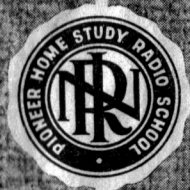


NRI
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RADIO RECEIVER TROUBLES

THEIR CAUSE AND REMEDY

REFERENCE TEXT 14X-2



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HOW TO USE THIS REFERENCE TEXT

This reference text is in two portions: (a) an *Index of Radio Receiver Troubles* (pages 1 to 8); and (b) a discussion of *Receiver Troubles, Their Cause and Remedy* (pages 9 to 26).

The index is divided into two parts. In the first part of the index, we have followed the rule that receiver troubles cause certain definite symptoms, so we have listed all the major symptoms. These symptoms have their most common causes listed under them.

The second part of the index, on physical symptoms, contains descriptions of conditions you may observe upon examining the set. These conditions may be present with any of the complaints listed in the first part.

To use this text as a means of locating defects, refer to the first part of the index and read the general information under each of the major headings. Determine from the receiver operation which condition seems to exist, then under that heading refer to the proper sub-section if there is one.

Also, refer to the second part of the index on "physical symptoms" to gain additional clues.

Under each heading in the index, you will find a list of the most common causes of the trouble. After most of the probable causes, you will see a number usually followed by a letter. The number refers you to a section, and the letter to a paragraph of that section in the "Receiver Troubles" portion of this text where you can get valuable servicing tips.

When reference is not made in the index to an explanation in the following sections, the information in the index is sufficient to indicate what is to be done.

Much of the information in this reference text can be of value to you only when you have studied much more of your NRI Course. This reference text will be more and more helpful as you proceed with your studies. Keep it handy and refer to it whenever you do service work.

INDEX OF RADIO RECEIVER TROUBLES

Part 1—Observed Effects and Probable Causes

THE way in which a radio receiver operates is a clue to the source of trouble. Turn on the receiver and see whether it does not play at all, or whether it plays improperly. The most common symptom is that there is no reception at all—the radio receiver is said to be “dead.” In other cases of improper operation, signals are received but they are accompanied by hum, they are distorted, there is noise, etc. The major symptoms are:

1. Dead Set.
2. Hum.
3. Distorted Signals.
4. Oscillation.
5. Noise.
6. Interference.
7. Poor Selectivity.
8. Weak Reception.
9. Intermittent Reception.
10. Dead Spots.

Under each of these headings, there are sub-divisions according to conditions. Many of these sub-divisions will depend upon what you can see as you examine the set. For example, under “dead set,” we may have conditions in which none of the tubes light, a few of the tubes light, or all of the tubes light. Each of these conditions indicates certain definite troubles, and these are listed under their headings.

Dead Set

The condition known as a dead set means that there is no reception—no signals are heard from the receiver. There may or may not be a slight hum from the loudspeaker, depending on which of the following conditions exist. Examine the set carefully to determine whether the tubes light, since this is your initial clue.

DEAD SET—NO TUBES LIGHT

In ac-dc receivers look for the following, first:

- One tube burned out in the series filament circuit; *6d, 6b.*
- Filament resistor, line-cord resistor, or ballast open or burned out; *sections 1, 8, 9.*
- Pilot light burned out; *7d, 7b.*

In addition, and for sets other than ac-dc, check the following:

- On-Off switch defective; *18a.*
- Set fuse burned out.
- Open lead in power cord; *29e, section 1.*
- Open primary, power transformer; *17a, 17b.*
- No line power supply; *check power outlet.*
- Burned out house fuse.

DEAD SET—SOME TUBES LIGHT

Here you may find that several or even most of the tubes light, but a few do not. Consider the following:

- Poor socket contact; *section 5.*
- Poor soldered filament connection; *section 5.*
- Open filament resistor; *section 1.*
- Burned out tube; *6d, 6b.*
- Part of ballast tube defective; *section 9.*
- Shorted secondary winding of power transformer; *17d.*

DEAD SET—ALL TUBES LIGHT

When examining the set under this condition, check through the list of physical symptoms in Part 2 of this index, to see if any are helpful.

- Try to localize by performing circuit disturbance test; *section 2.*
- Defective tubes; *section 6.*
- Short-circuited antenna coil or loop; *section 16.*
- Poor contact in tube socket; *section 5.*
- No plate voltage; *section 22.*
- Incorrect supply voltages; *section 22.*
- Transformer defective; *section 17.*
- Open circuit; *section 1.*

Defective choke coil; *section 17.*
 Defective filter condenser; *section 14.*
 Open or shorted by-pass condenser; *sections 11, 12, 13.*
 Variable condenser shorted; *15a, 15f.*
 Defective loudspeaker; *section 37.*
 Tube in wrong socket; *section 25.*
 "A" and "B" batteries run down; *section 21.*
 Line plug reversed (universal ac-dc sets); *29f.*
 Oscillator tube or stage defective; *section 38.*
 Coupling condenser open, shorted, grounded, or leaky; *sections 11, 12, 13.*
 Volume control defective; *10a.*
 Receiver alignment has been tampered with; *section 42.*

Hum

Under this heading we have a condition in which the receiver plays but there is a humming sound heard from the loudspeaker. There are two possible conditions—the hum is heard whether or not a signal is tuned in, or it is heard ONLY when a signal is tuned in. The second condition is given below under resonant or tunable hum. (See *section 34.*)

HUM AT ALL TIMES

Condition A: Ineffective or defective filters and power supply.

Defective rectifier tube; *6d.*
 Defective or open filter condenser; *sections 30, 14.*
 Grounded or shorted filter choke; *sections 30, 17.*
 AC power plug reversed.
 Loudspeaker field coil defective; *37a.*

Condition B: Voltage, tube, and circuit defects.

Open grid circuit; *1d.*
 Grounded or open choke coil, resistor, or plate circuit; *sections 1, 4.*
 Volume control defective; *10a, 1d.*
 Lack of ground on iron-core coils and transformers; *add connections.*
 Open in ground system; *1d.*
 Tubes weak or defective; *section 6.*
 Gassy power tube; *6c.*
 Cathode-to-heater leakage in tube; *6d, 6b.*
 Resistor grounded, open, or defective; *sections 8, 1c.*
 Unmatched power tubes; *section 6.*
 One half of a full-wave rectifier tube defective or weak; *6g.*

HUM IN UNIVERSAL RECEIVERS

Only when used on ac.

Defective filter system; *section 30.*
 Defective filter condensers; *section 14.*
 Defective tube; *section 6.*

RESONANT OR TUNABLE HUM

Hum from loudspeaker only when tuned to a broadcast station or its carrier.

Open loop antenna.
 Open control grid return; *1d.*
 RF stages oscillating; *section 31.*
 Defective or weak tube; *section 6.*
 Defective cathode by-pass condenser; *12a.*
 RF bias resistor incorrect value; *section 8.*
 Cathode-heater leak in tube; *section 6.*
 Incorrect screen grid or pentode tube used; *section 25.*

Distorted Signals

Signals are muffled or otherwise distorted. Several conditions exist: (a) signals are distorted all the time; (b) signals are distorted at high volume levels only; (c) signals are distorted at low volume levels only.

DISTORTED AT ALL TIMES

Located in rf system.

Oscillation; *section 31.*
 I-F or rf peaked too sharply; *section 42.*
 Natural, when accompanied by fading; *27k.*
 Interference between stations of nearly same frequency; *27l.*

Located in detector or avc system.

Detector defective; *section 6.*
 AVC not working; *section 39.*

Located in audio system.

Leaky coupling condenser.
 Gassy tube.
 Change in plate load resistor; *section 8.*
 One-half of push-pull transformer (input or output) shorted or grounded; *section 16.*
 Push-pull or push-push tubes not properly matched; *6g.*
 Bias resistor open.
 Push-pull or push-push stage regenerating; *32d.*
 One push-pull or push-push tube weak or dead; *6g.*

Located in loudspeaker unit.

Defective loudspeaker; *section 37.*
 Voice coil off center, *37c.*
 Voice coil turns loose; *37f.*

Iron filings or dirt in voice coil aperture; 37g.

Voice coil spider defective; 37f.

Field coil open or shorted.

Located in power supply system.

Incorrect voltage applied to power tube; section 22.

Incorrect grid, plate, screen voltages; section 22.

Defective electrolytic condensers; section 14.

General defects causing distortion or muffled signals.

Wrong tube in socket; section 25.

Tube or tubes defective or weak; section 6.

Open grid bias resistor or grid circuit; 1d.

Open or shorted condenser; sections 11, 12, 13.

Volume control defective; 10a.

A high resistance connection; section 5.

DISTORTED AT HIGH VOLUME LEVEL ONLY

Inexpensive receiver, natural; 23c.

Weak tubes; section 6.

Defective avc system; section 39.

Improper supply voltages; section 22.

Defective cone or voice coil of loudspeaker; section 37.

Receiver not tuned correctly; section 36.

DISTORTED AT LOW VOLUME LEVEL ONLY

No field excitation to loudspeaker; 37b.

Power tubes insufficiently excited; *operate set louder.*

Supply voltages incorrect; section 22.

Weak or defective tubes; section 6.

Oscillation

Under this condition, the receiver plays but the signal is accompanied by squeals, whistles, howls, or by putt-putting noises resembling the sound of a motorboat. Squeals, howls, and whistling are generally caused by a defect in the rf or i-f section of a receiver; putt-putting or motorboating normally indicates audio trouble. This condition occurs because a signal gets back from one point in a receiver to an earlier point where it is undesired. This feedback may be electrical, or it may be acoustical, when sound waves from the loudspeaker vibrate a tube or part in an undesired manner.

OSCILLATION DUE TO ELECTRICAL FEEDBACK

Condition A: Electrical feedback due to part or circuit defect.

Undesirable inductive coupling between circuits; section 31.

Open by-pass condenser; sections 11, 12, 31g.

Shorted rf choke or choke resistor; section 4.

High resistance or corroded connection; section 5.

Poor connection at rotor of variable condenser; 15b.

Poor connections in circuit or chassis and shields; 31g.

Open or shorted resistor; 8c.

Incorrect resistor; 8f.

Insufficient by-passing and filtering; 11b.

Incorrect by-pass capacity; 11b.

Motorboating; section 32.

Condition B: Change in adjustment or incorrect receiver operation.

High line voltage, 29e.

Excessive output voltage of power pack; section 22.

Excessive or incorrect plate, grid, screen, or filament voltage; section 22.

Defect in avc system; 39a.

Wrong tubes in socket; section 25.

Condition C: Receiver or tube defect.

Defective tube; section 6.

Gassy tube; 6c, 6b.

Open secondary, rf transformer; 16b.

Open grid circuit; 1d.

Shorted bias resistor; section 4.

OSCILLATION DUE TO ACOUSTIC FEEDBACK

Microphonic tube; section 33.

Loudspeaker too rigidly mounted in cabinet; 33d.

