HOW TO RECOGNIZE, LOCATE and REMEDY INTERNAL RECEIVER NOISE, and INTERMITTENT RECEPTION

44RH

PIONEER HOME STUDY RADIO SCHOOL

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BENJAMIN FRANKLIN.

WASHINGTON, D. C.

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Internal Receiver Noise

INTRODUCTION

A large number of service calls are due to the development of some noise in the receiver. The set owner wants the *popping,* or the *frying,* or the *hissing,* or the *rattling,* or the *whistling* taken out. Then, too, the set owner may complain that the set plays and cuts off and plays again, or cuts off and doesn't play until some part is adjusted or touched, or cuts off and refuses to play until the set remains inoperative for some time. The last type of trouble is referred to as intermittent reception and is the most intangible sort of service work that a serviceman may encounter. Both types of trouble will be discussed in this lesson, but internal receiver noise and whistles will be considered first.

INTERNAL OR EXTERNAL RECEIVER NOISE? The noise observed may have its origin outside the receiver—that is, it may be coming in through the aerial and ground pickup system, or over the power lines. External receiver noise will be treated elsewhere in the service course.

The first thing a serviceman must do when starting out to repair a noisy receiver, is to determine whether the noise is internal or external.

If the receiver is battery operated it is a comparatively simple matter to determine whether the noise is internal or external. To determine this the antenna is disconnected from the receiver, as is also the ground. Then the antenna and ground binding posts are short circuited by running a small length of wire from one to the other. With the volume control turned on full, no noise will be heard if the source is external to the receiver. On the other hand, if the noise is still heard, it is definitely proven that there is a defect in the chassis or power supply. This test, however, is applicable only in the case of well-shielded battery receivers. Modern sets are all properly shielded, but the test is not conclusive when made on older types of unshielded battery receivers.

In the case of A. C. operated receivers, noise may be coming in over the power line, in which case, even though the antenna and ground are disconnected and shorted, external noises will get through. The only way a definite check can be made on noises entering the receiver through the power line is by the use of a line **filter.**

A typical line filter is shown in Fig. 1. While the filter may not serve to eliminate all noises coming in over the line, if there are any noises of this sort it should reduce them considerably. If the filter eliminates the noise or reduces it considerably, it can be definitely assumed that it is coming in over the line. It would be wise to reconnect the antenna and ground to see if some noise is not coming by way of the pickup system. An increase in noise indicates that it gets in by both routes. If, however, with the aerial and ground connection shorted and with a line filter between the A. C. outlet and the receiver, the noise still persists, a receiver defect is indicated.

Should you feel that the noise is a receiver defect and appears only when a signal is fed to the receiver, test by connecting to the receiver input a well shielded modulated oscillator. This test should be made after you test for external or internal noise origin.

CLASSIFYING INTERNAL NOISE: We may classify or identify the various kinds of noises according to their characteristic sounds. This is an important factor in our effect to cause analysis. We may classify noise as to nature of the source, whether it is mechanical or electrical.

You should be able to recognize the various sounds that are referred to as noise. We have: *1.* Scratching, clicking, crackling, rattling and grating noises, generally due to a defective part or connection; *2.* Whistling or swishing noises, generally traced to oscillation and regeneration in the circuits; *3.* Ringing noises, gradually increasing in intensity. They are called microphonic noises and are traced to poor design, loose parts, defective tubes or to too much volume; *4.* Hum, which will be considered elsewhere in the course, generally due to defective parts, poor original chassis layout, faulty design, poor tubes or bad connections.

From the standpoint of isolating the origin of an internal noise, the classification of whether noise is mechanical or electrical is important. Mechanical origin of noise is quickly determined.

MECHANICAL NOISE

Isolating Mechanical Noise: Not all receiver noises reach the ear through the loudspeaker. All noises that are electrical in origin, of course, do, but mechanical noises may enter the ear directly from their source. For example, the laminations in the power transformer may have worked loose and may vibrate. Cabinet doors may develop rattles. Various parts of the receiver and the cabinet may have what is known as acoustic resonance, and when a loud note comes through the loudspeaker at a particular frequency a sympathetic vibration will be set up, resulting in sound (noise). Sometimes the core laminations of an audio transformer are caused to vibrate and act as a very weak speaker unit; in this case the broadcasts will be heard even with the speaker disconnected.

A simple test can be made to determine whether the disturbing noise comes from the speaker or not. If a dynamic speaker is used, the secondary of the output transformer is disconnected from the voice coil and a good wire resistance unit of the same value as the A. C. resistance of the voice coil is shunted across the secondary, as shown in Fig. 2. If a magnetic speaker is used,

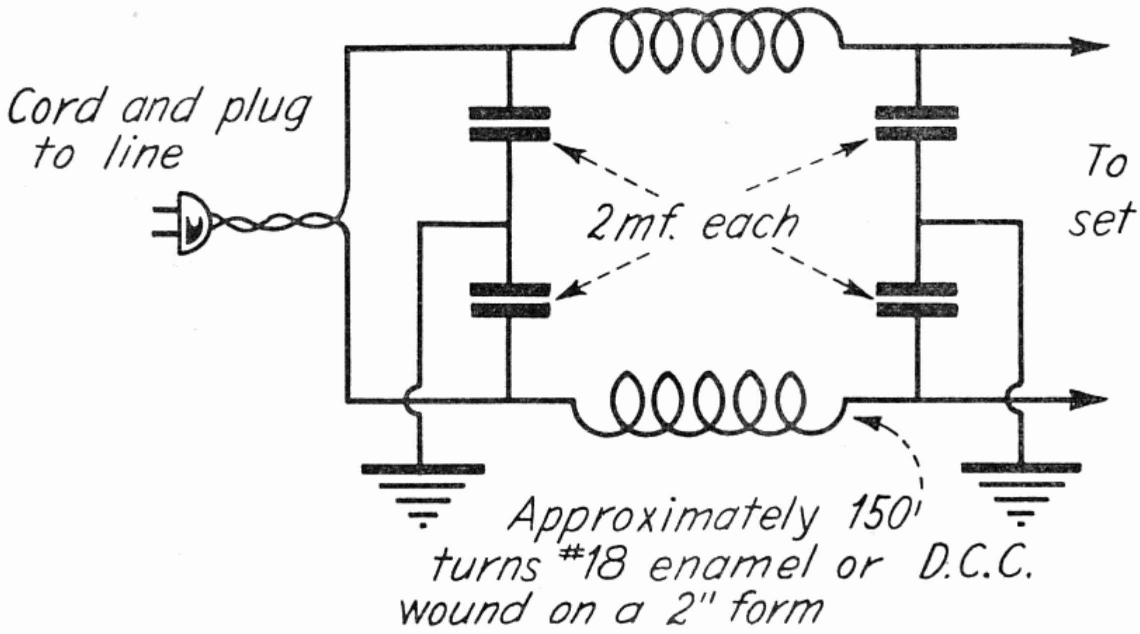

FIG. 1

the armature coil is disconnected and a shunt resistance is connected in its place. In the case of a dynamic speaker, the resistance may be from 6 to 30 ohms. In the case of a magnetic speaker, the average resistance is 4,000 ohms. There is no need of being exact in regard to the value of the resistance used in this test.

If the noise is still present with a resistance substituted for the magnetic unit or moving coil, we can be sure that the defect is mechanical, and that the sound is coming from the transformer laminations or some vibrating part. However, if there is no noise, test the speaker, in a manner to be explained shortly.

Microphonic Tube Noise: A very troublesome type of howling noise is caused by what are called "microphonic" tubes. These noises are most frequently low pitched ringing noises, which, when started, gradually increase in intensity. A microphonic tube is one which has loose elements—that is, the filament or generally one of the grids is not mounted very rigidly on its supports. As a result any mechanical vibration which reaches the tube causes the loose elements to vibrate. The distance between the elements varies, modulating the signal by varying the plate current in that tube. This changing plate current is amplified through the set and the speaker emits a howl.

There are two major causes for setting up tube vibration. First, sound waves coming directly from the speaker, which is technically called "acoustic coupling." Second the sound from the speaker causes the cabinet to vibrate and the cabinet vibrations are mechanically transmitted to the receiver chassis and then to the tube.

The detector is the most sensitive and the most likely to cause trouble. Placing your hand firmly on the detector tube will generally stop the howl, as the vibration is damped. In the older sets the detector tube was mounted on spring sockets or sponge rubber supports, which acted as a cushion or shock absorber. This is not as a rule necessary with present day tubes, because in the modern tube the elements are attached at the top to a mica disc which is supported by the glass dome. Modern tubes are designed to be non-microphonic.

