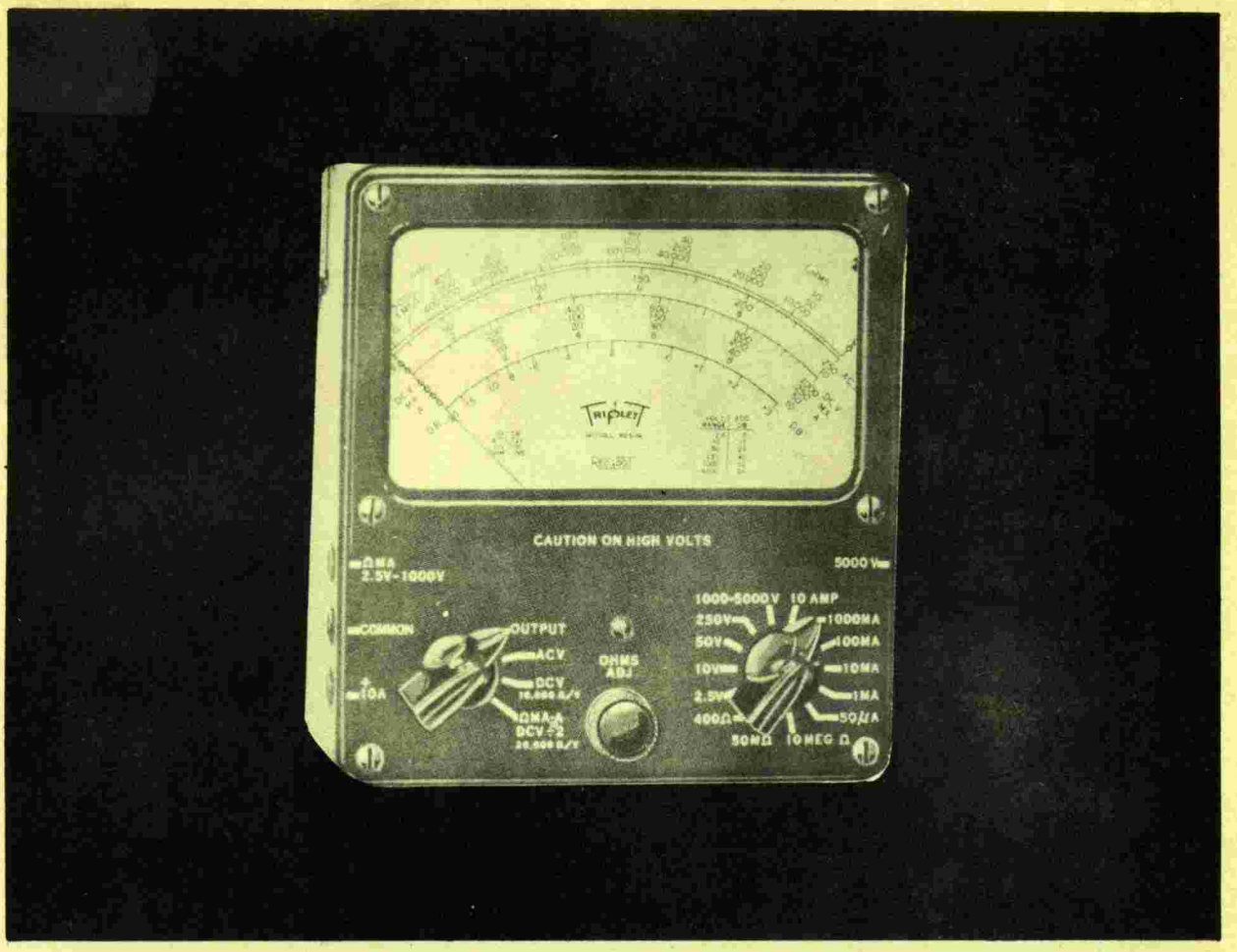

LESSON
48 RA

TEST EQUIPMENT AND RECEIVER ANALYSIS

RADIO-TELEVISION TRAINING SCHOOL, INC.
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TEST EQUIPMENT AND RECEIVER ANALYSIS

The type and amount of test equipment that a Radio serviceman should have depends upon a number of conditions as outlined below; and although there may be some differences of opinion, it will be quite generally agreed that the following suggestions are sound and practical.