Receiver not cushioned on rubber; 33c.

Condenser plates too thin; 15c.

WHISTLES ONLY ON CERTAIN DISTANT STATIONS

Natural condition; 27l.

Lack of selectivity; 23d.

Noise

The condition is described as noise when the signal output is accompanied by hissing, scratching, frying, rattling sounds. Such noises may arise outside the set because of external conditions, or may be internal. Internal noise may be

cur only while a control of the receiver is being adjusted, or it may occur at all times. It is also possible for noise to be mechanically produced and not be coming from the loudspeaker at all.

NOISE, INTERNAL, WHEN CONTROL IS BEING ADJUSTED

Plates of tuning condensers shorted; *15a*.
Defective bearing contacts on variable condenser; *15b*.
Dirt or flakes in variable condenser; *15a*.
Volume or tone control defective; *section 10*.
Power or band-selector switch defective; *section 18*.

NOISE, INTERNAL

Test for internal noise; *35a, b, and c*.
Loose or poorly soldered connections; *section 3*.
Poor or corroded ground connections; *section 5*.
Tubes, noisy; *6f*.
Natural circuit noise; *23e, 23f*.
Variable condenser connections defective; *15b*.
Volume-control connections defective; *1b*.
Audio transformer defective; *1b*.
Incompletely grounded shields; *19a*.
Pilot lamp loose in socket; *7c*.
Control grid clips loose or partially grounded; *3f*.
Battery terminals corroded; *section 3*.
Defective rf and i-f transformers; *1b*.

NOISE, EXTERNAL

The noise comes through the receiver, but arises from a source outside the receiver.

Test for external noise; *35a, b, and c*.
Static, natural; *section 26*.
Aerial rubbing or close to high-voltage wire.
Poor connections or high-resistance joints in antenna or ground systems.
Partially grounded lead-in or antenna.
AC plug prongs or cable connection to it loose; *section 3*.
Poor connections to electrical outlets in house.
Autos and trucks interfering in short-wave band; *26c*.
Noise entering through power line; *35b*.
Inter-station noise (avo receivers); *26d, 23f*.

NOISE, MECHANICAL

Noise does not come from the loudspeaker, but is heard only when the receiver is playing.

Loose parts in cabinet.
Resonant cabinet effects.
Resonant room effects.
Transformer laminations loose; *17e*.
Tube or coil shields loose; *19a*.
Microphonic tubes; *33b*.

Interference

Interference includes conditions in which the incoming signal has with it another signal. In addition to the symptoms below, look under poor selectivity, because many cases of interference are due to receiver design, lack of alignment, and other conditions under that heading.

CODE INTERFERENCE

Can be tuned; *27h*.
Cannot be tuned; *27i*.

Poor Selectivity

Also known as broad tuning. This condition is present when interference exists between desired signals and those broadcast on a channel other than the one to which you are tuned. No amount of receiver selectivity will help the condition wherein the interfering station is another one on the SAME channel—the set just picks up signals too well. However, if interference comes from a station on an adjacent channel, or on a channel other than the one to which you are tuned, then the selectivity of the set is open to question. Of course, receivers are different in their design and some are incapable of separating stations on adjacent or nearby channels, particularly when the interfering station is far stronger than the one desired. Several conditions arise: (a) receiver tunes broad on local or semi-local stations but is normal in other respects; (b) tunes broader than usual and signals somewhat weak; (c) tunes broad and only local stations are received.

BROAD ON LOCALS, SENSITIVITY NORMAL

Inexpensive receiver, broad tuning normal; *23c, 23d*.
Too close to local stations; *27d*.
Antenna too long; *28d*.
Station tuning broad is unusually powerful; *27c*.

TUNING BROAD, SENSITIVITY BELOW NORMAL

Loose and high-resistance connections; *sections 3, 5.*

High resistance in grid circuit; *section 5.*

Improper alignment.

No ground to receiver.

Variable condensers dirty; *15a.*

Low line voltage; *29c.*

Open or shorted by-pass condenser; *sections 12, 13.*

Weak tubes; *section 6.*

Shields not firmly in place, or a good chassis-shield contact does not exist; *section 19.*

TUNING BROAD, ONLY LOCALS RECEIVED

Dead or defective tube.

No plate voltage on an rf tube; *section 22.*

Open grid circuit; *1d.*

Variable condensers partially or totally shorted in some section; *section 15.*

See causes creating weak reception.

Weak Reception

This condition is also known as low sensitivity. It may be due to receiver design, but if the condition has developed over a period of time, then one or more of the following conditions exist. You may find that distant stations are weak but locals are normal, that many stations are picked up and all stations including locals are weak, or that local stations only are received.

Under the first condition, the defect is probably in the antenna or the rf or i-f sections. Under the second condition, the defect is in the second detector, audio system, or loudspeaker, whereas the last condition represents a general defect which may be anywhere in the set.

Location A: Pickup.

Poor or high resistance connections in antenna or ground; *28b.*

Aerial too short; *28a, 28c.*

Location B: RF section defective.

RF or i-f not aligned; *section 42.*

Open secondary, rf or i-f transformer; *16d.*

Shorted primary, rf or i-f transformer; *16c.*

Preselector and oscillator do not track; *section 42.*

Defective or dirty variable or trimmer condenser; *15a, 15f.*

Gassy rf or i-f tubes; *6c.*

Location C: Detector and avc.

C bias incorrect, accompanied with distortion; *section 22.*

Defect in the avc circuits; *39a.*

Location D: Audio circuit.

Audio transformer defective; *16c.*

Open or defective audio plate-to-grid coupling condenser, *12a.*

Location E: Power supply.

Low line voltage; *29c.*

Defective filter condenser in power supply; *section 14.*

No plate voltage to some stage; *section 22.*

Incorrect voltage; *section 22.*

Location F: Loudspeaker defect.

Permanent magnet weak; *37e.*

Field circuit open or shorted; *37a, 37b.*

General defects producing weak signals.

Poor contact at tube or tube socket; *section 5.*

Leaky condensers; *section 13.*

Open or shorted condenser; *sections 12, 13.*

Loose connections; *section 3.*

Defective or weak tube; *section 6.*

Open circuit; *section 1.*

Shorted circuit or part; *section 4.*

Grounded circuits; *4b.*

Open C bias resistor; *8c.*

Defective resistor; *8c.*

An inexpensive receiver; *23c, 23d.*

Open grid circuit; *1d.*

SIGNALS WEAK AT ONE END OF DIAL

RF or oscillator not tracking; *section 42.*

Oscillator high-frequency trimmer improperly set; *section 42.*

Oscillator low-frequency padder improperly set; *section 42.*

I-F alignment poor; *section 42.*

Coil turns shorted; *16c.*

Coils and condensers damp, dirty, and leaky; *16d.*

SIGNALS WEAK, DAYTIME ONLY

Natural receiving conditions.

Line voltage low; *29c.*

Receiver inexpensive; *23c, 23d.*

Intermittent Reception

There are two forms of intermittent reception. In one, we have a condition wherein the receiver is intermittently

dead—signals pop in and out so that sometimes they are at normal volume and at other times they are very weak or not audible at all. Any condition that could make the set dead can cause intermittent operation of this kind. The difference lies in the fact that the set does not stay dead. Since this condition is most commonly caused by a break that is self-healing, any attempt at testing may shock the circuit so that it goes back to normal operation. This makes this an extremely difficult condition to localize without special testing equipment.

Don't confuse this condition with that of fading. Fading occurs only on distant signals and is a condition wherein distant signals vary in volume from time to time because of natural atmospheric conditions. However, the variation is gradual—it is not sudden as is the usual case of intermittent reception caused by a receiver defect. Fading normally occurs only on distant stations, whereas intermittent reception may occur on any, including locals.

The other conditions of intermittent reception are the same as any other complaint—intermittent hum, intermittent noise, etc. See the particular condition for clues.

INTERMITTENTLY DEAD

Gassy tube; 6c.

Thermostatic connection or joint appears after receiver heats up resulting in fading or intermittent reception—has a definite time period; *section 1*.

Tube with thermostatic joint; 3i.

Opens, shorts, high resistance connections plus vibration. (Condensers are a very common source of this trouble.)

Poor connecting joints in antenna system; 28b.

Poor tube prong and socket contacts; *section 5*.

Coupling condensers defective; 12a.

Condenser defects a common source of trouble; *sections 11, 12, 13*.

Resistor defective; *section 1*.

Transformer or coil defective; *section 16*.

Volume control defective; 10a.

Dirt or metal flakes in tuning condenser; 15a.

Corroded or poorly soldered connections; *section 5*.

Improper wiping or pressure contacts; 5c.

Rectifier tube with low emission; *section 6*.

Dead Spots

The receiver tunes in signals normally over a portion of the tuning range, but does not operate normally over other portions of the tuning range. The set may receive signals at the high end of the band and not at the low, or vice versa. There may be spots along the band in which no signals are heard, or the set may be dead on certain bands or sections of bands when it is an all-wave receiver.

DEAD SPOTS

Natural conditions for your locality.

Oscillator cuts off at some tuning point; *section 38*.

Poor connection between tuning condenser rotors and chassis; 15b.

Shorts between tuning condenser plates at some tuning points; 15a.

Improper alignment of rf stages; *section 42*.

Preselector and oscillator do not track; *section 42*.

Part 2—Physical Symptoms

The following conditions may accompany any of the above complaints. When you are examining the set, keep in mind all of the following conditions. They may indicate where the trouble lies, or they may indicate points at which trouble may arise in the future.

CONDENSERS LEAK WAX

Poor ventilation.

Condensers leaky; *section 13*.

Voltage rating of condenser used too low; *11c*.

Excessive wax used in manufacture.

CONDENSERS HEAT OR SIZZLE

Loudspeaker cable not plugged in or connected to the main chassis; *37d*.

Excessive voltage across electrolytic condenser. (Caused by any defect or open in the receiver which will cause excessive voltage at this filter condenser.) *14h, 14i*.

Condenser defective or not used for some time; *14i*.

Electrolytic condenser improperly connected; *14g*.

Electrolytic condenser incompletely formed; *14h*.

FUSE BLOWS

Defective or gassy rectifier tube; *41a*.

Defective power tube; *section 6*.

Power line wiring grounded to chassis; *4b*.

Defective power transformer; *section 17*.

Line voltage dc instead of ac; *29a*.

Defective electrolytic condenser; *14f*.

Shorted or grounded filter circuit.

Defective line switch; *18a*.

Defective condenser across power transformer primary; *13a*.

GROUND CONNECTION SPARKS

Natural condition; *24d*.

PILOT LIGHT BURNS OUT OFTEN

Inferior quality of pilot light used.

Voltage rating of pilot light too low; *7b*.

Pilot light as a fuse, overloaded; *7d*.

Resistor in series with pilot lamp shorted; *7d*.

Resistor in shunt with pilot lamp open; *7d*.

