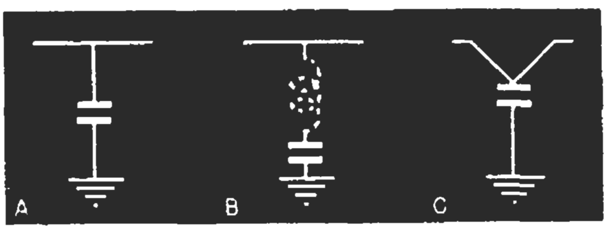


FIG. 32. The inductance of the wire lead is eliminated by the double-wire construction.

chassis by a sheet of mica. It may be held in position by insulated clamps or insulated rivets.

► Watch for connections like that in Fig. *31*, where wire *A* ends at the condenser plate and wire *B* completes the circuit to the succeeding parts. In other words, although wire *A* ends at the plate, the circuit continues. The reason for this peculiar connection is shown in Fig. *32*.

Ordinarily we would expect a bypass condenser to be connected as shown in Fig. *32A*. Actually, however, there will be a certain amount of inductance in the wire going into the condenser (Fig. *32B*). This inductance is therefore between the circuit and the condenser, and limits the effectiveness of the condenser. By bringing the circuit wire up to the condenser and continuing on as in Figs. *31* and *32C*, there is no common

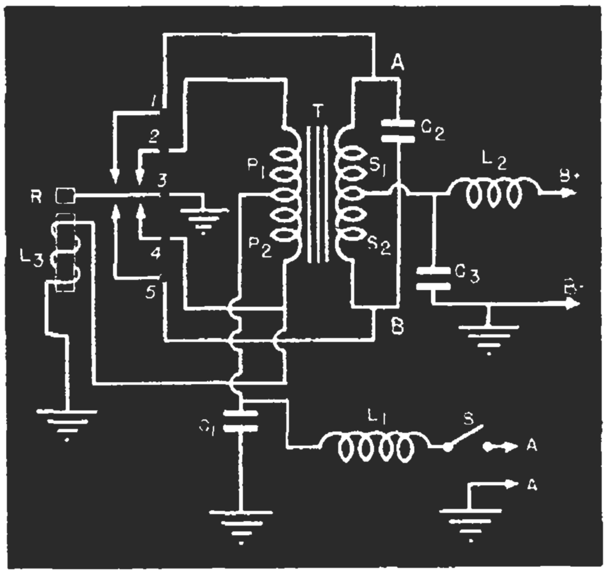


FIG. 33. A synchronous vibrator power supply.

lead to the condenser, so whatever inductance exists is that already in the circuit. Using the chassis as the ground plate of the condenser similarly eliminates the lead to ground, making the condenser far more effective at high frequencies.

Synchronous Vibrators. Some auto sets use synchronous vibrators to eliminate the rectifier tube filament current drain. In these, the vibrator both interrupts the current flow to make the pulses in the primary and mechanically rectifies the output of the secondary. The operation of the vibrator and primary circuit (see Fig.

33) is similar to that described for Fig. *30*. Current flows through choke L_1, through primary winding P_2, and through coil L_3. Coil L_3 attracts the vibrating reed *R*. When the moving reed touches the contact going to *4*, coil L_3 is short-circuited and the reed flies back to the other side.

In moving back and forth, the reed first touches the contacts going to terminals *4* and *5*, and then those going to terminals *2* and *1*. Touching the contacts going to *2* or *4* completes the primary circuit, while touching those going to *1* or *5* completes the secondary circuit, through the grounded reed connection.

► If the wires from the primary and secondary to the vibrator are correctly connected, the *B* supply will always deliver voltage with the proper polarity, as marked. On the other hand, if the connections are incorrect, the *B* supply polarity will be reversed and the set will not operate, as the tube plates will be negative instead of positive. If this circuit is operated for any length of time with the reversed polarity, the electrolytic filter condensers will be ruined.