In the first place, the volume of work done by the serviceman determines greatly how large an investment can be made in test equipment. A man who devotes his full time to service work and has his own shop needs more elaborate equipment than a man who merely services during his spare time and works out of his home. The kind of shop conducted by the serviceman also is an important factor, for a shop with good show windows on a main street should have the instruments displayed on an attractive test panel so that passers-by will be impressed by its appearance and have their attention called to the fact that here is a modern and well equipped service shop. Whether an instrument is to be portable or permanently installed also is an important item that needs consideration.

Certain test instruments are essential for proper service work while others are disirable and help to carry on the work in a more rapid and efficient manner. In fact, some of these instruments which were formerly considered desirable have now become essential for servicing certain types of modern receivers. A full-time serviceman can afford to invest more in a particular type of instrument than a spare-time service man, because he has a greater volume of work over which he can amortize the cost of the instrument.

Two instruments are generally considered essential, one of these is a volt-ohm-milliammeter and the other a tube tester. For portable purposes to be carried into the home a good tube tester with a built-in volt-ohmmeter section serves excellently, for it enables the serviceman to check the tubes and also

to make sufficient circuit tests to determine in most cases where the trouble lies in a defective receiver. For the shop a more elaborate circuit tester is desirable, since more detailed analysis work is usually necessary. The voltmeter should read up to at least 600 volts in thrse or four ranges, while the ohmmeter should measure down to one-tenth ohm and up to one megohm, although for general continuity testing a 100,000-ohm range is usually sufficient. As to the meter sensitivity, there also is occasion for discussion, but for all general service work, a one-mil meter rated at 1000-ohms psr volt is quite satisfactory. Higher meter sensitivities are very helpful in reading electrode voltages when checking receivers employing resistance coupled audio amplifiers.

The third instrument that is practically a necessity for the modern Radio service shop is a calibrated signal generator for balancing and alignment work. Here it pays to stretch matters a little and buy a quality instrument, for in the cheaper instruments the calibration is not so accurate and also they do not retain their calibration for any length of time. The reputation of the manufacturer should go a far way in guiding the selection of a signal generator. The tuning range should cover all frequencies over which modern all-wave receivers tune.

In addition to the above three instruments there are several others that are very desirable and that should be found in the up-to-dats service shop. Among these are the oscilloscope, a condenser analyzer, a signal tracing analyzer, etc. The applications and methods of operation of these various instruments are discussed in later lessons.

The Serviceman's Tool Equipment

The tool equipment of a Radio service man can be arranged into two groups, the tools that are essential and those that are desirable. The first group includes those that are needed to carry on Radio service work successfully, and

are listed in Group A below. The second group includes those that it is desirable to have in addition to the necessary tools so as to be able to do the work in a more convenient and efficient manner. These are listed in Group B. Some of the second group may at times be considered essential; but since they are not used so frequently, they need not be included in the initial installation, but can be added later on when the treasury permits expansion.

But it pays to buy good tools. A good mechanic can usually be recognized by the quality of the tools he uses and the condition in which he keeps them. Although the same work can be accomplished with cheap tools, with quality tools it can be done more conveniently and more rapidly. But when investment is once made in a quality tool, it should be kept in good condition and not be permitted to corrode and become covered with rust. A good service man always takes pride in his tool equipment.