Wrong type of pilot lamp; *7d*.

PILOT LIGHT FLICKERS OR DIM

Natural condition in ac-dc set when tuned to powerful station.

Pilot light loose in socket; *7c*.

Lamp rating too low; *7b*.

Line voltage fluctuates.

Defective connection or lead to lamp; *section 3*.

TUBES, RECTIFIER PLATES RED

Output of rectifier is shorted; *41a*.

Defective filter condenser; *30a*.

TUBES DON'T LIGHT

Defective tube; *section 6*.

Poor contact between tube and socket; *section 5*.

Open or short circuit; *sections 1, 4*.

Open primary, power transformer; *17a, 17b*.

Open secondary, power transformer; *17a, 17b*.

Open lead in ac plug cord; *29e*.

Tube in socket having lower than required voltage; *section 22*.

"A" batteries run down; *21b, c*.

Pilot light burned out; *7d*.

Set fuse burned out.

Filament cord resistor open; *29h*.

No line power supply.

Burned out house fuse.

On-Off switch defective; *29e, 18a*.

One tube burned out in the series circuit, universal receivers; *section 6*.

Filament resistor or ballast open or burned out; *sections 8, 9*.

Open in a series circuit, universal receiver; *1b*.

Cathode-to-heater short in one tube in series group, shorting out other tubes.

TUBES GO BAD OR BURN OUT OFTEN

High line voltage; *29b*.

Poor quality of tube used.

Low line voltage plus vibration; *29c*.

Ballast tube or resistor defective or incorrectly chosen; *9a, 9b*.

Tube placed in wrong socket; *25a*.

"C" bias too low; *section 22*.

Excessive "A" battery voltage or customer pushes filament current up for volume.

Pilot lamp in shunt with a filament open or burned out (ac-dc and 3-way receivers); *7d*.

Series or shunt resistor in filament shorted or open (ac-dc receiver); *7d*.

TUBES BLUE ON GLASS

Natural condition of fluorescence; *24c*.

TUBES BLUE INSIDE BETWEEN ELEMENTS

Natural in mercury-vapor tubes.

Shorted coupling condenser; *1b, section 13.*

Grounded filter choke; *17c.*

Shorted filter condenser; *section 14.*

Open bleeder resistor; *8c.*

Shorted or grounded loudspeaker field coil; *37a, b.*

Open grid return in power stage; *section 22, 1d.*

Excessive plate voltage; *section 22.*

Shorted bias resistor; *section 22.*

Positive grid voltage; *section 22.*

Defective by-pass condenser; *13a.*

RESISTORS OVERHEAT OR SMOKE

Resistor defective; *section 8.*

Incorrect size or wattage rating used in repair; *8b, section 25.*

Shorted to chassis; *section 41, 4b.*

Extra current due to a defect in associated equipment; *section 41.*

RESISTORS WARM

Natural condition; *24a.*

RECEIVER SMOKES

Shorted tube; *section 6.*

Shorted condenser; *13a, 41a.*

Shorted power transformer; *17d.*

Part of circuit overloaded; *section 41.*

Defective insulation; *17c.*

See "Resistors Overheat or Smoke."

RECEIVER UNSATISFACTORY

Natural condition; *section 23.*

Refer to specific trouble if reception is considered below normal.

RECEIVER TUNING MECHANISM DEFECTIVE

Dial slips; *20a.*

Bearings frozen; *20b.*

Cable broken or off pulleys; *20c.*

Condenser plates bent; *15a.*

Chassis not in proper position.

Cable loose; *20a.*

Tuning locked; *20b, 15d.*

Cable improperly restrung; *20c.*

SHOCK WHEN ANTENNA IS TOUCHED

Static electricity; *26b.*

SHOCK WHEN CHASSIS IS TOUCHED

If ground connection sparks on connecting; *24d, 29g.*

Universal and dc receivers, natural; *29g.*

SIGNALS AT MORE THAN ONE POINT ON DIAL

Condition A: Station heard both at the assigned frequency and at another point on the dial.

Natural or harmonics of broadcaster; *27f, 27g, 27j.*

Two chain stations, same program; *27k.*

Inexpensive receiver; *23c.*

Image frequency trap defective; *27g.*

Condition B: Local station rides in with a distant one (called cross-modulation).

Wrong rf or i-f tubes used; *25a, 27e.*

Too near local station.

C bias of first rf tube too high, or plate voltage too low; *section 22.*

First rf tube oscillating; *section 31.*

Antenna too long; *28d.*

Weak first rf tube; *section 6.*

SIGNALS NOT AT PROPER POINTS ON DIAL

Receiver not correctly aligned to dial scale; *section 42.*

Dial slipped on condenser shaft.

Cable slips; *section 20.*

Receiver improperly aligned; *section 42.*

VIBRATORS HAVE SHORT LIFE

Typical of auto radios and 6, 32, and 110-volt vibrator "B" eliminators. Continuous operating with excessive sparking causes burning of contacts.

Defective rectifier tube; *section 6.*

Defective filter condenser; *section 14.*

Defective buffer condenser; *13a.*

Defective tube in receiver; *section 6.*

Open bleeder resistance; *section 8.*

Defective transformer into which vibrator feeds; *17b, 17c.*

RECEIVER TROUBLES, THEIR CAUSE AND REMEDY

1. Open Circuits. (a) An "open circuit" means a break in the path of dc supply currents or signal currents.

(b) Between any two points or terminals of a dc path there must be a definite value of ohmic resistance. Test between these two points with an ohmmeter. If the ohmmeter reads a resistance value, you have proved that the path is continuous—you have tested for continuity; if you get no resistance reading the circuit is open and defective; if you get a varying reading, a make-and-break connection exists; if you compare the resistance value with what it should be, you have gone a step farther and may be able to tell if some part is shorted.

(c) A circuit diagram of the receiver you are working on is of great help, as you may trace each circuit for continuity or for exact resistance by referring to the diagram.

(d) When a circuit diagram is not available it is possible to check a dc path for continuity if the following rules are remembered. Continuity in any tube circuit should exist between: 1, a plate, and the filament (or cathode) of the rectifier tube; 2, a screen grid, and the cathode of the rectifier tube; 3, a control grid, and the common return; 4, a suppressor grid, and the common return; 5, a cathode, and the common return. The common return is the B— circuit; in an ac receiver and in some ac-dc types this is the chassis, but in many ac-dc receivers and 3-way portables this B— circuit must be located on the schematic, then some point tied to it may be used as the reference point.

(e) Because the electrodes of most tubes in a radio receiver are series fed (through the signal circuit parts), a continuity check for dc supply will be a check on signal circuits. The exception is inductive and capacitive coupling between stages or sections.

(f) As a rule a break in a dc supply circuit destroys reception; a break in a signal circuit may create many forms of troubles. A circuit disturbance test will

indicate the defective stage of a dead receiver.

(g) Any part in a circuit may be checked for an open by merely connecting an ohmmeter to its terminals. A coil, a resistor, or a transformer can be checked for continuity and exact resistance if you know what its value should be. Usually the circuit diagram gives the ohmic value. Condensers should test open (see section on condensers).

(h) When a part is being checked with an ohmmeter, one terminal of the part should be disconnected from the circuit, for if that part is shunted by some other part or circuit that conducts dc, a true reading will not be obtained.

2. The Circuit Disturbance Test. (a) When a receiver is dead—does not play—there are no symptoms to help you locate the trouble. A test should be conducted to find out which stage is defective. Since a radio receiver is nothing more than a chain of stages (rf, converter, i-f, detector, af, and loudspeaker sections in cascade), a simple test is possible. It is called the circuit-disturbance test, and is based on the principle that if any stage is disturbed or shocked, the current change in that stage will be relayed on towards and through the loudspeaker, coming out as a click—if the stages following the one disturbed are in working order. You can create a disturbance by 1, pulling a tube out of its socket and replacing it, but in ac-dc and 3-way portables, do not remove and replace the tubes; 2, touching the control grid of a screen-grid tube; 3, in the case of tuned rf stages, touch the stator section of the variable condenser in the stage being tested; 4, remove and return the control-grid cap of a screen-grid tube; or 5, momentarily short the grid of a tube to its cathode. Any one of these should produce a click or squeal.

(b) In locating the defective stage by means of the circuit disturbance test, start with the power output stage. A click means a normal section from the power tube through the loudspeaker. No click means lack of power supply, defective loudspeaker,

defective tube, or an open circuit—tests for which you will find in this reference book. If the output stage is working according to this click test, proceed to test the first audio, the second detector, the i-f, the oscillator, the first detector, and the preselector stages in the case of a superheterodyne, and the af detector, and the trf stages for a tuned radio frequency receiver. Use one of the five methods of getting a disturbance, previously mentioned. When you go from a click to no click, the defective stage is isolated. Test the tube, and check the continuity of that stage.

(c) Checking the oscillator in a superheterodyne receiver by the click method may give unreliable results. A sure test is made as follows. If disturbing the first detector tube produces a click, and connecting the antenna to the grid of the first detector (set tuned to a local station) doesn't produce signals in the loudspeaker, the oscillator is defective. Test the oscillator tube and the continuity of its circuits.

3. Loose Connections. (a) By a loose connection we usually mean a connection that appears to be properly made, but actually is not a solid one. All connections must be either soldered or securely clamped together.

(b) Any connection that is insecure, that is, its contact resistance varies, is a loose connection. When the connection opens electrically it may be considered an open connection, and a jarring or a vibration will often restore the connection.

(c) When noise is emitted from a receiver, and still exists when the antenna and ground leads are disconnected, and the noise changes when the chassis is violently slapped with the palm of your hand, a loose connection probably exists—a connection whose contact resistance is varying. However, this connection may be inside a tube or some other part, rather than just a poorly soldered external joint.

(d) Loose or improperly soldered connections can usually be located by touching the various joints in the receiver with a wooden stick. Of course, the receiver chassis and loudspeaker are removed from the cabinet, the chassis is set on one of its ends so all parts are easily seen and touched, and the receiver is turned on. An orange-

wood stick can be used. They are very durable and can be bought at any drug store. Press firmly on each joint. Very often joints that appear to be well soldered are held only by rosin. If the receiver is properly connected for operation, the pressure on a defective joint will usually produce a crackling sound in the loudspeaker. Another frequent cause of trouble is broken wiring under the insulation of flexible wire. Manipulation of the wire from side to side will usually indicate where the trouble is.

(e) Wiggle all cable plug connections, the ac plug, antenna and ground binding posts and leads, and battery lead connections if the receiver is of the battery type.

(f) When the loose connection is disturbed, the noise will be more violent or can be produced at will. Quite often the loose connection is inside the part, particularly in fixed condensers. Be sure to wiggle and snap with your fingers all tubes, tube top caps, parts covered with a can, case, or shield, and controls. If the loose connection is inside some part and the connection cannot be fixed, a new part should be used. Check socket contacts and connections.