The following remedies will generally be found satisfactory:

1. Change detector tube. A new tube need not necessarily be used if similar type tubes are used elsewhere on the chassis. Simply interchange tubes until a satisfactory tube is found for use in the detector socket. Although a tube may be microphonic when used as a detector, it will generally be satisfactory when used in an R. F. or A. F. stage.

2. In the very old table model sets using an external speaker, placing the speaker a short distance away from the set will often eliminate the howl. Turning the speaker in a different position may also help.

3. Use of the damper. "Tube damper" is the name of a heavy weight designed to fit over a tube. It is called a damper because it damps out or prevents the tube vibration. One of these weights placed on the microphonic detector tube helps to eliminate microphonic howls. In the case of tubes surrounded by a metallic shield the inside of the shield may be stuffed with asbestos wool. Try a modern tube of the same type.

Although a microphonic detector tube causes the most trouble, we should not overlook the first audio which also is sensitive to picked-up noise. Therefore, after correcting the effects due a microphonic detector tube and the noise is still apparent, correct possible trouble in the first audio stage.

Mechanical Rattles: Rattling noises that are by the process of elimination definitely shown not to exist in the speaker, as a rule are due to loose chassis parts. Any loose parts in the receiver or cabinet such as loose screws, nuts or hardware, if not securely mounted, may be set into vibration by the loudspeaker when operating. Noises thus developed are clicking, rattling, and

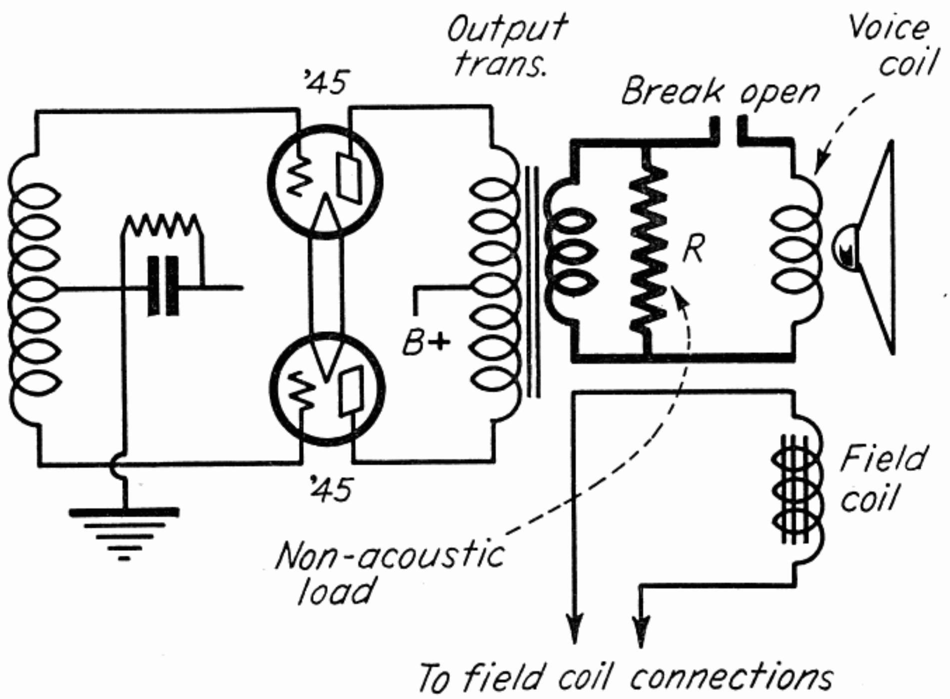

FIG. 2

metallic noises. The remedy, of course, is to go over the set and tighten all loose parts.

Mechanical A. C. Hum: A humming noise, if heard with the loudspeaker disconnected, may be due to vibration of the iron laminations in the power transformer, choke coils or audio transformers. The laminations may not be clamped tightly enough or a coil might be loose on its core. Tighten the clamps on the transformer or choke, wedge the transformer or choke coil tightly by means of bakelite spacers or thin pieces of dry wood driven in between the coil and the iron core. A study of the mechanical structure of the part will reveal the best possible way of correcting the defect. Quite often coating the ends of the lamination with a sticky non hardening varnish will stop this trouble. If the transformer is in a water tight case and the part does not overheat, pouring in insulation pitch may correct the disagreeable humming noise.

Mechanical Resonance: Noises which are directly caused in one way or another by the sound waves eminating from the loudspeaker are particularly prominent in sets where the loudspeaker is mounted in the same cabinet with the set. They are continuous ringing or moaning noises gradually increasing in intensity.

With a loudspeaker in operation, the sound vibrations set up mechanical vibrations which are transmitted to all parts of the set. For example, when the sound vibrations strike the tubes, microphonic noises are developed as previously explained. Sound vibrations similarly affect other parts of the receiver. This is readily proved in console sets by lightly touching the walls of the cabinet with the finger tips. The walls of the cabinet act like diaphragms. The greater the intensity of sound delivered by the speaker the more the cabinet will vibrate. But the magnitude of the wall vibrations is influenced by one other factor; namely, acoustic resonance. Every speaker we know has a "resonant" frequency—that is, it responds more to certain frequencies than to others. They are in effect "favorite" frequencies. Any part of the console is also capable of vibrating at its "natural" frequency —the frequency at which it vibrates most readily. When a frequency emitted by a speaker corresponds with the natural frequency of, let us say, the cabinet wall, a violent vibration of the wall takes place. This vibration is, of course, transmitted to all parts of the radio set, and may cause a microphonic howl.

In a number of modern receivers the chassis is made so that it floats on springs or sponge rubber. If such a support is included in the chassis which you are trouble shooting for this type of noise be sure that it is free to float. If freeing the chassis does not eliminate mechanical resonance, it may be possible that the rubber has hardened. Try new ones. If the set you are working on does not have this feature, unbolt the chassis and set it on sponge rubber. Be sure to keep the cabinet at least 2 to 4 inches away from the wall. The back of a console should be open.

Where a cabinet wall vibrates excessively, it has been found that, by lining the cabinet walls with celotex, or other acoustic sound absorbing material, the resonant frequency of the cabinet can be reduced or its amplitude of vibration reduced.

While we are on the subject of vibrating objects, it can be mentioned that the serviceman should look for loose ornaments, glass or wooden panels near the console speaker. Sympathetic vibrations may be set up external to the machine.

If the variable condenser plates vibrate, a howl is sure to be heard. Condenser plates have natural frequencies at which they vibrate most readily. When condenser plates vibrate the capacity changes periodically and the circuit is thrown in and out of resonance. The frequency at which this detuning takes place is the frequency at which the condenser plates vibrate. The variation in capacity has the same effect as if the radio wave were modulated at the vibration frequency. If these frequencies correspond with loudspeaker resonance peaks, the plates will vibrate more vigorously.

The same is true of inductance shields. The shields are subject to vibration if they are not rigidly mounted. When a coil shield vibrates, its position relative to the coil changes, and therefore, the inductance value of the coil changes. This causes detuning at the frequency of vibration, and a howl is set up. If the vibration frequency is the same as the natural frequency of the shield, the howl is intensified.

While the remedy in these cases may be obvious, it is not always easy to apply. Of course, shields should be fastened as rigidly as possible to the chassis. The original design is frequently at fault in that the shield material is too thin and subject to vibration. Thick shields are less apt to cause such trouble.

In the case of the condenser the vibrating plates are generally the rotor plates because they are not as rigidly mounted as the stator plates. Where it is possible, mounting the condenser on rubber or mounting the entire chassis on rubber feet will remedy the trouble, since the rubber acts as a shock absorber taking up the vibrations. Finally, mounting the speaker on rubber feet, and using celotex or some other sound absorbing material as a baffle will also assist in eliminating the howl.

ELECTRICAL DEFECTS CREATE NOISE

Electrical Origin of Noise: Any defect in the electrical circuit may give rise to steady or irregular crackling, scratching, grating, hissing and frying noises. They may be due to improper wiring connections, broken down insulation, poor tube prong contacts, shorted trimmers and variable condensers, defective tubes, defective variable and fixed resistors, defective coils and condensers, defective speakers, or run down batteries. We may hear whistles and hissing due to oscillation or regeneration in any

R. F., I. F. or A. F. stage. How can we recognize and repair such defects?

Electrical Connections: Defective connections or contacts are noise generators. This is usually readily detected by moving the leads to see if they are loose and noting whether the noise increases or decreases. Don't ever be afraid to pull on a connection if you suspect it of being defective. It is far better to have broken the connection entirely and to resolder it than to take any chances of having a rosin joint and an intermittent contact. The presence of a large amount of rosin around a soldered joint is almost a sure indication of an improper connection.