Group A

1 6" Long nose plier
1 6" Square nose plier
1 6" Diagonal Cutter
1 Heavy duty screw driver
1 Light weight screw driver
1 Small screw driver (for dial set screws)
1 Soldering iron (preferably electric)
1 Insulated aligning tool
1 Set socket wrenches (spin type)
1 Roll friction & 1 Roll rubber tape

Group B

1 Hand drill and set of drills
1 Medium bench vise (swivel)
1 Hack saw
1 Tapered reamer
1 Tap wrench and set of taps
1 Set open end wrenches
1 Set 45 degree box wrenches
1 Set files (round and flat)
1 Rivet punch and set
1 Light hammer

In addition to the above standard tools, a number of minor gadgets will often prove handy, such as the following: a bakelite rod about $\frac{1}{4}$ inch in diameter and

8 inches long to be used as a searching probe, a small mirror such as a dental mirror for looking "around corners" or viewing spots under the chassis that are hard to get at, a small alcohol or gasoline blow torch for concentrating intense heat on a small area, or a flexible shaft tuning wand for determining the resonance condition of coils and tuned transformers. An extension lamp with a 15 ft. cord and an adjustable clamp so that the lamp can be attached to a Radio cabinet, frequently comes in handy, especially when the set to be serviced is in a dark corner in the customer's home.

HARDWARE AND ACCESSORIES

A Radio service and repair shop should also be equipped with a supply of miscellaneous hardware and accessories, so that a job will not be held up due lack of a suitable screw or bracket of some kind. This hardware should include first of all an assortment of 6-32 and 8-32 cadmium plated nuts and machine screws of different lengths, round head and hexagon head. Washers and spacers of various sizes, lock-washers, soldering terminals and tabular rivets and eyelets, are also often needed. Cable clamps, small angle brackets, and insulated mounting strips frequently come in handy. A convenient way to keep these small parts is in covered glass jars arranged neatly on a shelf. Everything is then readily visible and accessible.

RADIO RECEIVER ANALYSIS

Skilled Radio trouble shooting is an art that is acquired chiefly through extensive experience and a thorough understanding of Radio circuit principles. Although every service man likes to work out his own pet scheme of receiver analysis, the procedure suggested here will help in formulating such a plan and save much time and labor in groping about aimlessly at the start.

Trouble in a Radio receiver may be due to a bad tube or a defective component part within the set itself. It may also be due to a faulty condition in one of the associated units as in the antenna, batteries, power unit, speaker, etc., or it may come from some external source that is in no way related to the

receiver and is often quite distantly located from it, as an electric sign, power station, etc. The first step in a trouble case then is to determine the nature or cause of the disturbance, and after this has been done the next step is to locate the defect and correct it if posible.

No Heater or Filament Voltage

If the tubes do not heat-up, check the power supply. With a test lamp or A.C. voltmeter (D.C. voltmeter if in a direct current district) see if there is power at the outlet, it might be that the circuit fuses are blown. Then examine the plug and cord leading to the set to be sure that the plug is making contact in the outlet, and that the wires are making firm contact with the terminal screws on the plug, or that the wire is not broken in the cord. If the receiver chassis is equipped with a fuse, test it to see if it is open. In some sets the fuse will be found under a small metal cover on top of the chassis, and in others a metal plate on the rear of the chassis must be unscrewed to gain access to the fuse. It is always advisable to carry along a supply of small glass fuses of the sizes commonly used in Radio receivers so that a return trip will not be necessary on account of a mere fuse.

In the case of A.C.-D.C. electric sets the failure of the tubes to heat-up may be due to a burnt out ballast tube or to a break in the series filament resistor. If this resistor is incorporated in the line cord, the break may be at the point where the resistor is attached to the plug, for frequently persons will pull on the wire instead of on the plug itself in order to disconnect a set from the electric outlet.