(g) If with the noise, definite receiver troubles are observed (hum, oscillation, weak signals, etc.), the symptom will very likely indicate the probable cause and location of the defect. Refer to the probable causes in the index under the symptom observed.

(h) A total break in a connection will not produce noise. These open connections can be traced with a continuity test. Furthermore, the symptom will often lead you to the probable location of the defect.

(i) Quite often the heat of the chassis will cause a connection to open and close. This difficulty is handled in the same way, although actual tracing of the defect may be difficult because the connection may, while being tested, become secure.

4. Short Circuits. (a) A short circuit may or may not destroy reception, depending, of course, on where the short exists. When a short destroys reception, the defective stage may be isolated by the circuit disturbance test. Read section 2. Then an ohmmeter check on each part in that stage will show up the shorted part; the ohmmeter will read zero or abnormally low re-

sistance. If the short cannot be cleared up, use a new part. When you suspect a partial short in a high-voltage tube filament in series with other tube filaments, measure the filament voltage. Low voltage on this one filament indicates that it is partially shorted.

(b) A part may be shorted or grounded to the chassis because it is pushed from its correct position, or the insulation of its lead through the chassis becomes worn. Repositioning the part or replacing the defective insulation removes the short.

(c) If the short does not cause a completely dead set, the symptoms observed will help localize the short, and then the parts in the circuit can be checked with an ohmmeter.

5. High Resistance and Corroded Connections. (a) Any connection or joint having a resistance much above zero ohms is referred to as a high-resistance connection. A resistance of even a few ohms is not wanted, as it produces many undesirable effects. Although a low range ohmmeter (0 to 10 ohm range) will allow you to check such joints, you can frequently see these poor connections. Here are a few hints in finding high-resistance joints.

(b) Joints that have an excessive amount of rosin are likely to become poor joints. Resolder such connections.

(c) A greenish covering on a joint indicates corrosion and eventually a high-resistance connection. Resolder such connections, or clean corrosion off if only a pressure contact is used.

(d) A connection made with excessive solder may have a high resistance if the two parts or wires to be connected are separated by a lump of solder instead of being soldered close together. Such joints are particularly objectionable in short-wave circuits.

(e) A good soldered joint may be made if the two surfaces to be connected are cleaned, tinned, and physically clamped together before being soldered. Acid or acid core solder must NEVER be used.

(f) High resistance and corroded connections will result in poor selectivity, lack of sensitivity, and many other symptoms indicated in the index of receiver troubles.

6. Tubes. (a) It is safe to say that a

majority of receiver troubles are caused by tubes. The filaments of tubes may burn out, tubes may lose their emission, their elements may short, the tube may become gassy, its characteristics may change, and poor connections inside the tube may develop.

(b) The most satisfactory test of a tube is to try a new one in its place. A test in a tube tester is not always sufficient because even though the tester may indicate that the tube is good, it may not be satisfactory for certain purposes.

(c) Gas is rarely indicated by tube testers. A tube with a *little* gas would be entirely unsatisfactory for use in an automatic volume control or oscillator stage, but it might work fine in another stage of the receiver. Tubes should show no glow *between elements*, and they will if much gas is present. A blue glow on the glass is natural, a condition of fluorescence.

(d) Elsewhere in the Course, we show how tubes may be tested in regulation tube testers. If you have such a tube tester you need only follow the manufacturer's instructions.

(e) By placing your hand on a tube while the receiver is operating, you can often tell whether it is working. If the tube is cool, it has no plate current and a new one should be tried. Excessive heat may indicate the presence of improper control grid voltage or circuit defects that would result in excessive plate or screen voltage and this would lead you to make voltage measurements on that stage.

(f) Noisy tubes can be tested by snapping them with your finger when the set is operating. If this causes the noise to show up, a new tube should be tried.

(g) Whenever tubes are used in pairs (push-pull, push-push), it is important that two tubes with the same characteristics be used. Otherwise hum and distortion may result. Full-wave rectifier tubes should have equal emission per plate.

7. Pilot Lights. (a) Pilot lights sometimes are a source of nuisance and trouble. They burn out or cause receiver troubles. Their voltage rating should be equal to the voltage of the filament line to which they are connected if a shunt connection is used, or their current rating equal to the line current if a series connection is used. Check

the voltage with a low range ac voltmeter if a large number of burn-outs occur; or check the circuit diagram and determine by referring to a tube table what the filament current should be of the tubes with which the lamp is in series.

(b) A pilot lamp with a higher voltage rating than the source voltage may be used, if sufficient light is obtained, but a low voltage lamp must not be used on a high-voltage source. For example, a 6.3-volt pilot lamp may be connected to a 5-volt source, but a 5-volt lamp must not be connected to a 6.3-volt source. A lamp with a higher voltage rating than its source will burn dim.

(c) If there are loose connections in the pilot-lamp circuit or the lamp is not screwed tightly into its socket, there may be a flicker. A loose connection in the pilot light circuit will often cause noise. You should be sure that the pilot lamp leads cannot be hit by the tuning condenser mechanism as it revolves.

(d) In most ac-dc sets, the pilot lamp is shunted across a resistor, a portion of a tube filament, or a section of the ballast tube. If the lamp burns out, excessive voltage will exist across the part shunted.

If the pilot lamp is shunted across a section of the rectifier tube filament and the rectifier plate is fed from the filament tap, be on the lookout for broken-down filter condensers as they would cause the rectifier plate current to be excessive and this would burn out the pilot lamp.

Always replace any burned-out pilot lamps found in universal sets. Use an exact duplicate type, because the voltage and current rating is very important in such a set.

8. Resistors. (a) Resistors are made in three general forms: 1, wire wound on a cylinder (porcelain or Bakelite) and often coated with baked vitreous enamel; 2, resistance material like carbon mixed with a binder (Bakelite, resin, or a ceramic), extruded into rods, cut and baked; 3, glass or porcelain coated with a resistive material. A resistor is rated as to resistance and power dissipation. For ordinary radio receiver use, wire-wound resistors are accurate to 5 percent, ceramic and coated (metallized) resistors are accurate to 10

percent. The exact value is dictated by the use to which a resistor is put. In making replacements, be governed by the service diagram or label or color code on the defective resistor.

(b) Power rating is important if you want the resistor to stand up. Grid resistors may be $\frac{1}{2}$ -watt types, plate resistors $\frac{1}{2}$ to 1 watt, bleeder resistors 5 watts, and power pack resistors must be calculated or manufacturer's specifications must be followed. In the final analysis, the watts dissipated in a resistor is the current through it in amperes, times the voltage drop. If the resistor is under the chassis or covered, the resistor should have a rating 4 times this computed value. If the resistor is well exposed to air a safety factor of 1.5 to 2 is enough.

(c) There is only one simple way of testing a resistor—with an ohmmeter. It should be able to measure as low as one ohm and at least as high as 100 megohms.

(d) In testing any resistance, always be sure that it is not connected to other apparatus, such as a coil, as this would give an apparent short-circuit reading; this can be determined by very carefully checking over the entire circuit to which the resistor is connected, using the schematic diagram if one is available. In case of doubt, disconnect one lead of the resistor from the circuit for test purposes.

(e) In the case of tapped resistors such as those used in some power packs, it is necessary to test each individual section of the resistance.

(f) It sometimes happens that a resistor may not burn out, but may change in value, either increasing or decreasing. In such cases, use an ohmmeter to check the resistor against the value specified in the manufacturer's service data.

9. Ballast Resistors. (a) Unless the ballast has been chosen correctly, the tubes will burn out or may not light. Ballasts are rated as to their current-carrying capacity and average voltage drop, as well as their terminal connections.

(b) When ordering a ballast be guided by the type number marked on the original unit, or state the make and model number of the receiver. There are also available universal ballasts which your distributor will

help you to choose. These will replace a wide variety of ballast tubes.

10. Volume Controls or Variable Resistors. (a) Volume controls usually are some form of variable resistance. They are either of the wire wound or coated type. First, connect an ohmmeter to the control and see that as the movable arm is rotated, the resistance varies without sudden changes. Sometimes it is possible to inspect a volume control for mechanical perfection. No wire should be loose and the resistor coating should not be flaky. The movable contact should be firm against the resistor element, and make a good contact. The arm should turn freely. If the resistance element is broken or worn, it should be considered defective and the volume control replaced.

(b) A popping, cracking noise heard in the receiver only when the volume control is adjusted is positive indication that the device is defective. Generally speaking, it is not practicable to attempt to repair a volume control. It should be replaced with a new one that can be obtained from the distributor of the receiving set in your locality, or from any large radio supply house if you give them the exact name and model number of the receiver.

(c) Before removing the old control prior to replacement, draw a picture diagram of the connections—then it will be easy to connect the new control.

11. Condensers, Fixed. (a) Most fixed condensers used in radio receivers use either paper or mica as the dielectric and are therefore referred to as paper or mica condensers. Paper condensers are housed in moulded Bakelite or paper containers with suitable leads protruding as the terminals; mica condensers are moulded inside of Bakelite forms. Mica condensers are usually small capacity devices, rarely over .05 microfarad; paper condenser values range from .0001 to .5 microfarad.

(b) Condensers are first rated as to their capacity—in microfarads. A variation of 10 percent (except in padding condensers used in the oscillator circuit of a superheterodyne receiver) is of no importance. Be governed by the service diagram for the correct value to use; the capacity marked on the condenser label or case is a sufficient guide. If no service diagram is available, use: .01

to .1 mfd for rf and i-f by-passes; .25 to .5 mfd for af by-passes; .00025 for grid leak detectors; .0001 for rf coupling condensers; .01 to .25 for af coupling condensers.

(c) The voltage rating of a fixed condenser is important. The voltage across the terminals to which the condenser is connected is your guide. The condenser's rating should be greater than this value. Many servicemen never use a fixed (paper or mica) condenser with less than a 600-volt rating even if the condenser is to be used in a low-voltage circuit. The increase in cost is only a few cents and this is excellent insurance against a call-back. Buffer condensers in vibrator power supplies should be rated at 1600 volts or more.

12. Open Condensers. (a) The easiest way to locate an open condenser in a receiver is to place the receiver in such a position that the connections to the various condensers can be easily reached. Turn the receiver on and then connect a condenser of approximately the same size known to be in good condition across the connections to the condenser which you are testing. If normal reception is obtained when you make the connection, it is an indication that the condenser under test is defective.

(b) Another method of testing a condenser is to entirely disconnect the condenser from its circuit and test it in a condenser analyzer. These devices will measure the actual capacity of the condenser as well as its leakage resistance (or in the case of electrolytic condensers the power factor). Condenser analyzers are very valuable when replacing condensers in circuits where capacities are critical. However, for ordinary radio receiver work they are not absolutely necessary and the trial of another condenser of about the same size is an entirely adequate test.