The presence of a green discoloration at a joint is a definite

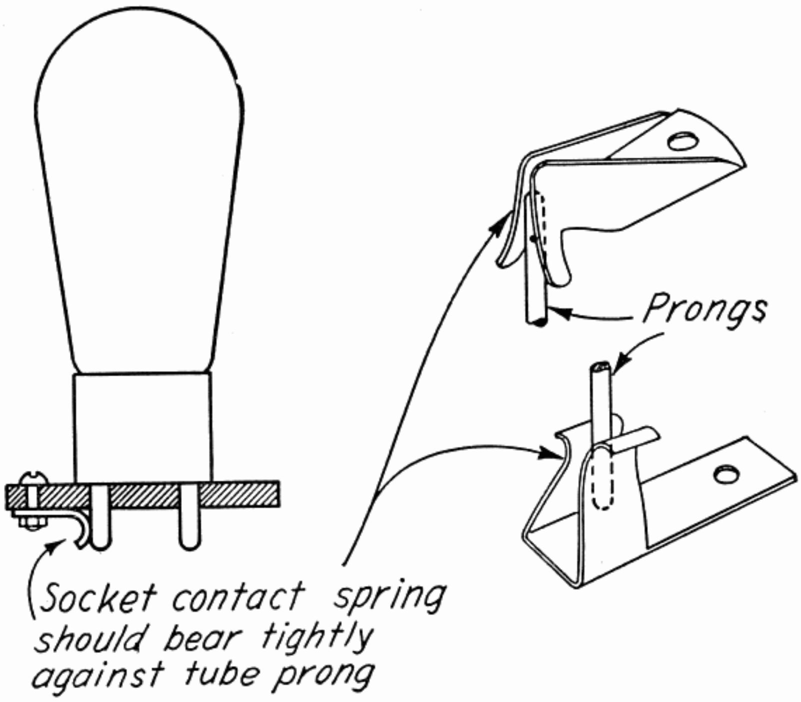

Fig. 3

sign of corrosion and indicates a possible source of noise. The only thing to do in this case is to resolder these joints after they have been perfectly cleaned. A poorly soldered joint will result in noisy reception in any radio circuit. This is because it causes irregular variations of current which are amplified and appear in the loudspeaker reproduction as disturbing noises.

Defective Socket springs are a sure source of noise. Some servicemen get into the habit of looking for this sort of trouble first, and by wiggling the tubes around in their sockets while the set is playing.

Socket spring contacts are made of rigid material which should spring back against the tube prongs when the tube is inserted in the socket. This material is usually a phosphor-bronze metal, nickel or cadmium plated. Socket contacts are really springs which exert pressure on the tube prongs at all times. Such springs may make good contact when new and then later develop poor contact for various reasons. The application of heat from a soldering iron to the spring may cause it to lose its temper and "its springiness." Heat softens the metal and continual pushing and pulling the tube out of its socket may result in giving the socket springs a permanent set away from the tube prongs with the result that intermittent contact is made or none at all.

If you bend a spring, it pushes back against the bending

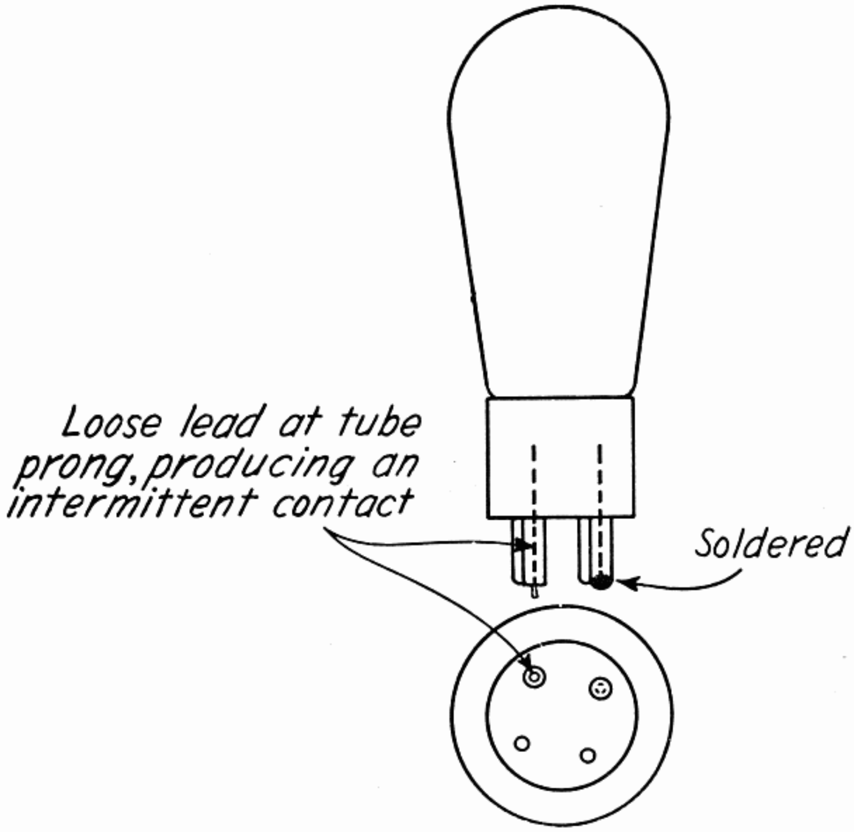

Fig. 4

force. This back pressure makes the contact. On the other hand, if you bend a piece of soft metal, it stays bent. This is what happens when the spring contact is soft. Bending the spring towards the tube prong till contact is made as shown in Fig. 3 will usually correct the trouble. However, if the spring is really bad or very soft, replacement of the socket is the best remedy.

Defective Tubes: If noise is traced to a tube and if examination of the socket spring contacts shows that there is a good contact between springs and tube prongs, the tube may be internally defective. Remove the tube and examine the tube prongs to see if there is a loose wire in the prong. Continual removing of the tube from the socket for various reasons may have caused the small amount of solder on a tube prong to have worked loose or dropped out. A drop of solder at this point will remedy this trouble, as shown in Fig. 4.

Even if the tube prong contacts are satisfactory, the trouble may be internal in which case a new tube is needed. Loose tube elements will cause noise. Frequently, a tube test will show up this defect. Tap the tube lightly with the fingers. No irregular noises should emanate from the speaker. A slight ringing noise may be noticed, but this is normal. If tapping a particular tube results in a crackling or sputtering noise, it is a sure sign that the tube is defective, or has internal loose elements or has a loose contact.

Defective Insulation: A frequent cause of a sputtering, hissing and frying noise is defective insulation. If an incomplete breakdown occurs between two points, noise results. Poor insulation in a power transformer may cause flash-overs and sparks. A frequent source of trouble is the bakelite terminal strip which generally carries all the metal terminals. The terminal strip should be thoroughly cleaned and dried. If leakage or breakdown has taken place, a part of the strip may have become carbonized or charred. This part should be scraped away with a knife. Dirt between posts may absorb water and at high potentials cause the same trouble. Dirt then, if present, should be removed. Breakdowns and leakage often become visible in the form of sparks which can be observed while the set operates in dim surroundings. In this way the offending part may be located. Power transformers, choke coils and filter condensers should be checked very closely since they are in the high voltage circuits. The rectifier tube socket should also be carefully examined for signs of leakage and possible breakdown.

Lead wires carrying high voltages, if close to wires at low voltage may result in trouble. If the insulation between them is punctured, there will be sparking between them and naturally noise will appear. This is especially true in hot, damp weather, and in humid areas where moisture condenses on the insulation. The only remedy in such cases is to use wire with the best of insulation, waxed and moisture proof (spaghetti,) and to separate wires and terminals at high and low voltages.* Where sets must

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* Sparks and insulation breakdowns are determined by voltage difference. One wire may be at a high positive voltage, while the other may be at ground or at a high negative potential.

be operated in damp localities such as along the sea coast, it is sometimes desirable to remove R. F. coils, choke coils and other small parts and soak them in hot paraffin. Should the coils become moist, bake them in a ventilated oven, before dipping in hot paraffin. This will drive off the moisture.

Failure of wire insulation may be caused mechanically. For example, if a high voltage carring wire is caught underneath a metal clamp, the insulation may be broken mechanically. The wire may be partially grounded, causing an intermittent electric breakdown. Examination of the wiring will do considerable to locate such causes of noise.