Tubes Heat-up But No Response

If the tubes appear to heat-up, but no signal response can be heard in the speaker, the tubes should all be tested in a reliable tube tester or with an oscillator and output meter. Any tube that is questionable or dead should be replaced. Sometimes a short develops in a tube only after it has been heated for a time. Tapping each tube with a small rubber mallet often brings such a

"floating" short or ground to heat-up. With metal tubes it is more difficult to judge their condition and a check is necessary with a reliable tester. It is true that some metal tubes become quite warm in operation, and hence one can usually tell if current is being supplied to the set by touching these tubes.

If the tubes heat-up and all check good and still no signal response is heard from the speaker, the next step in the process of elimination is to make a thorough mechanical check of the chassis without removing it from the cabinet. The aerial can readily be eliminated by disconnecting it from the chassis and then touching the aerial post with the finger. If no response is heard, proceed further. It has been found at times that the wires leading to the grid caps on top of the tubes touch the tube shields, or that the insulation has been worn through, thereby grounding the grid of the tube. Moving the wire or shield cap so that they do not touch will easily correct such a condition and permit the signal to come through.

Similarly, where an insulated wire extends through a hole in a metal chassis without a protecting grommet being used, the insulation may be worn through so that the bare wire touches the metal chassis and causes a direct ground or short which renders the set inoperative. Examining the chassis and locating any such protruding wires may reveal the seat of trouble without much effort having to be expended. Another condition that has been found to "kill" a set is a broken connection between the metal cap on top of the tube and the internal element to which it should be connected. Checking all the cap connections on the various tubes will readily indicate such a defect.

If such a preliminary examination consisiting of testing the tubes and making a mechanical inspection of the chassis does not reveal the cause of the set failing to perform, then it is necessary to remove the chassis and speaker to the shop where a more detailed analysis can be made of the various circuit components. Ordinarily, it is not recommended that any repairs be made in a customer's home, for this may not only reduce the revenue below what the job is worth, but a

slip of the soldering iron or other little accident may cause damage to the rug, or floor that can amount to many times what could be collected for the repairs. Furthermore, when it is taken to the shop, the chassis can be given a thorough cleaning, and any necessary balancing or aligning adjustments can be made that could not be accomplished so well in the home.

Giving the customer an estimate of what the repair chargesmay amount to when the set is taken to the shop, is not always possible, nor is it generally advisable. If the preliminary inspection reveals conclusively what the trouble in the set is, and the service man knows just about how much time will be required to make the repairs, then it may be possible to give an estimate. Or, if the service man has had previous experience with the same model receiver and he feels sure that the same condition is again at fault, then also can he give an estimate. But if his guess should be wrong, and the customer insists on the initial quotation, then it is just too bad. For that reason it is not safe at any time to quote a price until a thorough test reveals the exact cause of the trouble. If the analysis required considerable time and effort, and the customer does not wish to have the repairs made immediately, it is perfectly legitimate to charge for the examination and then later on apply this inspection charge toward the cost of the repairs.

Reproduction Is Noisy

If the receiver appears to operate all right but the reproduction is noisy - to determine if the source of the disturbance is within the set or external to it, disconnect the aerial and ground leads and short the Ant. and G'nd. posts on the set with a small piece of wire. If the noise disappears, it is evident that it came from some external source; if it diminishes greatly and can be heard only moderately in the background, it is external but is still coming in over the power supply lines. But if the noise continues unabated, it originates within the set. Noise originating from some external source is often very difficult or even impossible to track down, and the only solution frequently is the in-

stallation of a noise reducing antenna system. With such systems these local noises, are not readily picked up and their interference is thus reduced to a minimum.

The power supply lines can be protected against serving as a pick-up for local noises by equipping the Radio set with a filter, if it is not already so provided. A simple yet effective filter consists of two .01-mfd. 400-volt condensers connected in series across the primary of the power transformer with the middle or common connection between the two condensers connected to a low-resistance ground. These two condensers can be mounted in any convenient position under the chassis near the input terminals of the transformer. Where such a twin-condenser filter is not sufficient or adequate, special line filters are available that have been designed for this particular purpose. In fact, it is always advisable for service men to carry one or several such filters on every call, for frequently the customer can be persuaded to purchase one, especially if he is shown how it improves reception and eliminates disturbing noises. Such line filters are sold by the various wholesale houses and they always offer the service man a good source of extra profit.