13. Shorted Condensers. (a) Condensers, not of the electrolytic type, can best be tested for shorts and leaks by connecting an ohmmeter across their terminals. A steady reading should not be obtained. A momentary deflection of the pointer of the meter, which then returns to the infinite ohms position, indicates that the condenser is neither open nor shorted. If a steady deflection is obtained, it indicates that the condenser is defective, and it should, of course, be replaced.

14. Electrolytic Condensers. (a) Electrolytics are made in two forms for use in radio receivers: the wet type in a long cylindrical aluminum can; and the dry (paste electrolyte) in a paper or metal container. Some are made with 2, 3, or 4 units in one container. An electrolytic condenser has polarity. In the metal container unit, the can is invariably negative, and the insulated electrode is the positive terminal; in the case of paper wrapped electrolytics the container near each lead or lug is marked + or -. If no marking is to be seen, the red lead is invariably +. In the multiple units, a code marking (lead color code) should be on the container.

(b) Electrolytic condensers are rated as to capacity and working voltage. For filter use, the most common sizes are 20 and 40 microfarads, although smaller and larger capacities are readily obtained. Use only condensers with a rating of 450 to 475 dc working volts in ac sets. 150V dc is the correct working voltage for ac-dc sets.

(c) AF by-pass condensers are often of the dry electrolytic type. As the required voltage rating is low and the capacity high, a small compact unit is available. Units of 10, 25, or 50 microfarads with 25 to 50 volt ratings are used. For filtering rectified A supplies, 15-volt, 1000- or 2000-microfarad dry electrolytics are used.

(d) In replacing an electrolytic, be guided by the specifications given on the circuit diagram.

(e) Electrolytic condensers sometimes develop troubles which are not made evident by tests the ordinary ohmmeter can make. For this reason, it is recommended that, if a large amount of service work is done, a 20 and 40 mfd electrolytic condenser with a high voltage rating be carried on all jobs for test purposes. The leads of the condenser suspected of being defective can be unsoldered and the one you know to be in good condition can be connected in the circuit in its place. This will give you a check on the original condenser.

(f) To test for a short circuit or excessive leakage in an electrolytic condenser, an ohmmeter should be used. An ordinary electrolytic condenser having a leakage resistance above 1 megohm is very good, and if it is at least 100,000 ohms, the condenser

is usually satisfactory, although this depends upon circuit conditions. (If you have any doubts try a new condenser.) In checking electrolytic condensers with an ohmmeter, you must know the polarity of the test probes. An ohmmeter contains a battery, and the probe to which the positive of the battery connects must always be connected to the positive terminal of the electrolytic condenser, otherwise, the condenser will not function properly, and the leakage resistance your meter indicates will be far lower than the true value. (This is only true of electrolytics.) Ordinarily an ohmmeter is not marked to show which probe is positive, but you can find out by touching the probes to the terminals of an electrolytic condenser that you know is good. The meter needle will swing towards zero resistance at first, then as the condenser dielectric film "forms" and the condenser charges, the needle will move toward a higher resistance value. Wait until the needle stops (or almost stops) and record the resistance indicated. Next, discharge the condenser by touching its leads together or by shorting its terminals with a screwdriver. Then interchange the ohmmeter probes and repeat the measurement. One of the readings you get will indicate considerably higher resistance than the other. The meter was properly connected when the higher resistance reading was made—at that time the positive probe was connected to the positive terminal of the condenser. Mark the probes to indicate which is positive on ohmmeter tests and you are then ready to test electrolytics for leakage.

(g) If electrolytic condensers are connected into a circuit with the wrong polarity, they will pass too much current. This may cause them to make a hissing or frying noise, and if kept up for any length of time, will ruin the condenser, rectifier tube, and filter chokes.

(h) A voltage applied to a condenser higher than its rated working voltage will cause it to hiss and fry and eventually break down. Any defect in the power stage or loudspeaker that removes the load on the power pack and increases the rectified output voltage will have this effect. If the loudspeaker cable is disconnected in circuits where the field is used as a choke, the input condenser will be overloaded.

(i) Electrolytic condensers that have not been used for a long time, especially in cold weather, may hiss and fry when voltage is applied to them because they are improperly formed. Usually this will not last over a few minutes, after which they will be in good condition. But if they hiss, watch the rectifier tube. If the space between the elements starts to turn blue, shut off the power at once. Use a new electrolytic.

(j) If there is a white corrosion around the end of an electrolytic of the can type, it should be replaced since the seal has broken and some of the electrolyte has vaporized. A swollen appearance in a paper-encased electrolytic indicates that the condenser is defective. An electrolytic should not feel warm to the touch after the receiver has been operating. If it does, the condenser should be replaced at once, because it is leaking excessively and may damage other parts.

15. Tuning or Adjusting Condensers.

(a) Many service calls may be traced to defects in the tuning condensers. The plates of the condensers sometimes touch each other. They should be carefully bent so that this does not occur. Dust or dirt between the plates may be removed with a pipe cleaner. A metallic fuzz sometimes gets between the plates, causing shorts to occur at some points of the dial setting. A pipe cleaner will not remove this. It may be removed by burning it off by the application of a high voltage across the condenser plates. Unsolder the lead to the stator plate and apply the high voltage directly across the condenser, turning the tuning knob so that all shorts will be burned out. Dirt may be removed and leaks between plates may be eliminated by the same process. This voltage may be obtained from the high voltage winding of a power transformer, not the one in the set. To protect the transformer, a 100-watt lamp should be placed in series with the primary.

(b) The connections between the rotors of the tuning condensers and the chassis are very important. If there is a poor connection, the ground will have to be through one of the other tuning condensers and this may result in oscillation. When spring wiping contacts are used, bend them

to get a good contact and if necessary sandpaper all points of contact.

(c) In some poorly designed receivers, the condenser plates are so thin that they will vibrate. Naturally this change in capacity will cause very unstable reception. In most cases a new condenser gang is about the only remedy, although some servicemen float the condenser on soft sponge rubber to reduce the vibrational pickup.

(d) If you find that it is impossible to tune a receiver over its entire range, examine the tuning condensers, as they may hit a wire or other stationary object which prevents them from turning.

(e) Trimmer condensers sometimes short and they should be tested for continuity. Remember when testing any condenser to disconnect one of its leads; otherwise you will obtain a reading through some object shunting it. If the mica in a trimmer condenser appears cracked, it sometimes may be removed and a new piece installed.

(f) To check a section of a ganged condenser or a trimmer, unsolder the lead from one end of the condenser so the coil shunting it is disconnected, and check the condenser with an ohmmeter. No reading should be observed.

16. Coils, RF Chokes, and AF Transformers. (a) RF coils are designed to have a definite inductance, a minimum amount of distributed capacity, and high Q factor. The Q factor can be evaluated only by special equipment or by observation of the effects of a new part, not from the dc resistance. Audio transformers are designed for a definite frequency range, dc primary current, turns ratio, distributed capacity, and power handling ability. Tests for these properties are not made by the serviceman.

(b) The usual tests are for continuity, opens, shorts, grounds, and dc resistance of the windings. In a tuning section, the coils must match: have equal inductance and distributed capacity, best accomplished by using identically constructed coils.

(c) To test for continuity or winding resistance, use an ohmmeter, the probes connected to the two terminals of the winding you wish to measure. Be governed by the

values given on the circuit diagram. Shorts between a few turns are not easily detected by this test. Shorts in rf transformers can be judged by inability to line up the stage with another, broad tuning, and lack of selectivity. In audio transformers no easy means of detecting a short between a few turns is possible. Of course, a replacement will quickly show up any short; the improved action of the receiver will indicate its presence. Opens are easily detected by a continuity test. By unsoldering the terminals of a coil, choke, or transformer, grounds or shorts to the core are easily detected with an ohmmeter. Connect the ohmmeter to one terminal of each winding (the receiver leads unsoldered), and to the core, or to the chassis of the receiver. No reading should be observed. Leaks are detected by employing a high range ohmmeter (at least 100 megohms).

(d) Opens occur because of poor soldering, corrosion at joints, and physical tears; shorts are produced by high-voltage arc-overs, atmospheric conditions (moisture and fumes in the air), and tampering; leaks occur because of accumulation of dust and dirt plus moisture or breakdown of insulation; and changes in inductance occur because the windings get loose, are crushed physically, or the shield has been disturbed.

(e) A physical inspection of coils is imperative. If the coil is moist be sure to bake it under a lamp. Go over joints and connections. Be sure the windings and shields are intact.

(f) If an rf or i-f coil is damaged, use a new coil. Do not try to replace a secondary or primary. Get a whole new part and if possible an exact duplicate made by the receiver manufacturer. If it is not possible to get an exact replacement, a universal replacement, available from most radio parts jobbers, may be used. With universal replacements, you will receive instructions for their installation.

17. Power Transformers and Iron Core Chokes. (a) Power transformers are designed to operate from a line of a definite frequency and voltage; to supply definite voltages from the secondaries when definite currents are drawn; and to handle a definite total amperes $\times$ volts—the apparent watts rating. Iron-core chokes are designed to

have a definite inductance (usually measured in henrys) when a definite dc current flows through them. They must be able to handle this current with negligible temperature rise. The serviceman in making a replacement must assume that the new device is correct in these respects because reliable makers rate their devices correctly. Other than this the usual tests are for opens, shorts (continuity), resistance of windings, and leakage. A number of special tests will now be considered.

(b) In testing a power transformer or iron core choke in the chassis with an ohmmeter, make sure that there are no resistors or other parts capable of passing a dc current connected across it. Otherwise the readings will be incorrect. When in doubt unsolder the connections, so the terminals of the device are free.

(c) A test should be made between the transformer terminals and the core of the transformer. No reading should be obtained. If the ohmmeter shows a reading, it indicates that the winding is grounded or leaky to the core or shield and the transformer should be replaced. No reading should be obtained when testing between any secondary winding and the primary winding. As the center tap on the secondary of the power transformer is usually grounded, unsolder the connection for a ground or leak test.

(d) Shorted turns in some cases can be checked with an ohmmeter, comparing the resistance you read with the value given on the circuit diagram. A short in the primary may increase the secondary voltage and overheat the transformer; a short in the secondary will reduce the secondary voltage of the section shorted and overheat the device.

The best way to check a transformer that has been overheating is to remove all tubes and let the transformer cool off. Then with the tubes removed plug in the set and turn it on. If the transformer continues to heat, gives out an odor, or smokes, it is defective and must be replaced. If it does not overheat with the tubes removed then there is probably a short in the B supply. The filter condenser and rectifier tube should be carefully checked. Also, leaky coupling condensers feeding power output tubes, and

gassy power output tubes can cause excess current drain from the power transformer.

(e) Loose laminations in a replacement part are usually due to faulty construction, and the defective piece of apparatus should be returned to the manufacturer. In some cases the laminations can be tightened by tightening the bolts holding the apparatus together or by driving a small wedge between the laminations.