Variable Condenser Plates: The variable condenser some-

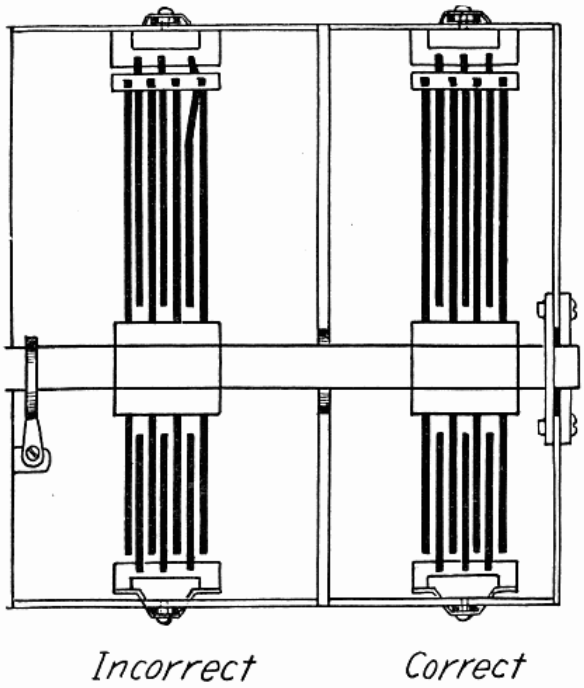

FIG. 5

times is the cause of clicking noises, especially as it is rotated. If the clicking noises occur at some definite dial setting, it is probably due to the condenser plates being bent out of line. As the position of the rotor plates are varied, the bent plates short against adjacent stator plates and a clicking noise is heard. Figure 5 illustrates such a condition. The bent plates should be straightened out and the condenser lined up to clear neighboring plates. After condensers are mechanically realigned, the stages should be electrically realigned.

In practically all receivers which have been operating a year or more, dust will have collected along the surfaces of the condenser plates. In time sufficient dust collects to make contact between the stator and the rotor plates as they are rotated. This dirt having a high resistance, short circuits the plates and a scratching type of noise is heard as the receiver is tuned. The remedy, of course, is to clean the condenser plates. This is best done with an ordinary tobacco pipe cleaner. Rub the cleaner over the entire surface area of both rotor and stator plates. Be sure to remove all dust and particles present. The use of air under pressure for this purpose is quite advisable, if a supply of compressed air is available. Many servicemen have at their workshop a hand bellows for cleaning purposes.

A number of variable condensers have been made where the plates of the condenser have been copper or cadmium plated. The plating often peels, resulting in noise as the main station selector dial is turned. A temporary cure, is to disconnect the condenser from the receiver and apply a 300 to 500 volts A.C. or D.C. source to the two condenser terminals. Be sure to use a series resistor to limit the maximum current flow. If the trouble persists use a new replacement condenser, with heavy aluminum plates. Such a procedure will only be possible if the dial is not calibrated in kilocycles or meters, as you are bound to upset the calibration. Do not try a replacement in superheterodyne receivers, as you are bound to have serious trouble in tracking.

A pressure contact between the rotor shaft and the condenser frame is the only electrical contact provided in most ganged variable condensers. If you find that noise traced to a variable condenser is not due to shorted plates, suspect this moving contact. Attach a pigtail connection. Drill the shaft and solder into the hole a flat flexible braid wire. Starting with the variable condenser open, or closed, wind up the braid and solder or clamp the other end of the braid to the condenser frame.

A Defective Gassy Tube will often give an undesirable *hiss.** This is particularly true if the tube actually glows. Test the plate and grid voltages. If they are not normal correct the defect causing it before trying a new tube. If the new tube works, try the old tube. Never try to adjust the voltages so a gassy tube may be used. Never try a new tube before checking the supply for abnormally high plate and low grid voltages.

Variable Resistors or potentiometers used as volume, tone

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* Do not confuse this with the hiss found in supersensitive receivers. As the tubes most likely to be gassy will be in the detector and A.F. system, you can check natural circuit and tube hiss (thermal agitation and tube shot effect) by shorting the input of the first or second R.F. stages. Hiss following this test is probably due to a gassy tube. Regeneration always accentuates hiss.

and minimum sensitivity controls very often become defective because they are constantly adjusted. They also may give rise to undesirable noise. Such defects are quickly identified by operating the receiver. If the defect is not a mechanical one that is easily remedied by soldering, bending contacts to get a better electrical connection or separating loose wires, it is far wiser to discard the control for a new one. Defects in the carbon strip of non-wire wound resistors cannot be successfully repaired. A new control should be used or if it is possible to obtain a new resistance element it should be installed. Don't try to "doctor" the resistance strip with a pencil or carbon smear, as such repairs are not permanent.

Resistors are frequently the cause of noise. It is not rare to find a noisy wire wound resistor. Because the kind of wire used in resistors is not easily soldered to, poor terminal contacts often occur. In some cases the manufacturer has only used pressure or clamp terminal contacts. High resistance wire wound resistors are made with a fine wire which breaks easily. A spark connection at the break gives rise to unusually severe noise.

Carbon and metallized resistors of even reliable make may have poor cap connections (point where the resistor unit makes contact with a moulded cap). Recent improvements in construction have naturally reduced such a possibility, yet you should be on the lookout for poor cap connections.

Test resistors with an ohmmeter and twist caps gently or press hard on terminal contacts for erratic needle readings.

Because of the granular construction of moulded carbon resistors, heavy current may cause uneven distribution resistance resulting in erratic current flow, in turn, giving rise to a hissing output. Usually this will be accompanied by a condenser or circuit breakdown which causes excessive current to flow through the resistor. It is assumed that the set maker had no original intention of overloading the resistor.

Bypass and Filter condensers may be the source of noise. Particularly suspect the type that is in a case. The internal leads may make poor terminal connections. A condenser that has been internally punctured may have an arc between the foil plates. Grimy, dirty condensers may be leaky on voltage rises. Often a moulded condenser is riveted to the chassis, the rivet connected to one side of the condenser (low potential terminal). If the rivet works loose, noise will be heard. Wet electrolytic condensers if operated beyond the safe voltage may sizzle, the noise coming direct or through the circuits. If a condenser looks like a possible source of noise, first be sure that it is mechanically perfect, that the circuit voltages are correct. Then try a new condenser. The condenser, unless defective, should hold a charge, have no unreasonable leakage, and should be able to handle peak voltage. This you can only determine by direct test, not by guess.

*Coils and Transformers,** in fact any electrical component of a receiver may produce noise, if their terminal leads or wires, if the wire used in the device, opens so that only a poor or arc connection exists. An ohmmeter test will show internal defects by its inability to hold its resistance reading.

Poor wire joints caused by electrolysis may even produce noise due to the voltages produced at the joint, modulated by vibration. Poor coil and transformer insulation may often be charred or carbonized and give rise to unwanted noise.

The speaker is another source of noise, and any one with some experience in repairing receivers can recognize most speaker noises without making complicated tests. If you are doubtful of whether or not the noise is due to a speaker defect, substitute a speaker known to be in good condition for the suspected speaker. This will immediately tell you whether or not the speaker regularly used with the receiver is defective. If you are employed by a dealer or distributor of receivers, you will find it convenient to have an extra speaker of the type used with the receivers you service most.† If a substitute speaker is not available, you may connect a head set to the secondary of the output transformer, listening for possible noise in the sections ahead.

Those noises which are due to the speaker proper are, in general, mechanical in origin, and therefore consist of rattles, clicks and scratches. Most troubles can be detected by a keen visual inspection. Any mechanical moving part of the speaker should be examined for rigidity and alignment with reference to other parts of the speaker. The two main types of speakers in use are the balanced armature and moving coil units driving either a cone or a column of air through a horn.

In another lesson complete instruction on the repair of

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* In another text special tests on condensers, coils and resistors are taken up. Here we are only concerned with the fact that they may be a source of noise, how they may produce noise and the obvious service remedies.

† The makers of the Philco receiver, supply their distributors with a master speaker arranged so that the field resistance and inductance, and the proper speaker impedance can be adjusted for all types of their receivers.

speakers is given. This should be reviewed, keeping in mind defects and breaks which lead to receiver noise. We should mention here that in inspecting a speaker, look for loose parts, poorly soldered joints, loose nuts and screws, improper centering of armature of moving coil, dirt in air gap, bent driving pins, wet paper, fatigued diaphragms, locked armatures, loose turns on the voice coil, charred or defective insulation, open field coils and weak permanent magnets. Don't forget that, unless the speaker you use in tracing noise is perfect, and is a satisfactory electrical replacement for the defective one, it is a useless instrument for the detection of noise.

Battery Operated Receivers: The battery power supply is often a source of noise. The terminals corrode and poor internal or external connections develop. Moving the receiver around may have resulted in the development of poor external connections. The battery leads should be braided or tied together if possible, and kept free from contact with any moving object so that there is never any strain put on the battery connections and there is no chance for the insulation to be cut through by rubbing against a sharp object.

If a storage battery is found with corroded terminals, clean them thoroughly with a toothbrush and ordinary ammonia, but be careful not to spatter any on the house furnishings or in your eyes. If the battery clips are found to be corroded, clean them in the same way. Then apply with a small stiff bristle paint brush a thick coat of pure white vaseline to prevent future corrosion.