For this reason, you must watch polarity when you connect a receiver with a synchronous vibrator to a car battery. If the vibrator circuit is wired to work properly in a car in which the negative terminal of the car battery is grounded, it will deliver the wrong polarity in a car in which the positive battery terminal is grounded—and vice versa. Therefore, if the circuit is wired to be used with the negative side of the battery grounded, but you want to put it in a car in which the positive side of the battery is grounded (or vice versa), it will be necessary to reverse *either* the leads to the primary or the leads to the secondary of the power supply transformer. It makes no difference whether you reverse the primary leads or the secondary leads, but you must be sure to get a *pair* from the same winding—not one lead from each winding. For example, you can take the leads *A* and *B* from the secondary of transformer *T* and interchange them at the vibrator, so that *A* goes to *5* and *B* to *1*, or you can reverse the primary by interchanging the leads so as to connect P_1 to *4* and P_2 to *2*. Don't make the mistake of reversing *both* pairs, as this leaves things the same as before.

Often this change can be made merely by unplugging the synchronous vibrator unit, turning it half a revolution (180°), and plugging it back in again. This can be done if the socket contacts are arranged as in Fig. *34*, so that reversing the vibrator this way automatically reverses the connections to one set of the terminals. (This arrangement is found *only* on some of the 5- and 6-prong synchronous vibrators. The *non-synchronous* vibrator and *other* synchronous types will plug in their sockets *in only one way*.)

Some sets have terminal boards with leads which either plug in or can be easily unsoldered for making this reversal.

► Always connect your bench power supply or battery to the set with the same "grounded" battery terminal connected to the chassis as will be connected to it in the car the radio is to work in. (You may not know this polarity in all cases.) As a check to see that the proper connections are made, connect a d.c. voltmeter between B+ and the chassis so the meter + goes to B+ and the meter — to the chassis. Turn the set on and watch the meter. If it reads up-scale, the proper battery polarity connections have been made.

If the meter deflects down-scale, turn the set off quickly to protect the filter condensers. If the set was working in a car and is to go back in the same car, reverse the connections to your battery or supply (since the polarity of the set is obviously correct for the car). On the other hand, if the set is just being installed, connect it to your battery according to the known polarity of the car and if necessary, reverse the connections of the vibrator for this polarity.

It is important to remember that *this polarity question does not come up at all for a non-synchronous vibrator using a tube rectifier,* as the tube will automatically pass current from whichever plate happens to be positive at any moment and therefore is always correctly connected.

VIBRATOR CIRCUIT DEFECTS

As we have shown, the vibrator is a noise source and requires considerable shielding and filtering, even when working normally. When it becomes erratic in performance, the amount of interference can assume terrific proportions. Furthermore, like any other mechanical device, a vibrator will eventually wear out. Arcing makes the contacts worn and pitted, and the reed loses its springiness. Thus, the vibrator has a definite life period just like a tube and must be replaced from time to time.

In addition, any short or leakage in the B supply circuits will draw excessive current through the vibrator, producing increased sparking and greater contact wear. For longest vibrator life, the receiver must be kept in tiptop condition.

In particular, the buffer condenser should always be checked whenever the vibrator is found defective. The buffer condenser must withstand high-voltage surges; even though they are usually rated at 1200 to 2000 volts, they still break down from time to time. Of course, a defect here would short-circuit the secondary and thus overload the vibrator heavily.

The size of the buffer condenser is rather important. The vibrator has a definite rate of operation (which is today around 115 cycles per second), and the vibrator, transformer, and buffer condenser are designed as a unit to suit this rate. However, different vibrator rates—and correspondingly different condensers—have been used. Should you have to replace a buffer condenser, be sure to get one with a similar or higher voltage rating than the original and *with the same capacity as the original.*

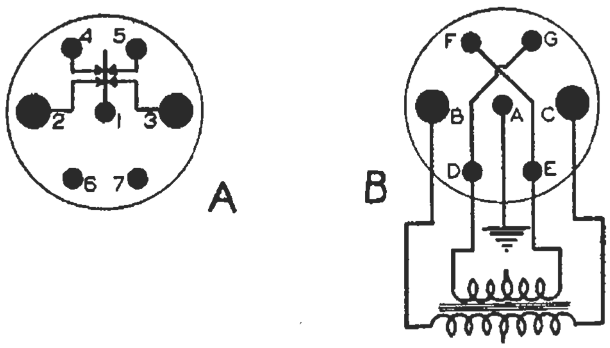


FIG. 34. The prong arrangement for a reversible synchronous vibrator is shown at A, while the socket connections are shown at B. When plugged in one way, the contacts 1, 2, 3, 4 and 5 make contact to socket terminals A, B, C, D and E. When the vibrator is removed, turned through a half circle and plugged in again, the vibrator contacts 1 to 5 inclusive now make contact to socket terminals A, B, C, F and G. This automatically reverses the connections to one of the windings on the transformer. The vibrator will fit the socket in only one of these two ways, because prongs 2 and 3 are considerably larger than the others, so no other plug-in arrangement is possible.