18. Switches. (a) The power (ON-OFF) switch may become defective. If it opens (won't turn on the set) neither the tubes nor the pilot lamp will light. Of course, a careful check must be made to determine definitely whether or not the receiver is getting its power from the wall outlet. The power cord and plug, and fuses if used, must be in good condition. If the switch is open, there will be no continuity when the plug tap terminals are tested with an ohmmeter; if it stays closed, it will be impossible to turn the set off.

(b) The wave-band switches used in all-wave sets may cause noise if they are dirty. Dirt will also cause certain bands on an all-wave receiver to be dead. Clean the contacts of the switches with a clean cloth (free of oil) using a little carbon tetrachloride. (Warning: fumes from carbon tetrachloride are very poisonous. Don't inhale, and set up a fan to blow the fumes *away* from your face. Have the room well ventilated.) This will remove all grease and dirt from the switch contacts.

(c) The rotating arms of all of the sections of a wave-band switch must rotate when changed from one band position to another. Any switch arm failing to make contact should be repaired or replaced.

19. Shielding. (a) Shielding is used to prevent undesired coupling between circuits. Lack of or poor or inefficient shielding will result in oscillation and broad tuning. Dirty connections between shields and the chassis make them ineffective, and you should be sure that the connections are tight and clean. A little sandpaper rubbed over the points of contact between the shield and the chassis will eliminate this cause of trouble. Loose shielding will result in mechanical noises when set into vibration by sound waves from the speaker. Also, loose

shielding will cause noises to arise in the receiver circuits and this noise will be heard from the loudspeaker. Bending the shields so that they grip their supports tightly will prevent this. Be sure that the shields are in place, and not pushed out of line or to one side.

20. Mechanical Troubles. (a) Once the source of a mechanical trouble is located, the repair is obvious. If a dial cord slips, the tension on the cord should be increased. The manner in which this should be done will be clear after an examination of the particular system in use. Perhaps a spring has slipped off its hook or a screw needs tightening.

(b) If a bearing is frozen (jammed), a penetrating oil should be worked into the housing; if the shaft does not turn freely, remove it and rub it down with a fine sandpaper, return it, and use a lubricant with a graphite base. The condenser gang must turn easily, particularly where a rubber friction drive is used—lubricate the bearings.

(c) Where the dial cord has broken, it is necessary to install a new cord. Often you will be able to obtain specific instructions on restringing the cord along with the new cord. It is possible to get along without such instructions, but one must pay careful attention to the system, figuring out in one's mind just how the cord must go on if the system is to work properly. You may have to try two or three times before you get it just right.

21. Batteries. (a) Portables and receivers for areas not having electric power, use batteries, which become exhausted. Batteries should always be tested under load—the receiver should be turned on and warmed up before measuring battery voltages.

(b) "A" Batteries furnish power to heat the tube filaments, and when they run down (when the voltage drops), the emission drops. This may reduce sensitivity or result in a dead set, particularly in sets in which the oscillator stops working. Batteries 10% low are suspect; try others to see if operation is restored to normal.

(c) If a three-way portable (ac-dc-battery) works on power lines but not from batteries, the batteries are probably low.

(d) "B" and "C" batteries must furnish current to the various electrodes of the tubes. Follow the markings on the cable tabs or the receiver instructions.

(e) "B" and "C" batteries should be replaced with new ones just as soon as the voltage has dropped 20 per cent, or when the set operation is affected.

(f) If the battery voltage is very low or zero, it may have run down because the set was left turned on, or there may be a poor internal connection or a defective cell. Replace the battery, but check the circuit for shorts before doing so.

22. Voltage Measurements As An Aid In Locating The Defect. (a) Voltage measurements afford a quick check on the voltage supply circuits but are of no use when certain signal circuit defects exist. For example, an open coupling condenser or a shorted tuning condenser will have no effect on the operating voltages.

(b) A good multimeter with a high ohms-per-volt rating or a vacuum tube voltmeter should be used to measure voltages.

(c) The following index is to help you interpret voltage and current readings. Study the index carefully.

HIGH PLATE VOLTAGE

Insufficient load on power pack because of weak tubes.

Open bleeder.

Short-circuited voltage-reducing resistance.

High line voltage.

High grid-bias voltage.

Shorted filter choke or loudspeaker field in power pack.

LOW PLATE VOLTAGE

Open or leaky filter condenser.

Leaky coupling condenser.

Insufficient grid bias.

Shorted bleeder resistance.

Low line voltage.

Defective operation of line ballast.

Leak through bypass condenser.

Shorted or defective section of voltage divider.

Defect in power transformer.

Defective rectifier.

Defective filter choke or loudspeaker field.

NO PLATE VOLTAGE ON ALL TUBES

Shorted filter condenser.

Defective rectifier tube.

Open filter choke.

Open in —B circuit.

Ground in output tube plate circuit.

Open loudspeaker field or choke.

NO PLATE VOLTAGE ON ONE TUBE AND REDUCED PLATE VOLTAGE ON OTHER TUBES

Shorted bypass condenser

Grounded plate circuit.

Grounded plate coupling unit in plate circuit.

Shorted plate element in tube.

NO PLATE VOLTAGE ON OUTPUT TUBES

(Plate Voltage Available on Other Tubes)

Open in plate circuit.

Open in output unit.

Open in grid-bias resistor.

Plate-to-chassis condenser shorted.

TUBE ABNORMALLY HOT

Gassy tube.

Insufficient grid bias.

Excessive plate voltage.

Excessive screen-grid voltage.

Open grid circuit.

Leaky coupling condenser.

TUBE IS COLD TO THE TOUCH

Open plate circuit.

No plate voltage.

Open filament circuit.

Defective tube.

Very high negative bias.

HIGH GRID BIAS

High value of bias resistance.

Defective bleeder resistor.

Defective condenser or resistor in grid return.

LOW OR NO GRID BIAS

Shorted bias resistance or bypass condense.

Defective resistance or incorrect value.

LOW OR NO SCREEN VOLTAGE

Open variable control for screen-grid voltage.

Open screen-grid circuit.
Open resistance in screen-grid circuit.
Shorted screen bypass condenser.

HIGH FILAMENT OR HEATER VOLTAGE

Incorrect value of voltage-reducing resistance.
High line voltage.
Insufficient load upon filament or heater winding, open filament circuit, or defective tubes.
Wrong tube.
Some other tube in filament string has a partially shorted filament.

LOW FILAMENT OR HEATER VOLTAGE

Wrong tube in socket.
Incorrect line-voltage-reducing resistance.
Defective operation of ballast
Short circuit in transformer.
Short circuit in filament circuit.
Defective tube.

23. Customer Complains, but Condition Natural. (a) You want the customer's opinion of what is wrong—because your job is to service that complaint. But you must know whether a complaint is unreasonable. If you find that it is unreasonable, explain the situation as carefully as you can without offending the customer. Experience is an important factor in judging the performance of a receiver. Receivers are frequently poor in one or more ways. A receiver may be loud and clear but have poor selectivity; or it may be selective but poor in quality.

(b) In general, the more tubes used in a receiver, the better it should perform—not including avc tubes, squelch tubes, automatic tone-control tubes, and tuning monitors, as they are merely aids to simple operation. A superheterodyne receiver is generally better than a trf receiver. Selectivity and sensitivity are improved with more rf and i-f stages. This should be used as a guide. Tone and volume are greatly governed by the size of the cabinet, the type of power output tubes, and the cost of the receiver (including good workmanship and design and good material).

(c) Too much should not be expected of inexpensive receivers. They do not have

the sensitivity, selectivity, volume, nor fidelity of a higher priced receiver.

(d) Some of the shortcomings of an inexpensive receiver that cannot be readily changed are: only local stations are strong, distant stations are weak or absent (try a longer aerial); only local stations are heard during the day; receiver tunes broad.

(e) Very sensitive receivers are naturally noisy except on local and powerful stations. Circuit and tube noises exist and cannot be remedied. The customer must be told to expect this on distant stations.

(f) A receiver with avc will be noisy when tuned between stations because it is operating in its most sensitive condition.

24. Natural Conditions That Are Not Defects. (a) A resistor may become warm—it is only when it gets unusually hot that a defect is indicated. A grid, or an avc resistor should not get hot, but a bleeder resistor, a power-pack voltage divider, or a line-voltage regulating resistor is supposed to get hot. A defect is indicated only when it gets so hot that it is red (O.K. for line ballast resistor), smokes, melts, or chars surrounding parts.

(b) Ballast tubes get hot; in fact they work because the resistance elements are working at high temperatures. The vacuum tubes get hot even to the point where it is impossible to touch them safely. The rectifier and power tubes heat up the most. Only when the plates turn red is a defect definitely indicated. Check voltages and currents if in doubt.

(c) Certain tubes, especially power tubes, have a blue glow *on the glass envelope*. This is natural and is caused by the glass fluorescing under electron bombardment. Don't confuse this with a blue glow in the space between the cathode and the plate, which indicates a defective tube or improper operation.

Exceptions: mercury vapor rectifier tubes *should* have a blue glow between the elements. Also, voltage regulators should glow with an orange color.

(d) It is natural to see a spark when connecting the ground lead to the ground binding post in a receiver where a condenser is connected from the ungrounded supply line to the chassis. If you reverse the power line

plug in the outlet, the sparking will probably stop. You should insert the power plug so that the sparking is observed when the ground is connected. When this condenser is used and the ground is left off, touching the antenna or even the chassis may result in a shock. Connecting the ground will stop this.

25. Incorrect Replacement Parts. (a) Sometimes wrong parts are found in receivers because another serviceman did not know or use the right value. Tubes may be found in the wrong sockets because the owner mixed them up while examining them.

26. Outside Interference. (a) Noises originating outside the receiver can usually be determined by removing the aerial and ground wires (or shortcircuiting the loop antenna if one is used). If the noise still persists, it is an indication that the noise originates IN the receiver or accessories (batteries, tubes, power unit, or loose connections) or is coming in over the power line.

(b) Natural interference (static) presents itself as varying sounds, usually loud crackling or crashes. Static is a natural phenomenon, and up to the present time no means of successfully overcoming it has been devised for AM sets. (FM receivers are not generally affected by static.) Static interference is much more noticeable during the hot summer months and makes it impossible to receive distant stations with any degree of regularity. In fact, it is sometimes so bad that it is impossible to obtain satisfactory results except possibly on the very strong local stations. Accumulations of static electricity on the aerial wires sometimes become so great as to shock a person touching the antenna system or antenna binding post of the receiver.

(c) The ignition systems of automobiles and trucks passing along the road or street will cause static-like interference in short-wave reception. There is no remedy for this type of interference other than placing the antenna and lead-in as far as possible from the highway.

(d) On some types of receivers it is natural to receive a large amount of static and other noises when tuning from one station to another, or when switching from one

band to another in an all-wave receiver. The only remedy for this type of trouble is to turn down the volume control on the receiver before making the change.