Run down B batteries are also frequent sources of sputtering and crackling noises. Each 45 volt B battery should be renewed when the voltage under load falls below 37 volts.

Often it is a single cell in a B battery that is a source of trouble. If this is the case, the voltage of the B battery when operating under full load will drop off. A voltage measurement of the battery when it is not delivering power is not an accurate check, as defective cells recover to a certain extent when not working. Always test a B battery with a high resistance voltmeter with the receiver in operation or with an equivalent resistance connected across the battery. If there is a shorted cell in the battery, its voltage will drop off 1.5 volts for each defective cell. The drop may be even more than this, due to the defective cell acting as a high resistance. Replacement of the B battery is the only remedy.

Storage batteries may be tested in the same way if there is no hydrometer handy. If the voltage of an ordinary 6 volt storage battery drops off as much as 1.5 or 2 volts, it either needs re-charging or a cell is defective. A freshly charged A battery may cause some of the older type battery sets to oscillate at first when the volume is turned on full, as the battery may deliver slightly more than 2 volts per cell. Explain this to the customer telling him to keep the volume at a point where oscillation does not occur until the battery looses its excessive charge.

NOISE DUE TO REGENERATION AND OSCILLATION

Noises which are characteristic of some form of feed-back and oscillation generally manifest themselves as high pitched whistle, squeal, howl, and "put-put" noises, the latter commonly called motor-boating. Feed-back or regeneration may occur in one form or another, in almost every set. It occurs whenever the

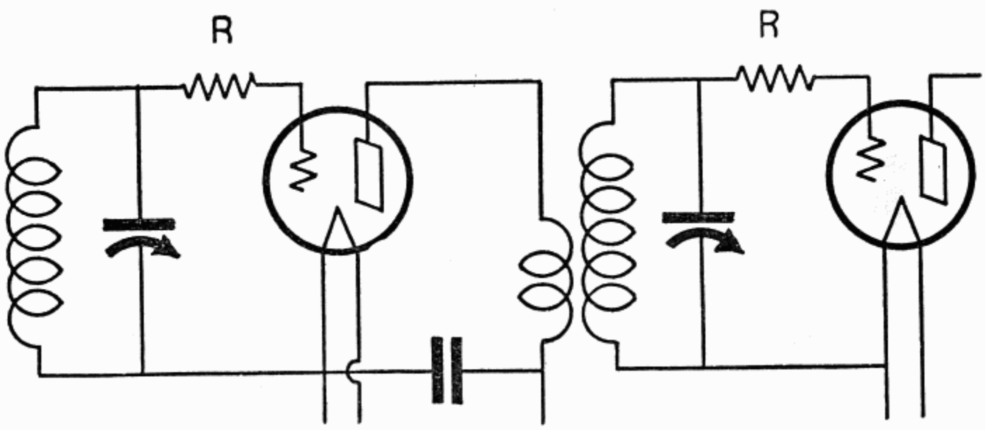


FIG. 6

plate circuit of a tube is accidentally coupled to its control grid, and whenever the output of an amplifier is coupled to any part of the amplifier ahead of it. This is especially true in screen grid sets.

When the set oscillates at radio frequency a characteristic squeal or whistle is heard. The pitch of this whistle changes, going up and down in scale, as the variable tuning condenser is rotated slightly from the point at which the squeal is heard.

Receivers which employ feed-back and oscillation neutralizers may squeal or whistle if the neutralizing adjustment has been jarred or tampered with. Replacing tubes may cause the original neutralization adjustment to be ineffective. Open grids in the R. F. section, defective or inadequate grid suppressors often give rise to squealing. These facts you are acquainted with, but you should remember that neutralizers are used only in

R. F. and I. F. stages where triode tubes are employed. Triode amplifiers are generally to be found in the older receivers. This does not mean that screen grid and pentode tube stages will not oscillate, but it is generally due to shift in grid and plate wires, or an open shielding, or an open condenser, or excessive plate or screen voltages, or initial poor design.

When you have finally traced the squeal to a feed back not

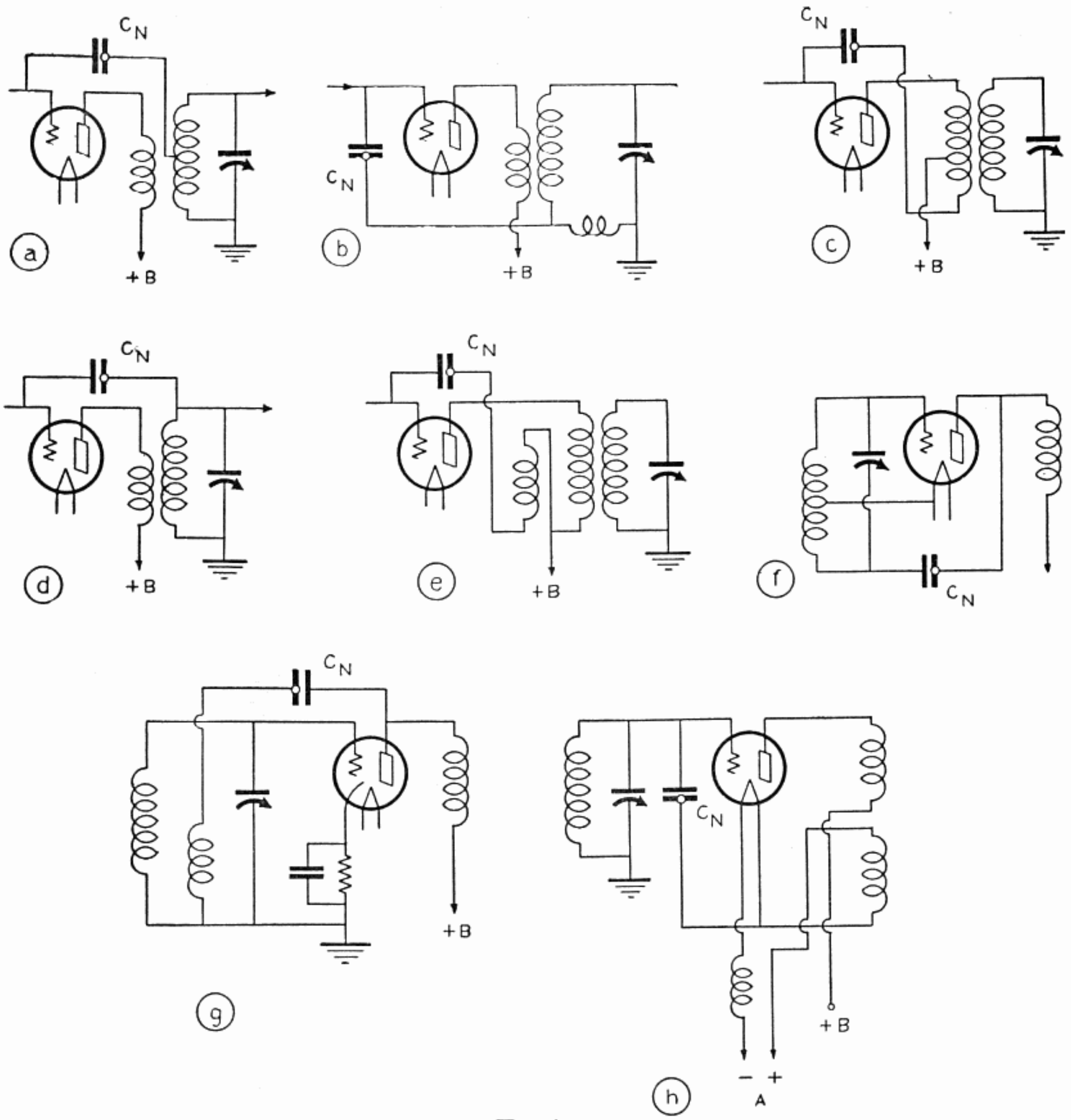


FIG. 7

due to an imperfect ground, excessive supply voltage, imperfect shielding, open by-pass condensers, or misplaced plate and grid wire, and no scheme of neutralization is used then suppress the squeal by placing a resistor in the grid circuits as shown in Fig. 6. It is generally inadvisable to add neutralizing circuits although the scheme shown in Fig. 7d may be tried. Grid suppressors varying from 100 to 1,000 ohms may be tried, connected in series with the control grid connection in each case using the smallest value necessary to destroy the objectionable feedback.