► Some sets use a cold cathode rectifier, which depends on gas ionization for conduction. The advantage of this tube is that it eliminates the filament current drain of the normal rectifier tube, so that the radio draws slightly less current from the storage battery. However, circuits using cold cathode tubes are subject to oscillation, which in turn produces noise.

If you find such a tube is causing interference, and if the automobile battery is not too heavily loaded by gadgets, substitute a regular heater type rectifier. Usually the only change necessary is to wire the filament circuit (and even this may already have been done by the set manufacturer).

Testing Vibrators. How can we determine if the vibrator is defective? For the man doing a great amount of auto radio business, a vibrator tester is worth while. This test instrument is similar to a tube tester in its operation. The vibrator is plugged into the proper socket and its worth is determined by checking the output voltage across a certain recommended load and measuring the current the vibrator draws. The vibrator, to be efficient, must deliver a rated voltage with a minimum of current drain. The output of an aging vibrator will drop off slowly but the current consumed will increase rapidly. Therefore, the first indication of a defective vibrator is a higher-than-normal current drain.

If the receiver draws an abnormally high current, which may be shown by the car ammeter or by blowing fuses repeatedly, suspect the vibrator, but remember it may just be overloaded by some fault within the set. Hence, if you find a radio is drawing excessive current and you do not have a vibrator tester, you should first check the B supply circuit with an ohmmeter to be sure there are no leaky condensers or shorts. If there are none, try another vibrator to note the performance of the receiver. Improvement indicates the original vibrator was faulty.

► Suspect the vibrator if it makes an erratic sound and the B voltage is lower than normal. (The vibrator should produce a steady buzzing sound which does not vary in pitch after the set has warmed up.) Also, defective vibrators frequently will not start operation until the set is kicked or jarred or the ON-OFF switch is snapped off and on several times.

► Defective vibrators should normally be replaced. In emergencies, it may be possible to get a few more weeks of operation by cleaning and filing the contacts and bending the vibrator reed. The contacts can be cleaned by using a thin, flat ignition or jeweler's file. After filing, the gap between the contacts should be adjusted to about .003 to .006 inch (about the thickness of this page). Then, try the vibrator and make further bending adjustments, if necessary, to obtain steady, smooth operation with a minimum of sparking.

Even at best, it will be impossible to approach the accuracy of the factory adjustment. Once contact arcing and spring fatigue have begun, no adjustment will hold for more than a few weeks at most. It is far better to make a replacement if at all possible.

CHECKING THE SET IN THE CAR

Because of the trouble involved in taking the radio out of the car, it is best to make as many tests as possible with the set installed. Usually, taking off a cover will let you remove the tubes for testing. Most modern vibrators are of the plug-in type, so they can easily be removed for checking or to try another one.

Should the owner complain of unusually short tube and vibrator life, be sure to check the voltage coming from the low-voltage supply *with the car engine running.* In many such cases, a poor connection exists at the car storage battery terminals or the battery is over-discharged so it has a high internal resistance. This extra resistance in series with the battery prevents the battery from "pulling down" the generator voltage, because the battery does not draw the normal charging current. This means the generator may deliver as much as 8 or 9 volts to the low-voltage circuit. This increased voltage is applied to the tube filaments, and also will be stepped up in proportion, producing as much as a 100-volt rise in B voltage. Both conditions produce an excessive tube current and shorten tube life.

Oscillation, or a remarkable sensitivity rise when the generator is charging, is a clue to this voltage rise. If you find the voltage between the radio A lead and chassis is above normal when the generator is charging, check the battery and its connections. In some cases it is best to connect the radio A lead directly to the battery and to run another lead from the grounded battery terminal to the radio chassis. The voltage then can never rise above the battery voltage as long as the battery is in good condition.

► If the set is dead, check the fuse in the A lead. Auto radios should use fuses rated at no more than 15 amperes. If this fuse blows, you can be fairly certain that the vibrator contacts were stuck together at least momentarily. This may occur once in a great while without there being any real trouble, but it usually means that the vibrator contacts are quite worn, or that the vibrator has been overloaded. If a new fuse blows out at once, there is definitely something wrong in the power supply of the radio. Of course, you should check the set rather than just replace the vibrator, as there may be an overload.