27. Station Interference and Broad Tuning. (a) There is no receiver made with reasonable sensitivity, selectivity, and fidelity that will not suffer from station interference. The designer recognizes the fact that one good quality works to spoil another desirable feature and strikes a balance. It is your duty to acquire by experience the ability to judge what performance should be expected from the receiver you are servicing.

(b) If the customer prefers selectivity to fidelity, peak the tuning stages. If this does not reduce interference a satisfactory amount, install a wave trap. The trap should be designed for the broadcast or the short-wave band in which interference is present.

(c) Connect the wave trap in series with the antenna lead wire when the trap's coil and condenser are in parallel. For all-wave antenna systems connect the coil and condenser in series and connect the trap across the two leads to the receiver. Tune the receiver to the station desired and adjust the wave trap to eliminate the undesired station.

(d) The types of interference you will encounter are as follows: if the receiver is located too near a local broadcasting station, the station may be received over a wide range of the station selector scale. This is referred to as broad tuning. Assuming the receiver alignment is satisfactory, a wave trap should be used, tuned to the powerful local so stations to either side can be tuned in.

(e) Often a local station can be tuned in with distant stations, but when a station is not tuned in, this station interference is not obtained. This difficulty is referred to as "cross-modulation" and is due to the fact that the local station is causing the first tube to act as a detector, so the signals are mixed. A high C bias or low plate voltage on the first rf tube may produce this interference; check voltages with manufacturer's recommended values. Try a wave trap tuned to the local station.

(f) If the local station radiates harmonics,

there will be interference on higher frequencies. A 610-kc broadcast may be heard at 1220, 1830, 2440, etc. This is no fault of the receiver, and nothing can be done to the receiver to eliminate these undesired signals. If you are sure that the station is radiating harmonics (check this fact on several receivers in various localities) call the station engineer. He will gladly make a check.

(g) In some supers a station having a frequency equal to the dial setting plus or minus twice the i-f may ride in on the desired signal. This is called image interference. A trap tuned to the interfering signal will help eliminate this interference.

(h) If you find that a local short-wave station interferes on a lower frequency range of a receiver (for example, the broadcast band), tune the local out with a wave trap.

(i) If long-wave code stations (below 500 kc) are interfering with reception of a superheterodyne receiver, the station is probably of the same frequency as that of the i-f section. A wave trap may be inserted in the antenna lead-in. You may also set the i-f to a slightly higher or lower frequency. Realign the receiver completely. (This may throw the station dial calibration off.)

(j) It is worth remembering that many customers report that they hear the same station at different positions of the tuning dial. This is repeat-point reception when the second point is twice the i-f from the proper point. Sometimes, however, they are hearing the same program coming from different stations, and have not noticed that they are listening to a chain program.

(k) When we stop to realize that there are several hundred stations on at the same time in the broadcast band, it is reasonable to expect some interference. First, several stations may be on the same frequency and a sensitive receiver, regardless of its selectivity, will pick up both or several of the stations. Nothing can be done to eliminate this interference, which is often recognizable because one fades in while the other fades out, or all come in at one time, creating a hash of words or music.

(l) Garbled reproduction called "monkey chatter" is heard when adjacent channel stations are both heard together. Nothing can be done with an ordinary receiver unless

you wish to reduce fidelity by peaking the tuning systems. In a high-fidelity receiver with variable band width, reduce or compress the band width.

28. Antenna System Troubles. (a) Indoor aerials and loop antennas never give the same results as good outdoor antennas. When greater distance reception is wanted, an outdoor antenna should be used. Most receivers equipped with a loop also have aerial and ground binding posts. If there are no provisions for an outside antenna, you can arrange one turn of insulated wire around the outside of the loop in the same plane as the loop wires. One end of this wire should then be connected to the receiver chassis through a .01-mfd, 600-volt paper condenser. The free end of the wire may then be connected to an outside antenna.

(b) The ends of all wires to be joined should be scraped clean and then soldered and taped. The ground wire should be connected by means of an approved ground clamp to the cold water pipe, or to a pipe driven into the damp ground. Scrape the surface of the pipe under the clamp so as to form a good electrical connection. The ground wire should be soldered to the ground clamp. In all-wave antennas a poor connection can exist at the coupling transformer. Examine all taps, connections, and switches carefully for loose, dirty, or corroded connections.

(c) Antennas that are too short cause signals to be weak, and since some sets are more sensitive at one end of the dial than the other, this effect is more noticeable at the less sensitive end. In some cases, the aerial resonates at the end with good reception and falls off in efficiency at the other end of the band. A change in length, generally an increase, is a remedy for this.

(d) When an antenna is too long, the receiver may not be selective, the volume of local stations may be uncontrollable, or station interference may exist. Cut the length of the aerial to the size suggested by the manufacturer of the receiver, or insert a condenser in series with the aerial. A small fixed condenser of approximately .0025 mfd or .0001 mfd is usually helpful.

29. Power Supply Defects. (a) An ac receiver with a power transformer must not

be connected to dc power lines. Fuses may blow or the power transformer may be damaged. Universal receivers, however, will operate on either ac or dc. Determine definitely the correct operating line voltage to be applied to the receiver if there is any question at all about the proper power supply.

(b) The tubes in a radio receiver will go bad quickly if the voltage supplied to them is above their specified working values. Check for high power-line voltage.

(c) Low line voltage may cause weak signals. In the case of three-way receivers the set may be dead.

(d) When low or high line voltage is suspected, measure with an ac voltmeter. If several of these complaints are found in the same district, report the condition to the power company.

(e) A burned out house fuse or receiver fuse, or an open in the power cord will make it impossible for the receiver to operate.

(f) When operating universal ac-dc receivers, or dc receivers from dc lines, the line plug must be inserted in the outlet with the proper polarity. Often all tubes will light and yet no signals will be heard because the line plug is reversed. In an ac receiver, hum may exist because of a reversed plug. These conditions may be easily corrected by merely removing the plug and inserting it again in reverse, thus reversing the polarity of the power supplied to the receiver.

(g) Many ac-dc sets have one side of the power line connected to the chassis, so you may get shocked when touching such a chassis if you are grounded. Stand on a *dry* board floor rather than a concrete floor. Be careful not to touch the chassis with a ground wire or set the chassis on a sheet of metal that is grounded.

(h) Whenever several tubes in a receiver do not light, look for a poorly soldered filament connection, an open filament resistor, a poor socket prong, or a poorly soldered joint at the tube prong. A break in a filament cord resistor may be found in some ac-dc receivers.

30. Defective Filter System. (a) A grounded filter choke coil or a leaky or shorted filter condenser will throw an un-

usually large load on the rectifier tube and the power transformer. If there is no fuse, the transformer may overheat and eventually break down, or the rectifier tube elements, particularly the plate, will get red hot, emit gasses, and a blue glow will arise between the elements. A blue glow between elements is a definite indication of a filter defect, except in the case of a mercury vapor rectifier tube. Shut the power off at once and check chokes and condensers.

31. Regeneration and Oscillation. (a) *Regeneration* in a radio receiver is generally recognized by a swishing or rushing sound as you tune in a station; *oscillation*, which is generally excessive regeneration, makes itself known by squeals and howls, either with the set tuned to any dial position, or when tuning through a station.

(b) Superheterodyne receivers often produce a squeal or howl when tuned because the harmonics of the i-f or local generator are beating with the incoming signal or some other signal passing through the pre-selector even when the signal itself is not audible.

(c) Open or defective output filter condensers in the power pack may cause oscillation.

(d) An open screen-grid by-pass condenser couples the plate to the grid, often producing oscillation.

(e) An open plate supply by-pass condenser will allow rf signals from the plate to pass into the supply circuits and then to a grid circuit, causing oscillation.

(f) Most servicemen usually track down a defective condenser by holding a good condenser of about .05-mfd across the suspected one. If the trouble clears up, replace the original condenser.

(g) Any high-resistance connection may be a source of plate-to-grid feedback, and a good soldered connection should be made. Corroded or dirty wiping contacts at the rotors of variable condensers often result in regeneration and oscillation.

32. Motorboating. (a) This term describes the sound produced in some receivers, resembling the putt-putt-putt of a single-cylinder gas engine. It is in reality a low-frequency oscillation produced by high common impedance in the plate circuit of

the audio amplifier. However, any combination decoupling and filter system defect may result in motor-boating. Electrolytic condensers should be checked first.

(b) Defective tubes are to be suspected, and new ones should be tried. By-pass and filter condensers should be checked for opens by shunting them with others.

(c) Open grid returns will result in a sound quite similar to motorboating, and such circuits should be checked with an ohmmeter, using a circuit diagram as a guide.

(d) Push-pull and push-push stages may oscillate or motorboat. The simplest cure is to insert a 200 or 300-ohm resistor in series with each grid; and if this does not completely solve the trouble, connect similar resistors in series with each plate. In each case, connect them next to the socket terminals. Check the plate by-pass condensers.

33. Mechanical Feedback. (a) Sound emitted from the loudspeaker is, to a more or less degree, acoustically (through the air) or mechanically (through the cabinet and chassis) fed back to the signal circuits. This may result in a howl that rises from zero intensity to a high amplitude. Recognizing the means of coupling indicates at once the solution of the trouble.

(b) Microphonic tubes, (tubes with loose, easily vibrated internal elements) are a common source of trouble. Tapping each tube while the receiver volume is turned up and while the receiver is tuned to a station will quickly lead to the identification of the microphonic tube. Replace it with another tube.

(c) In some receivers, the chassis floats on sponge rubber or springs. If they harden or lose their elasticity, microphonic noises arise. Adjust springs and replace hardened sponge rubber. Receivers are shipped with the chassis temporarily bolted down. Before the radio is placed in operation, free the chassis so that it will float.

(d) If the felt rim on the loudspeaker has hardened or has been omitted, or if the loudspeaker is too tightly bolted to the baffle, mechanical feedback will be strong. The felt rim used should be soft and only moderately snug to the baffle board.

34. Hum. (a) When a low-frequency

humming sound is heard at an annoying level, excessive ac is reaching the loudspeaker. There is always some ac in the output. Receivers with a small baffle have plenty of hum current in the loudspeaker, but the hum is not reproduced because of the small baffle area. For high-fidelity receivers, hum output must be kept very low, and any power-supply defect may result in hum.

(b) Hum is generally one of three forms: 1, *general hum*, existing at all times, whether a station is tuned in or not; 2, *tunable or resonant hum*, existing only when the set is tuned to a station, particularly a powerful station; 3, *mechanical hum* coming from a part and not through the loudspeaker.

(c) General hum is easily identified. You will hear it coming from the loudspeaker soon after the power switch is turned on. A strong hum louder than the broadcasts that you can tune in indicates, as a rule, a total break down. A mild hum, not heard in a normal receiver of the same make, indicates inadequate filtering or some minor circuit disturbance.