Feedback from the plate to the grid circuit was eliminated in a large number of the old receivers, by a counter-fed voltage. Figures 7a to 7b show some of the circuits used. These circuits are used in either filament or heater type triode tube circuits, never in tetrode and pentode tube circuits. The theory of adjusting an R. F. stage is as follows: With the filament circuit of the tube open, tube inactive, the signal may be passed into the next stage either through the grid-plate capacity of the tube or through the coupling circuit associated with C_n, the neutralizing condenser. As the two signals fed through are in opposition to each other neutralizing is realized when C_n is adjusted so no signal is passed on.

In Radio circuits where filaments are in parallel merely opening the filament circuit of the tube whose stage is to be neutralized is necessary to make the tube inactive. Use a universal socket adapter with an insulation peg in the filament lead or slip a soda fountain straw over one of the filament prongs. In series filament circuits, as used in some receivers, the filament is opened at x in Fig. 8 and the external filament circuit is completed with a resistor R equal to the rated tube filament voltage drop divided by the rated tube filament current. Other schemes have been suggested as operating the tube at high grid cut-off bias, or opening the plate circuit without disturbing the plate supply to cathode by-pass condenser, point y in Fig. 8.

The usual procedure in neutralizing the circuits shown in Figs. 7a to 7h is as follows:

1. Tune the receiver to a modulated signal generator adjusted to about 1000 kc. A local station may be used.
2. Make the tube ineffective as an amplifier in the way just described. Tube filament will not light or heat. Start with the R. F. or I. F. stage nearest the receiver input that employs a neutralizing circuit. Always use the tube to be left in the receiver. Therefore, first test the tube for mutual conductance.
3. Using the appropriate neutralizing tool adjust C_n, the neutralizing condenser, midway between the adjustments where an aural output signal is heard. If removing the tool upsets the adjustment, compensate so that no signal is obtained when the tool is withdrawn.
4. Restore the normal connection of the tube so that it will amplify.

5. Repeat the procedure for each R. F. and I. F. tube provided with a neutralizing adjustment.

If, after neutralizing the set, the oscillation noises still continue, it indicates that there are some other forms of feedback coupling present.

In general, if oscillation is present in the radio frequency stages, the following may be the cause—this may be true even of modern screen grid and R. F. pentode tube systems.

1. *Poor or No Grounds.* Receivers may oscillate if a poor external ground is connected to the receiver. In fact short wave regenerative receivers often work better when the main ground is disconnected.

Various parts of the receiver are grounded for example: one end of grid coils and resistors, cathodes, C bias resistors, variable

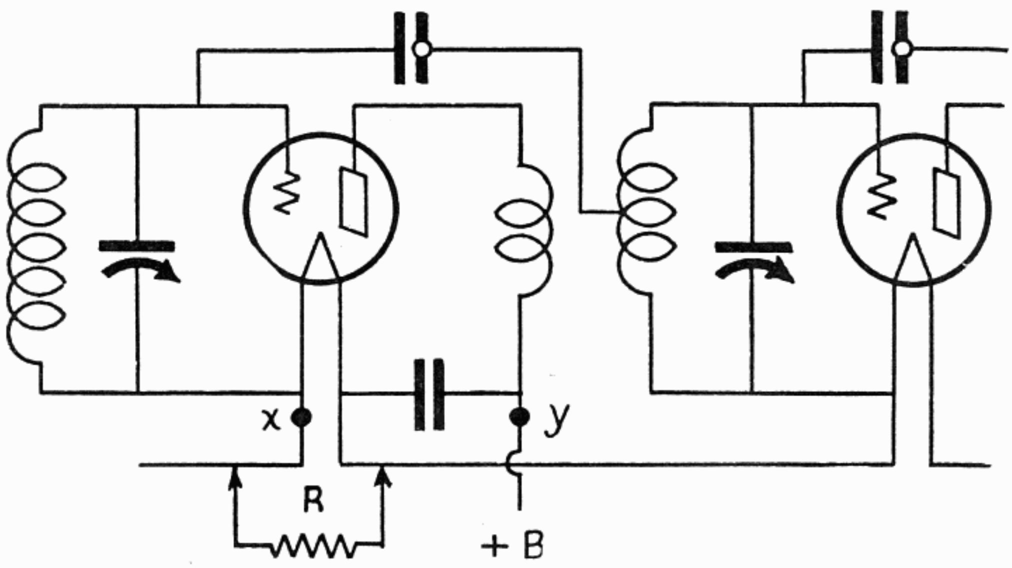


FIG. 8

and fixed condensers, shields, etc. Should a poor ground connection exist at some point in the receiver, the signal current may be forced to take another path to ground, often coupling with another stage to set-up regeneration and oscillation.

In broadcast receivers it is customary to use the chassis frame as the common ground connector. For low R. F. frequencies the impedance of signal paths through the chassis is so low that even if various stages have a common coupling through the frame, the voltage drop existing is too small to cause serious feedback. Should a ground connection at some part open or even become a high resistance joint, the signal will take another ground path, with the resultant feedback. The remedy is to go over the chassis for poor coil, condenser, resistor and shield ground connections.

Short wave receivers often employ special ground wires from the various circuit components, connected together at the ground binding post or some common point in the chassis. Unless these ground wires are carefully laid out, feedback is likely to occur. Look for misplaced or open ground lead wires.

2. *Too much gain* or amplification will also cause excessive regeneration or oscillation. There is a definite limit to the amount of amplification which every set is capable of giving, and still be stable. This limit is primarily set by the amount and nature of the shielding—the layout of the lead wires, and the constants of the circuit. The better the shielding in a given set the more amplification we can get out of it along with stability. But there is a definite limit to this amplification which is set by the designer of the receiver. Now if there are any conditions which tend to increase this amplification, feedback and oscillation will occur, with resultant noises. The amplification of an R. F. stage increases with the plate voltage and also with the screen grid voltage applied to the tubes. Check these voltages to see if they are excessive.

3. *Imperfect shielding*. The object of shielding is to prevent coupling from one coil to another, or from one condenser to another. Reliable makes of receivers are supposed to have satisfactory shielding. The trouble frequently arises when the shields are not securely in place. For example, the shield over a coil may not be clamped tight to its bottom plate leaving an opening or crack. This crack is sufficient to allow the magnetic field to leak out and enter another stage and so cause oscillations with resulting squeals. Shields may not be properly grounded. The shielding should, therefore, be examined to make sure that it is in good condition.

4. *Open by-pass condenser*. In some receivers, for the sake of economy, the tubes may be operated from a single bias resistor shunted by a condenser. The screen grids and plates connect to a common supply terminal shunted to ground by a single condenser. See Fig. 9. Should one of these condensers open, coupling from one stage to another may cause regeneration or oscillation. In general any open by-pass condenser in any type of circuit may cause undesirable interstage coupling attended by squeals and whistles. Even if the condenser is intact, its by-pass action may be inadequate. Try a condenser with a larger capacity or use resistor-capacitor filters. Open or inadequate by-pass condensers give rise to a howl or squeal that may be heard without tuning the receiver.

5. *Haphazard wiring* of the plate and grid leads may result in coupling, causing oscillation. If the grid and plate leads in the radio frequency circuits are wired very closely together or run parallel to one another, voltages are induced from one circuit into the other causing regeneration. These should be separated and placed as far apart as practicable so that these couplings are eliminated. In most cases it is best to have the plate leads nearest the chassis.

AUDIO FREQUENCY REGENERATION

Whistling noises, squeaks, put-puts and howls may be developed in the audio frequency amplifier independent of the radio frequency amplifier. The following causes for this trouble with the remedies should be carefully studied.