► When the complaint is weak reception or a dead set, try a short piece of wire as an aerial in place of the car antenna. If the wire used as an aerial restores reception to normal, be sure to check (with an ohmmeter) for possible shorts between the lead-in and its shielding, and between the antenna and the car body. Remember—the car body is the ground system, and the antenna must be insulated from it.

► If your initial check shows that the trouble is within the radio, not caused by the installation or by interference, it will be necessary to take the radio out.

► Be very careful to notice where all control cables and leads fasten to the receiver when you take it out. Make a sketch of the cables and their location. This is particularly important if you do not have the installation instructions for the particular radio at hand, as of course you will leave the control head and antenna on the car and must connect the controls and cables properly when the set is reinstalled.

It is a good idea to keep installation instructions on any set you install, so you will have them available for your service work later, on similar models or the same set.

WORKING ON THE SET AT THE WORKBENCH

The equipment needed at the workbench has already been described. With such equipment available, you can connect the set on your bench and work on it exactly as you would on any other radio having a similar complaint. You can use the same test methods and the same test equipment as you would use on an a.c. receiver having a power transformer.

► The extreme compactness of an auto set will make it slightly more difficult to trace circuits and locate parts than in the standard receiver. Unless you have a layout diagram of the set, you will have to use the tube socket terminals and an ohmmeter for identifying connections and parts.

When using an ohmmeter to check the B supply circuit of a set using a synchronous vibrator, remember you may get false readings to chassis through the vibrator. Unplug the vibrator, if possible, or disconnect it

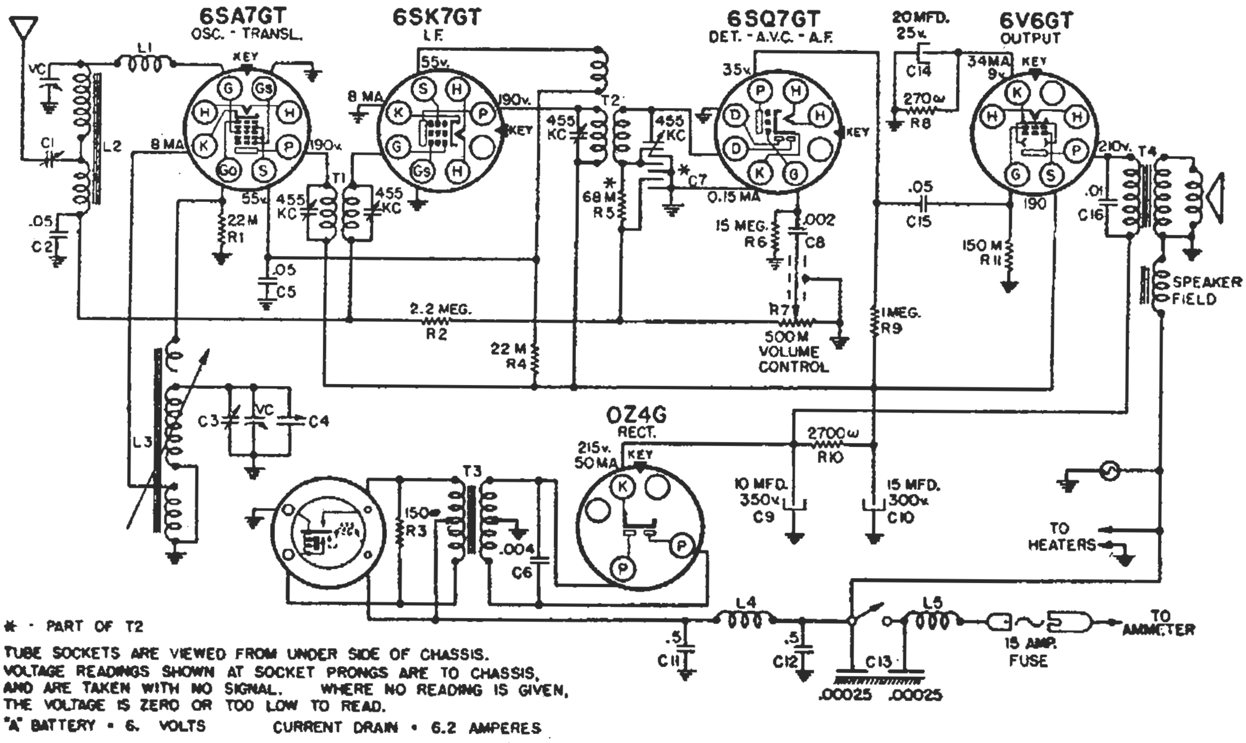


FIG. 35. Wiring diagram of the Silvertone Model 7091, having features found in many auto sets.

from the power transformer when making these tests.