Noise may result from a faulty connection in the line cord of the receiver. For example, the screws holding the wires to the attachment plug may be loose, or the prongs on the plug may be bent so that they fit loosely in the outlet, or the line wires feeding the outlet box may not be securely attached. One of the main line fuses may be loose, or theremay be some other faulty condition in the conduit system. Whenever such an intermittent contact exists, it always causes noises in the receiver. Noise can also be caused by other electric appliances attached to the power lines. A toaster, for instance, may have one or several wires touching occasionally, or an electric hair dryer or fan motor may be sparking at the brushes. An electric light bulb may be loose in its socket or some other attachment plug may be loose in its outlet. Noise can also be caused by an automatic elevator starter, a condition that is frequently encountered in apart-

ment hotels, etc.

Noises can also result from a faulty condition in the antenna and lead-in installation. If the antenna wire touches another antenna or some grounded object, it will cause noise, or if the antenna intermittently touches the branch of a tree. A cracked lead-in insulator may cause a partial ground that results in noise. The ground connection may be loose, or the contact surfaces may be badly corroded, causing noise. If a poor electrical contact exists where the lead-in joins the antenna, disturbing noises may be caused in the receiver. A defective or a worn window lead-in is often a source of noise. In the majority of cases the seat of the noise will be found external to the receiver, rather than within the set itself. But if the noise originates from an external source over which the set owner has no control, then the only means of combating it may be the installation of a noise reducing antenna system.

Noise Originates Within A Set

The best procedure in the shop is to turn on the set and send a modulated signal through it from an oscillator tuned to 1000 Kc. Turn the attenuator full on so that a strong signal is heard from the speaker. First make a mechanical inspection of the chassis exterior for a loose tube, loose grid caps or shielding elements. See that all mounting and set screws are drawn tight, and there is no dust or dirt in the tuning condenser, and that good contact is made between the rotor shaft and frame. An ordinary pipe cleaner serves well for cleaning between the plates of a condenser. A pilot lamp may be loose in its socket and cause noise.

The chassis is then turned up-side-down and a check made of the wiring system and all circuit components. A handy tool for this purpose is a bakelite or fiber rod 5/16th inch in diameter and 8 inches long, filed to a point at one end and screwdriver edge at the other. With this rod go over the entire circuit system, from the antenna connection to the speaker output terminals. Touch every

wire and soldered joint to make sure that good electrical contact is established at each. Touch each condenser and resistor to see that there is no loose connection or that it is not touching the chassis or other adjacent units. Any loose joints or defective parts usually show up during such an examination. A strong oscillator signal is preferable to a station signal during such a test.

Noises within a set may be caused by defective tubes. Such tubes can usually be spotted by snapping them with a finger or tapping them with a small rubber mallet. If the tubes contain loose elements,noises will be heard in the speaker. Carbon resistors frequently become noisy due to partial disintergration caused by overheating, etc. Bypass condensers as well as filter condensers can also partially break down and become noisy. The quickest way of locating such noisy units is to localize the noise to a particular stage of the receiver. For example, if the 1st R.F. tube is removed and the noise ceases, it is evident that the noise originated in that stage or some place prior to it. If the noise persists, it originates in a later stage; and additional tubes are then removed one by one until the faulty stage is found. Each resistor and condenser associated with the stage is then checked by replacing it with a new one known to be in good working order. The detector plate bypass condenser and the cathode bypass condenser are often at fault, as are also the screen bypass condensers, since these operate at rather high potentials. Such defective condensers produce the familiar sizzling and frying noises.

Volume controls are also very frequent source of noise within a set; but when such a control unit has once become noisy, not much can be done to clean it and restore it to quiet operation.