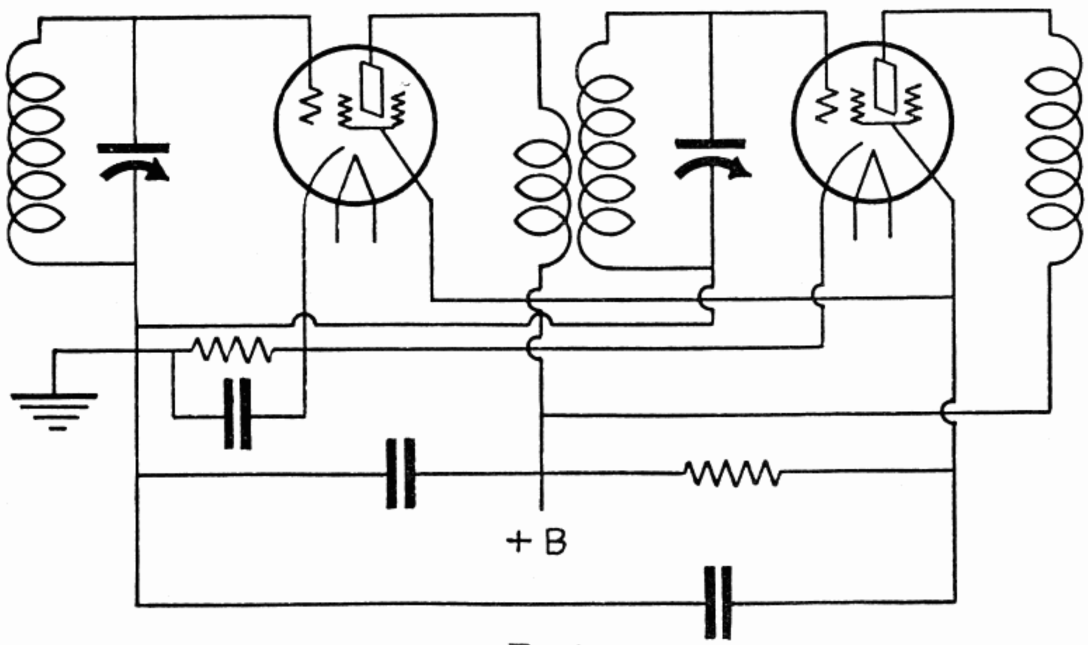


FIG. 9

1. Coupling between speaker leads and detector grid circuits. If the speaker leads, A. C. line leads or plate leads from the audio frequency tubes are close to any part of the detector grid circuit, such as a grid resistor, grid condenser, grid lead wires or near the detector tube itself, a squeal may be heard. The remedy, of course, is to remove these leads as far from the detector circuit as possible.

2. An open plate circuit in the detector may also cause howling. This may be an open in the primary of the transformer located in the plate circuit of the detector, or an open plate circuit between the power pack and the audio transformer, or an open power supply bypass condenser in the plate circuit.

This particular trouble is easily verified by checking the plate-chassis voltage. If this voltage does not exist check the plate supply. If this is found intact the plate coil or resistor is open. Complete the connection or replace the defective part. If the howl is still present, the detector tube may be defective and should be tested. However, if the tube and transformer are O. K. but there is no plate supply voltage, check the power supply by tracing all connections and make the necessary corrections.

3. Open grid circuits in any part of the audio amplifier will cause a low pitch squealing or howling noise. An open secondary of an audio transformer, an open grid input resistor or an incomplete grid return may be causing the trouble. This condition is generally indicated by an absence of grid bias voltage on the audio frequency tubes. Where a high resistance path is normally provided for applying the grid bias, an open grid circuit is best checked by measuring the cathode-chassis voltage and the plate current.

4. Open by-pass condensers or insufficient by-pass condenser capacity in the plate or grid bias circuits of the audio frequency tubes will cause the same noises. This is generally the cause of motor-boating. When motor-boating and hum are heard it may be due to inadequate power pack filtering particularly the filter output condenser. Check plate-cathode by-pass condensers, increase their value or use a capacitor-resistor filter, the resistor being of low value (5,000 to 20,000 ohms).

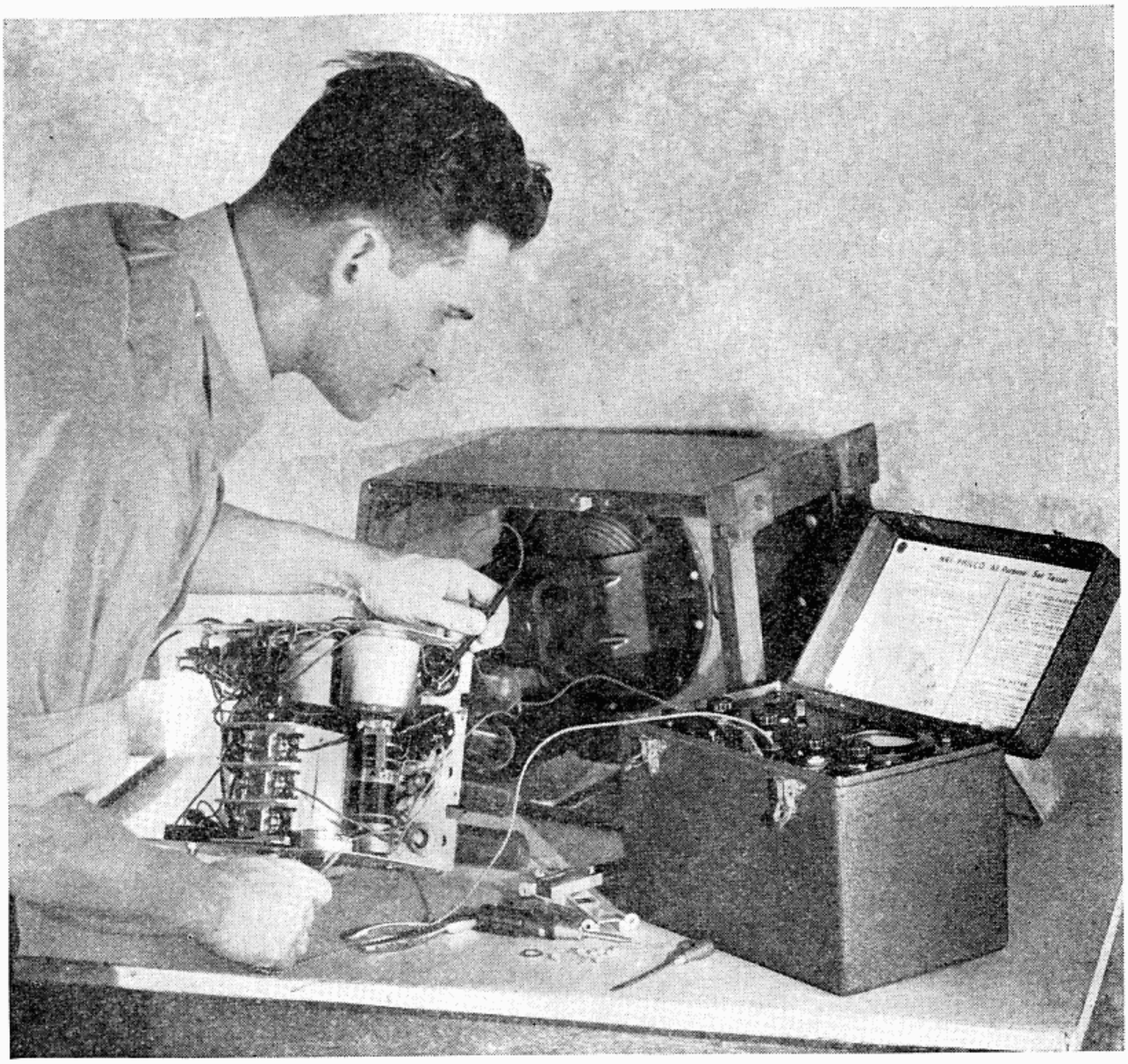
INTERNAL RECEIVER NOISE ISOLATION

From what has been said so far in this text, we should have a clear insight as to the causes of internal receiver noise and feedback squeals and their remedy. For the serviceman the most important initial step is the isolation of the defective stage or, if possible at once, the exact defect. A systematic procedure yields the quickest results. Here is a suggested procedure.

1. First determine if the noise is external or internal as previously explained. With experience you will be able to detect feedback oscillation and tube or regeneration hiss. Remember that squeals can be radiated from a neighbor's receiver. Regeneration that is produced when tuning a receiver to some station is produced within the receiver under test. You now know that the noise is at the receiver.

2. Check for surface defects and test for mechanical noise in the manner previously explained. Are there any loose parts on

the chassis, in the cabinet, near the receiver that will cause resonant vibration? Are tube or coil shields open, creating feedback? Is the detector or first A. F. tube microphonic? Does the speaker cord come anywhere near a tube to cause feedback? Are any of the tubes poorly held in their sockets? Are the control grid caps firmly in place and do not make contact to the tube shield?



Working on an open chassis

3. Effect to cause reasoning has an important place in noise and feedback isolation. Does the noise or rattle sound as if it originates in the speaker? Does the howl sound like an open grid? Does the squeal sound as if it is due to ineffective neutralization? Is the noise the result of tuning the dial or making a normal receiver adjustment? Does jarring the chassis give the noise? What you hear may have a lot to do in telling you the location of the defect. This can only come from experience. When an effect

leads you to a possible cause of trouble always check the source before extensive repairs.

4. Failing to locate the defect while the chassis is in the cabinet and by now being reasonably sure that the defect is internal, remove the chassis from the cabinet. Place the receiver on one end, supporting it if necessary, and remove the bottom chassis plate if one is used. The bottom of the chassis and all the wiring must be in full view. You should be able to turn the power switch on, get at the top of the chassis—that is, get at any part while the set is in operation or turned off. Again go over the underside of the chassis for surface defects. Are there any poor soldered joints, any corroded joints, are the coil shields firmly in place, are the socket prong contacts making firm pin contact, can you see loose contacts, does the insulation look charred or worn away? Turn the set on and preferably in dim lighted surroundings, look for sparks or arcs. Only after an extensive visual check proceed to a systematic noise isolating procedure.