► The metal case about an auto set acts as a shield for the receiver to keep down some of the interference. There will be an unusual number of screws holding lids to the case, and usually spring wiping contactors will be employed between the lids and the case to assure electrical continuity and a tight fit, thus providing an effective shield. After removing the necessary screws, you will frequently have to pry the lid off to get inside. Be sure to replace all these screws when you have finished the servicing, to prevent the possibility of an increased amount of interference.

As has been mentioned, most auto sets have a removable lid over the tubes and the above-chassis parts. After opening this lid, a careful examination of the case will show what is necessary to get underneath the chassis of the receiver. In some instances, the opposite side of the case is a lid which is held on by screws and can be removed. In other instances, the receiver chassis itself comes out of the box.

On some of the older models, you may find that the receiver chassis comes out of the box or case, but some of the filtering equipment in the A battery leads and in the antenna leads remains in the case. In other words, a plug-in arrangement will be used between this filter equipment and the receiver chassis itself. Service information on such receivers is very desirable so the proper terminals in the receiver can all be identified when it is taken from the case.

► A typical auto set diagram is shown in Fig. *35*, and the parts layout is shown in Fig. *36*. This particular receiver does not use an r.f. stage at the input of the receiver, but does have regeneration introduced in the i.f. stage to increase the sensitivity. The screen grid lead is coupled by a small coil to transformer T_2 in such a manner that regeneration occurs.

Condenser C_7 is worthy of note. This condenser is actually three condensers in a single unit, as it composes the trimmer for the secondary of T_2, a by-pass condenser between the secondary return of this transformer and chassis, as well as another by-pass condenser from the end of R_5 to set chasssis. The condenser is made up of alternate layers of metal plates and mica insulating strips, and appears to be just a part of the trimmer condenser for the i.f. winding. When you open a transformer of this kind, you will find that this trimmer condenser apparently has four terminals instead of the usual two, but the extra terminals actually go to the other condenser sections which are underneath the actual trimmer.

The resistor R_8, connected across the primary of the power transformer, helps to keep down the high-voltage surges common in vibrator operation. Notice that this set does not use an r.f. filter in the B supply lead from the cathode of the rectifier tube. This is rather unusual—most auto sets have this feature.

► In addition to having the same troubles as a standard a.c. receiver, auto sets have a few extra troubles caused by the nature of the installation. Better-grade tube sockets must be used, having tight gripping contacts, to prevent the tubes from working loose. Even so, a poor contact can develop at a tube prong due to the excessive vibration to which the set is subjected. This same vibration can jar loose parts which are not firmly mounted and may pull terminals loose if the mounting leads have been pulled too tightly in the original installation of the part in the set.

SERVICE HINTS

Here are a few additional facts about auto receivers which will prove helpful in servicing these receivers.

► Poor connections must be avoided at all costs. It is extremely important that good soldering be done in auto receivers to prevent terminals from breaking loose or working loose.