(d) Tunable hum is generally produced by a defect that throws ac into the rf section, causing some rf tube to be modulated.

(e) When hum is heard and placing your ear next to the loudspeaker shows that it is not coming through the loudspeaker, some part, usually the laminations of an audio or power transformer or iron-core choke, is vibrating. Wedge the laminations or tighten the core bolts.

(f) Quite often hum is accompanied by other defects—no volume, smoking parts, regeneration, oscillation, motorboating, etc. Isolating the primary defect and correcting the trouble will eliminate the hum, too. If inadequate filtering exists in the power supply system, replacing the condensers with others of less leakage, or adding more filter condensers (to increase the filter capacity) may eliminate the hum.

35. External Noise. (a) The test for external or internal noise is to disconnect the antenna and ground leads from the receiver, or short circuit the loop antenna terminals, and listen for the original noise. Slap or shake the receiver chassis to check for loose connections. Now if no noise is heard, we have definite proof that noise was

coming from an external source. If noise is still heard, it is internal, or it may be coming through the power line.

(b) Most modern radio receivers have a line-noise filter built in. In some cases it is merely a condenser across the line input; in better receivers, two condensers in series are connected to the line, and the connection between them grounded; or in other receivers a shield is placed between the primary and the secondary of the power transformer. If in doubt about noise coming in over the power line, use a commercial line filter between the receiver plug and the wall outlet. If the antenna input is shorted and the insertion of the filter eliminates the noise, install a line filter; if the filter does not eliminate the noise, the cause is internal; if the filter has eliminated the noise, but restoring the antenna-ground connections brings back the noise, the elimination procedure is as follows:

(c) Install a noise-reducing antenna. Get the straight away as far up in the air as you can, away from metal objects and power, telephone, and trolley wires. Always run it, if possible, at right angles to lines. The length of transmission line is immaterial in a well designed, noise-reducing antenna. Use an all-wave antenna for all wave receivers.

(d) In most cases, a well installed noise-reducing antenna will eliminate external noise. In the other cases, the offending device in the locality must be traced and a noise filter installed on it. Use a commercial type designed for the device in each case.

(e) Poor connections to electrical units within the house, such as fans, small motors, sewing machines, and other electrically operated devices, will cause noise. Defective switches and power outlets cause interference and should be corrected or replaced.

36. Signal Circuits Overloaded. (a) Each receiver is rated to handle a definite output without distortion. If this is exceeded by tuning to a powerful station with the volume control wide open, distortion is inevitable. The customer must be instructed to reduce the output to a reasonable amount. If the overloading produces cross modulation, try a wave trap.

37. Loudspeaker Troubles. (a) Loudspeaker fields that are suspected of being open or shorted may be checked with an ohmmeter. When a field is open or shorted, remove the field and take off the insulating paper. Sometimes the trouble is right on the surface of the coil and can be repaired. If repair is not possible, install a new field.

(b) Lack of excitation on the field may be due to a defective rectifier or to a shorted filter condenser ahead of the field. If the field is open or shorted there will be no excitation. A quick check for this condition is to hold a steel screwdriver about a quarter of an inch away from the pole piece. It should be strongly attracted if the field is being properly excited.

(c) The voice coil sometimes becomes uncentered and rubs against the pole pieces. You can check up on this by moving the cone in and out with your hand, pushing as nearly as possible on the center. If the spider is held by screws, the voice coil can be recentered easily. If the spider is glued in place, it usually is necessary to replace it.

(d) Never operate a receiver with the loudspeaker disconnected. If the receiver uses electrolytic condensers, this will cause overload on the first condenser. If the condenser is of the wet variety, a hissing sound will be heard, indicating that the condenser is breaking down.

(e) Weak magnets in pm dynamic loudspeakers are a source of trouble. The loudspeaker must be replaced.

(f) Loose turns on the voice coil or a cracked spider cause distortion, which, once heard, is easily recognizable in the future. Replacement of the voice coil and cone is the only cure.

(g) Dust and metal filings collect in the voice coil gap in all loudspeakers that do not have glued-in spiders and dust caps. This causes a distortion similar to that caused by loose turns on the voice coil. With the power turned off, grating sounds can be heard when the cone is moved back and forth with the fingers. Dust can be blown out or cleaned out by moving a strip of paper around the voice coil. Filings are held by the field magnetism; in a pm dynamic, the filings must be removed by picking them out or wiping them out with Scotch tape. Filings may be removed from an elec-

trodynamic loudspeaker by holding it with the voice coil down and hammering on the rear of the field housing; applying ac to the field will make this easier, as the ac wipes out the residual magnetism twice each cycle.

38. Oscillator Troubles. (a) When the oscillator circuit of a receiver is suspected of being defective, one of the simplest tests is to touch the ungrounded side of the oscillator tuning condenser with a moist finger. A click in the loudspeaker should result when the terminal is touched and also when the finger is removed; if only one click is heard, the tube is not oscillating. Another test is to measure the dc voltage across the oscillator grid resistor. If the oscillator is working, you should measure between 5 and 15 volts dc across the resistor. No voltage or an extremely low voltage shows that the oscillator is not functioning.

(b) When in doubt, try a new oscillator tube. Go over the connections in the oscillator circuit with a hot soldering iron, because a high-resistance connection will prevent the oscillator from functioning—possibly over only a section of its range. Test the continuity of the oscillator circuit and compare it with that of a schematic diagram of the receiver. All resistors should be tested for proper value, and condensers should be checked for opens by trying new ones. Improper alignment of the oscillator stage will cause the set to be dead over a portion of the dial. This may also be caused by excessive control-grid voltages, particularly in combination detector-oscillator stages using a pentode tube such as a 6C6. You may try reducing the value of the bias resistor by about one-third of its present size. In circuits using a pentagrid tube such as the 6A8, try increasing the value of the oscillator grid resistor by about one-third of its rated value. In battery sets, look for low filament voltage on the oscillator.

(c) If the mica spacing in any of the oscillator trimmer adjustments appears to be split or dirty, try a new piece of mica. Do not neglect the fact that the plates of the tuning condensers may rub at some portion of the dial setting. If everything seems to be in good condition as far as you can determine, the installation of a new exact

duplicate oscillator coil would be worth while.

(d) When adjusting the oscillator of a receiver, you may find at the very high frequency adjustment, two points at which a signal can be received. Use the adjustment that results in less capacity of the trimmer condenser. If you select the other position, the receiver will be dead at mid-scale.

39. AVC Troubles. (a) When an avc trouble is indicated, you should, first of all, try new tubes in the avc stage and in the stages controlled by it. Then, the continuity of the circuit should be tested with an ohmmeter, using a wiring diagram of the receiver. Resistors of improper value should be replaced with others of the right value, and by-pass and coupling condensers should be checked for opens by shunting them with others of about the same value known to be in good condition.

40. Tuning Indicators. (a) If the eye does not close when you tune in a powerful local station, first check the avc action, by connecting a high resistance dc voltmeter or a vacuum-tube voltmeter from the avc lead to B minus. When you tune to a strong station, the voltage between these points should increase. If it does not, the avc system is inoperative and you should be on the lookout for leaky avc filter condensers, open resistors, and receiver defects that are not permitting the signal voltage to be applied to the avc tube.

(b) If the receiver is dead, but the indicator eye closes normally when you tune to a point where a station should be received, you know that everything is all right between the second detector and the antenna. This definitely places the trouble in the audio section or loudspeaker of the receiver.

(c) If the receiver is dead, and the eye does not turn green but has a red glow, then operating voltages are not available in the receiver, and you would look for a power supply defect.

(d) If the receiver operates normally but there is no closure of the eye, and avc voltage is present, then the resistor between the plate and the target of the tuning eye tube is probably open. This generally has a value between 100,000 ohms and 1 megohm. It is located in the socket for the tuning eye

tube. The socket may be pried apart with a screwdriver, the resistor located, one of its leads unsoldered, and the resistor checked with an ohmmeter.

41. Associated Defects. (a) A part may be overheated, destroyed, or made defective because some other associated part is defective. For example, a shorted by-pass condenser may overload a resistor and burn it out. When a part looks as if it has been overloaded, always check to see why. Otherwise your replacement might also be damaged.

42. Receiver Alignment And Balancing. (a) A radio receiver once properly aligned seldom gets badly out of alignment unless it has been tampered with. Aging of parts will, of course, change the frequency to which the various circuits are tuned, but this change is slight and if you are experienced, you can simply adjust the trimmers for maximum output and do a good job. This presupposes that you can identify the various trimmers, and because of the difficulty in doing this with some receivers, it is best to have the manufacturer's instructions. These usually identify all the alignment trimmers. If you cannot identify the trimmers, you may get the set very badly out of adjustment and then a signal generator will be needed for realignment.

(b) There are two types of receivers in use today, the trf receiver and the superheterodyne. Both must be aligned on occasion. The trf receiver, however, is very simple and no special equipment other than a screwdriver is required.

(c) To align a trf receiver, tune in a weak station at about 1400 kc. Adjust the trimmers on the condenser gang for maximum sound output. If the receiver dial setting does not correspond with the frequency of the station, turn the receiver dial in the correct direction where the station should be picked up, until the station is barely audible. Then readjust the trimmers again.

Repeat this procedure until the station comes in at the proper point.

(d) To align a single-band AM superheterodyne, a signal generator is necessary. Connect the output of the signal generator, (tuned to the i-f of the set) between the control grid of the first detector and the chassis. Turn the attenuator (volume control) on the signal generator so the signal can barely be heard. Adjust the i-f trimmers for maximum loudness. An output meter will make a better indicator than your ear. A high resistance dc voltmeter or a vacuum tube voltmeter may be connected across the output of the diode detector, and adjustments made for maximum dc voltage.

Next connect the output of the signal generator to the aerial and ground posts of the set. (If a loop antenna is used and there are no antenna and ground terminals, make a two or three-turn loop of wire, connect the signal generator to this loop, and bring it near the loop antenna on the set.) Tune both the receiver and the oscillator to 1400 kc. Adjust all the trimmers on the condenser gang for maximum output, the oscillator trimmer first, keeping the signal generator attenuator set so that the signal is low. If the receiver has specially cut oscillator plates that visibly differ from those of the others on the condenser gang, this completes the alignment. If, however, all sections of the tuning condenser are alike in appearance, the receiver is equipped with a low-frequency padding condenser. To adjust this, tune the receiver and the signal generator to 600 kc. Tune the receiver back and forth across the 600 kc mark on its dial while you adjust the padder. Adjust the padder at the point where signals are strongest. Repeat the 1400-kc. oscillator adjustment, as there is some interlocking.

(e) For all-wave and short-wave receivers and FM sets, always refer to the manufacturer's instructions.



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A handwritten signature in cursive script, reading "J. E. Smith".