5. *Stage by Stage Elimination Test.* Starting with the output stage short the input circuit, grid to grid short in a push-pull or push-push stage, grid to chassis short in single tube output stages. This removes the effects of the previous stages. If the noise which at this point is easily recognized, is heard, the trouble is in the output stage, tube or tubes, output coupler or the power supply. Be sure to check the electrical voltages and currents. If the main voltage supply is producing the noise, a plate-chassis supply voltage measurement will show a decided tendency to vary erratically—the needle will jump around. Try shorting the input of the preceding stage. An increase in noise definitely indicates a defect in the supply.

If the output stage check does not isolate the defect, proceed to short the input of the first A. F. stage or detector whichever couples to the output stage. If noise now comes in, it is due to a defect in this stage or its power supply connection. Check the circuit carefully for defective parts. Proceed this way through the detector, I. F. section, oscillator, pretuner until the source of trouble is definitely located in a particular stage.

In the R. F. stage where the trouble has been traced to the variable condenser, short the input of each of these R. F. stages so you can detect in which section of the gang condenser the defect exists.

Another stage isolation procedure would be to insert a headset (phone) or a milliammeter in each stage proceeding from the antenna input to the receiver output. Headphones connected in series with the defective circuit will reproduce the noise. Noise in the stage will cause the meter needle to flicker. A universal socket adapter is a valuable quick aid for such tests.

The most frequent source of noise within an isolated stage is due to varying resistors, intermittent or poor contacts or opens. An ohmmeter is the essential device in noise isolation. Poor connections or contacts are observed by a flickering needle reading. Variable resistors are tested in the same way, except the ohmmeter should show a smooth increase or decrease in reading. Always shake the part that is being tested for noisy connections.

Tubes may block intermittently due to open supply circuits, particularly the grid supply leads. Voltage readings should show normal applied electrode voltages.

Intermittent Reception

When the customer's complaint is that the set plays for a short time and then cuts off, only to repeat this performance, you have a trouble shooting problem that is referred to as intermittent reception. There are various types of intermittent reception, namely:

1. Set plays, cuts off and plays, at regular intervals.
2. Set plays, cuts off and doesn't play until the set is jarred. Mechanical disturbance.
3. Set plays, cuts off and doesn't play until the main power switch is turned off and on, or a control grid cap is touched, or some tube is pulled out of the socket, or turning off and on some light or electrical device on the same power line as the set. Electrical disturbance.

Frankly the isolation of the defect causing intermittent reception is the most intangible, most elusive sort of job that a serviceman may tackle.

If the set cuts off and plays, cuts off and plays at a definite time rate, you will invariably find the trouble due to a thermostatic electrical connection. In general, you will find it in a circuit which carries current. Thermostatic joints are those which make contact intermittently due to heat expansion of dissimilar material, for example, solder and copper. When the receiver, tubes or any part or any connection is at room temperature the connection is complete. When the temperature rises, dissimilar expansion opens the connection. If the temperature rise is due to heat produced at the joint, the cut-off will be of short time duration. If the temperature rise is due to the average heat of the chassis, the cut-off will be of longer duration. In the first case we probably have a break in a supply current carrying joint, and in the second case probably a signal carrying joint.

Tubes are often to blame for intermittent reception. If any of the welds between the elements and the support to the lead conductor should open or short because of expansion, the amplifying action of the tube is destroyed and the set cuts off. As soon as the tube cools off the connection is restored, or the short opens and the set plays. The set may not cut off entirely, merely fade to a low sound level.

Resistors or coils carrying current may open up after carrying current for a short while. Any contact connection is subject to thermostatic action. One serviceman in an attempt to associate the time of cut-off with the probable cause of a thermostatic joint gives the following table:

Period	*Probable Cause*
0 – 3 minutes	Defective tube, supply current carrying joint.
3 – 5 minutes	Resistors that are slow to heat up, particularly types with large heat radiation surfaces. Series filament resistors in universal D.C. and battery sets.
Over 5 minutes	Transformers, coil, or joints that are affected by the surrounding temperature or carry only weak currents.

In some cases the joint after opening up will stay open, because the joint has no spring to return the lead that moved away. Such connections may remain open until the set is mechanically jarred. You may track this down by a stage by stage elimination procedure, being extremely careful to prevent mechanical jarring.

Where the set is restored to operation by an electrical disturbance (try a mechanical disturbance first), reception may be restored because the electrical surge results in an arc connection. Look for sparks in the chassis. Noise will probably accompany the restoration of performance. An open circuit connection, like an open grid resistor or coil, may still permit the receiver to work until some electrode, particularly the control grid, develops a charge sufficient to block the operation of the stage. Any slight electrical disturbance will unblock the stage, restoring operation. In superheterodyne circuits the local oscillator may block and thus stop operation. Any electrical disturbance may reestablish oscillation.

If intermittent fading is observed, then you may have an open by-pass condenser. Intermittent rises in volume may be caused in the same way. Be sure that antenna and ground system is intact. Shake the aerial and ground leads, listening for noise, or better still connect a signal generator to the input after the fading appears. Thermostatic joints in coupling condensers invariably destroy reception and defects here may easily be confused with resistor and coil opens. Only a replacement condenser will check such defects.

A systematic procedure for isolating the defect of intermittent reception is recommended.

1. Start with a search of possible surface defects, including an inspection for a defective pickup system.

2. By an effect to cause reasoning you may be able to tell what and perhaps where the trouble may be.

3. Check tubes. Put in a new set of tubes and leave them play for a time greater than the cut-off period. Then replace the old tubes one at a time, each tube tested for a reasonable period.

4. Open chassis. Look for sparks and arcs. Look for corroded or resin joints. Check condensers for opens by shunting them with ones known to be in good condition. Be sure in the latter case that you make this substitution while the set has cut off.

5. Try a stage isolation procedure. In A.V.C. sets using a visual indicator, watch the indicator before and after cut-off takes place. In other circuits place a plate milliammeter in each stage. Where the number of meters are limited you will have to check one stage at a time. A change in any supply circuit will generally show up as a change in plate current in the defective stage. Defects in signal circuits which do not carry an electrode current or complete a voltage connection can only be checked with a vacuum tube voltmeter.

You may start with the signal generator connected to the detector and leave the set on for a reasonable period. If the cut-off does not appear, advance the signal generator to the input of the previous stage. When reception is restored by the least touch or electrical disturbance, a stage elimination test is about the most reasonable procedure to take.

6. After the defective stage is found, inspect every circuit

component. You may have to change every part in the circuit. Do so one at a time.

7. When you feel that the defect has been repaired, play the receiver for at least three to four hours over the cut-off period, before approving the job.

Keep a record of all defects for future reference. Be sure to record the make and type of receiver. Weaknesses in certain designs may result in intermittent reception. If you consult the service manager of the local distributor of the receiver you are working on, he may give you some valuable clues to the possible trouble.

It may take you ten minutes or ten days to correct an intermittent defect. Most of the time will be lost in waiting for the receiver to cut off. So always do such jobs along with other bench repair jobs. Intermittent reception defects traced to internal defects are best located at the bench and to one side so as not to interfere with your regular work. Be sure that the chassis is open, and on end so that you see and can get at every part. Don't get discouraged, the best service technicians realize that a defect of this kind has no mercy on their patience.

TEST QUESTIONS

Be sure to number your Answer Sheet with *the number* appearing on the front cover underneath the title of this text.

Place your Student Number on every Answer Sheet.

Never hold up one set of lesson answers until you have another ready to send in. Send each lesson in by itself before you start on the next lesson. In this way we will be able to work together much more closely, you'll get more out of your Course, and the best possible lesson service.

1. Where would you look for noise if upon connecting a headset to the secondary of the output transformer after making a test for mechanical noise, the noise disappeared?
2. What sounds indicate an open grid in the A.F. amplifier?
3. How would you cure motor-boating traced to an A.F. stage?
4. An expert Radio-Trician cured a severe rattle noise by moving the radio to some other position in the room. Moving the cabinet away from the wall in the first position did not stop the rattle. What defect did he find?
5. What kind of noise would indicate the possibility of dust between variable condenser plates?
6. Where would you expect to find the trouble, if intermittent reception reoccurred in intervals of 2 minutes?
7. What effects might be observed if a thermostatic joint existed at the terminals of a by-pass condenser?
8. What is the purpose of the test in which the aerial and ground post of the receiver are shorted, and a line filter is temporarily inserted in the supply leads?
9. How would you test for poor tube socket contacts, when the chassis is in the cabinet?
10. How would you test for a poor contact in a coil?