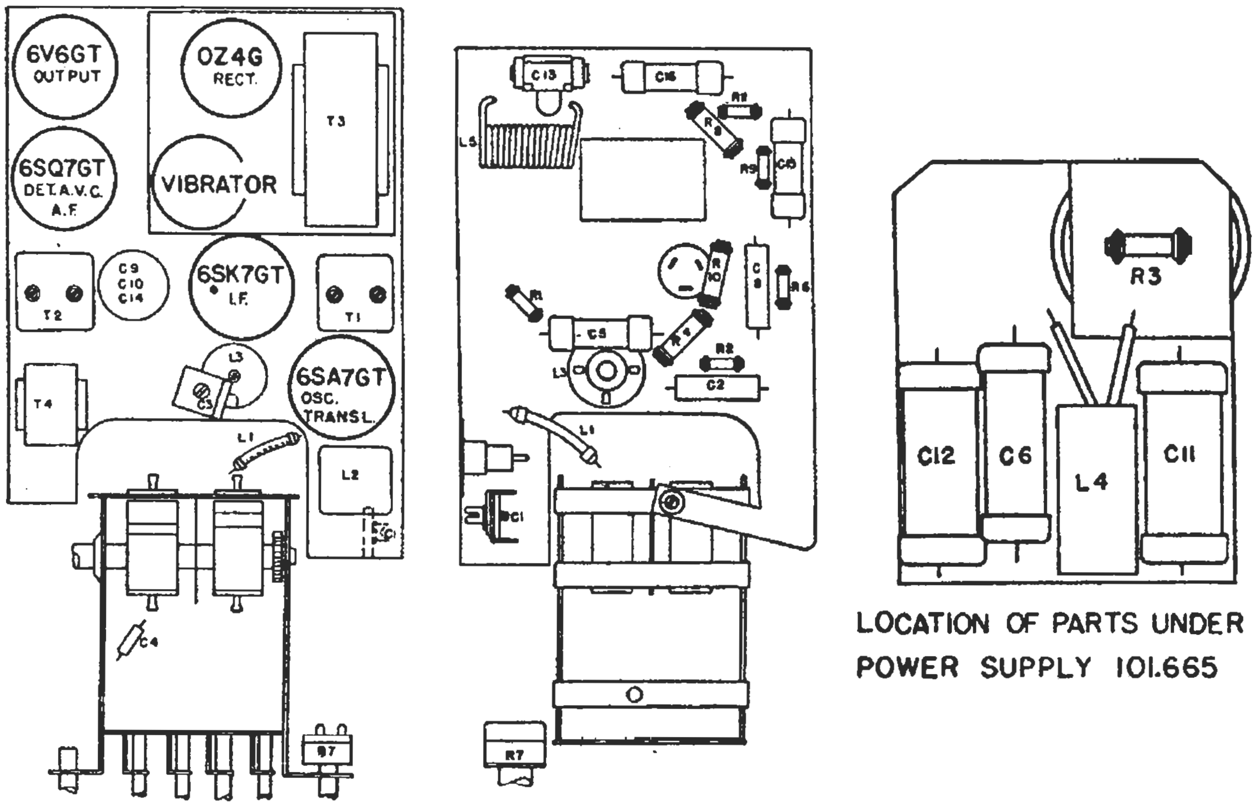


FIG. 36. Parts layout for the set shown in Fig. 35. These layouts are helpful on auto sets, where the crowded layout makes parts identification somewhat more difficult.

► Don't be afraid to jar an auto set when noise is the complaint. Lift it up an inch or so and drop it on your workbench. It will get shocks at least this severe in normal operation in the car, and frequently you will have to duplicate road conditions to localize the trouble.

The normal vibrator noise, which should be audible directly from the vibrator, is a steady hum or buzz. If this changes in pitch or stops and starts, the vibrator is not running steadily and may be either defective or overloaded.

A hissing noise, particularly if reception is weak, usually indicates a defect in the r.f. stage or antenna. The noise is the usual first-detector tube noise. Be sure to check the contacting device to which the antenna cable connects. It may be corroded or the springs may be weakened so that it is not making good contact.

► Oscillation in auto sets is due to the usual causes. However, since these receivers are highly sensitive, very slight defects may cause trouble. The positioning of leads may be quite critical and the alignment will have to be checked carefully. A poor connection somewhere can easily cause oscillation. In those models having regenerative circuits, changes in the tube characteristics may cause excessive regeneration. Another tube may cure the trouble, or it may be necessary to adjust the position of the feedback coil if such an adjustment is possible.

► Hum in an auto set will not be 60-cycle hum. The frequency of the vibrator is usually around 115 cycles per second (although some vibrators have frequencies of from 85 to 165 cycles per second). Therefore, full-wave operation will give a hum frequency of 230 cycles. This hum frequency is easier to filter than one of a lower frequency, so you will frequently find a resistor used instead of a choke coil in the filter circuit. Incidentally, practically all speaker fields on auto sets are 6-volt fields, and operate in parallel with the tube filaments from the storage battery. This type of field cannot be used as a choke coil.

From this, the hum will be 115 cycles if caused by a faulty rectifier or by grid pick-up, or will be 230 cycles if caused by defective filter condensers.

Cathode-to-heater leakage in the audio tubes will not normally cause hum unless there is some unusual stray-field condition. The filament supply is d.c., not a.c., so leakage will cause bias voltage upsets and thus distortion rather than hum in auto sets.

Farm Radio Receivers

Farm radio receivers are not only sources of entertainment—they are a means of getting up-to-the-minute knowledge about weather and crop information and prices, which are vital to the farmer. A simple, reliable radio is desired for this service, so the average farm receiver is relatively straightforward in its design. Some have short-wave bands, although most are just standard broadcast band receivers.

Of course, the receiver must be sensitive, as the farm may be quite some distance from broadcast stations. It must also have reasonably good selectivity, because there will probably be no strong local stations to over-ride interference from more distant stations.

▶ As the average farm is at some distance from broadcast stations, you will usually find a good aerial is needed. A standard antenna of the inverted L type, or one of the modern noise-reducing varieties, should be used—erected as high as possible. Since the aerial is relatively in the open, it must be rugged enough to withstand storms and high winds. Springs, or a weight and pulley arrangement, should be employed if the antenna is to be supported by trees, for trees sway a great deal in bad weather and might easily snap a rigidly-connected aerial. If a wind-charger is used, keep it and the antenna as far apart as possible to minimize interfering noises.

▶ A good lightning arrester is necessary on a farm radio. A heavy wire should be run from the lightning arrestor to an earth ground. This wire should run in a straight line to earth if possible, and the arrester should be installed at the point where the antenna lead-in enters the home. Not only is this good practice—it is a requirement in many communities for fire insurance.

▶ These farm radio receivers are serviced in the same manner as are other receivers, but their rural location will make some differences in your working practices. For example, you will find it necessary to carry more equipment with you, as it is not economical to go long distances, pick up a radio, bring it back to your shop for some simple repair, and then return it. Ordinary repairs should be made on the spot.

A serviceman working on farm receivers will usually carry with him a multimeter, signal generator, and tube tester. If the receiver requires use of signal-tracing equipment, it is more economical to bring the set to your shop. To handle such work, servicemen frequently travel over a route, picking up the set one week and delivering it another when they come back over the same territory.

Since power lines will not always be available, your test equipment should be battery-operated, or your service truck must furnish power for its operation. Tube testers represent the greatest problem, as there are few battery-operated types available. However, some 110-volt a.c. tube testers can be converted to use, or are furnished with, a vibrator type converter which operates from a 6-volt storage battery and furnishes 110 volts a.c. for operation of the tube tester.

Many farms have power lines and will use standard a.c. receivers. However, others must depend on battery-operated sets. Many of these will be vibrator powered. Let's consider these types briefly.

▶ Vibrator-powered farm radios may operate from 32-volt farm lighting sytems or from a 6-volt storage battery. The 32-volt systems include a gasoline-engine-driven generator for charging the 32-volt battery, but the 6-volt storage battery must be charged by some other means. Wind chargers have been developed which work reasonably well in most sections of the country. These consist of a wind-mill system driving a generator which is used to charge the 6-volt battery.

The erratic nature of such a charging system means that the farm radio must be rather economical in its power consumption so as not to run down the battery too rapidly. Synchronous vibrators are commonly used, as shown ing Fig. 37, to save the filament current required by a rectifier tube. As this figure also shows, economical low-voltage tubes, with filaments in

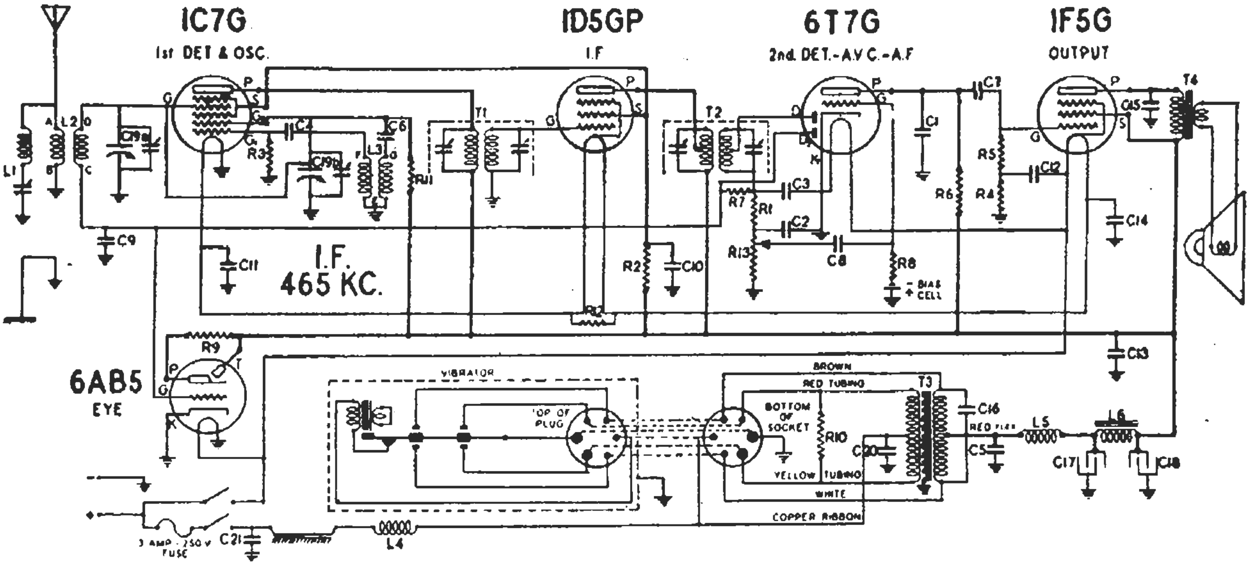


FIG. 37. A typical 6-volt vibrator-powered farm radio.

series, are frequently used to reduce filament power requirements.

► Now for a few service hints:

In a receiver like the one shown in Fig. 37, some of the tube filaments are arranged in series, so you cannot pull out any of the series tubes for circuit-disturbance testing. The set is much like an a.c.-d.c. receiver in this respect. Sets which operate on 32-volt systems also usually have some series-parallel arrangement of tubes. In fact, about the only farm radios which do not have some series-connected tubes are 6-volt sets which use 6-volt tubes throughout. For this reason, these receivers usually require circuit-disturbance tests very similar to those given a.c.-d.c. receivers.

In using an ohmmeter to check the B supply of any kind of receiver equipped with a synchronous vibrator, you may get puzzling readings caused by connections made through the vibrator. Unplug the vibrator, if possible, or disconnect it from the power transformer when you make ohmmeter measurements on the B supply circuit in such a receiver.

The use of a synchronous vibrator means the storage battery *must* be connected with the correct polarity, so be sure to follow the markings on the leads.

Lesson Questions

Be sure to number your Answer Sheet 44RH-1.

Place your Student Number on *every* Answer Sheet.

***Send in your set of answers for this lesson immediately after you finish them,* as instructed in the Study Schedule. This will give you the greatest possible benefit from our speedy personal grading service.**

1. What three things are always done to eliminate electrical interference when installing an auto receiver? A by-pass condenser at the [illegible] the A lead + the ammeter, a by-pass condenser at the generator, a suppressor at the distributor.

2. How would you bond the engine to the fire-wall? Place one end of the bonding cable under a cylinder head bolt. The other end is screwed to the fire wall.

3. What could you do to eliminate a click, heard only when the brakes are applied, even when the car is standing still? Place a condenser between the stop light lead and the car chassis.

4. Suppose you have to connect an auto set using a synchronous vibrator to a storage battery on your work bench. What test can you make with a voltmeter to determine that the connections are made with the proper polarity? Connect a D.C. voltmeter [illegible] B+ and the chassis with the + meter going to the B+. If the meter reads upscale [illegible]

5. What frequency would you expect hum in an auto set to be: 60 cycles; 115 cycles; 120 cycles; or 230 cycles?

6. Would cathode-to-heater leakage in an audio tube be likely to cause hum in an auto set?
No

7. Which of the following fuse sizes can be used for an auto set: 1-amp.; 5-amp.; 10-amp.; 15-amp.; 20-amp.; 25-amp.?

8. When ordering a replacement buffer condenser (like C_5 in Fig. 30), what must be specified in order to get the proper replacement? It must have as high a voltage rating and must have the same capacity as the original.

9. Is the field coil of an electrodynamic auto-set speaker used as a choke coil in the B supply?
No

10. What precaution is necessary when taking an ohmmeter reading in the plate circuit of a farm receiver using a synchronous vibrator?
Disconnect the vibrator to prevent false readings.