In transformer-coupled audio amplifiers the primary of the transformer is oft the cause of noise. To check this it is only necessary to convert it to a resistance coupled stage by disconnecting the plate lead of the winding and connecting a suitable high resistor from the socket plate terminal to pos. B

on the transformer. Also, a .01-mfd condenser is connected from the socket plate to the grid terminal on the transformer. If operation becomes silent, it is evident that the transformer winding was noisy. If sufficient gain is available, this temporary connection can be made into a permanent repair. In dynamic speakers the flexible wires connecting to the voice coil sometimes fray and become very noisy. In power switches the contacts become worn and loose and set up crackling noises.

Reproduction is Weak

If the reproduction is weak, it may be due to a low tube, a poor antenna-ground installation, or a defective unit within the receiver itself. The first step, therefore, would be to check the tubes in a reliable tube tester and replace any that appear defective or exhausted. If the tubes are not at fault, and the line voltage at the outlet is up to normal, then the following observations should be made.

If local stations come in amply strong, but distant stations are abnormally weak, this would indicate that the antenna pick-up is lacking. To check the installation disconnect the antenna lead-in from the Ant. post on the set. If an appreciable drop in volume occurs, it is evident that a good signal pick-up was had; but if the volume does not change much, the antenna is deficient in some way. The antenna may be too short for the available signal strength, or the antenna or lead-in may be touching some grounded object. The contact where the lead-in joins the antenna may be corroded and hence be of high resistance. There may be a break in the lead-in wire, and this will reduce signal strength.

If all stations are weak below normal and the antenna appears to be functioning properly, attention must then be directed toward the receiver itself. First, it might be well to measure the socket voltages, for these will at once indicate if there is any faulty condition in the circuit system. If plate or screen voltage is missing at a socket, it indicates that either the series resistor is open or that a bypass condenser is shorted. If all voltages are below normal, the

power supply should be inspected. A transformer winding may be partially shorted, the rectifier tube socket may be charred, a filter condenser may be partially broken down, or part of the voltage divider may be shorted out. If the voltage distribution is quite normal throughout the receiver, further observations are necessary.

Weak reproduction may be due to lack of gain in the R.F. or I.F. amplifier caused by poor alignment or improper neutralization. Hence, check the neutralization if the receiver is of the T.R.F. type, also the balancing or alignment. If the receiver is of the superheterodyne type, also check the I.F. alignment and the tracking of the oscillator.

The volume control may be worn out and be the cause of the weak reproduction. One of the R.F. or I.F. transformers may be open, or shorted entirely by a defective trimmer condenser. Sometimes an accumulation of dust and moisture may short a trimmer condenser and thus impair the operation of the entire tuned stage.

If the above analyses do not reveal the cause, a further examination must be made of all the other component parts. Check all bias and voltage dropping resistors and bypass condensers. Some resistors may have a different value when hot than when cold. Test the A.V.C. system, for a gassy tube or faulty resistor here can greatly cut down the sensitivity of the receiver. In the case of battery operated receivers weak reproduction is generally due to exhausted batteries or corroded terminal wires and contacts.

Reproduction Is Distorted

Distortion is a deformation of the signal voltage waves as they travel through the successive stages of a Radio receiver. Such distortion is very often caused by poor exhausted tubes, especially by weak power tubes in the output stage. A bad rectifier tube in the power supply may cause low socket voltages that produce distorted tube operation. In dual purpose tubes one section may give out before the other does, and hence impair the performance of the receiver.

Two tubes in a push-pull amplifier may be badly mismatched and create distortion. Therefore, when distortion is encountered, a thorough test of all tubes should first be made.

The second step is to check the socket voltages to see if the proper operating conditions are provided for each tube. If a plate or screen voltage is low, check the circuit for a series resistor that may have broken down or changed in value, or for a bypass condenser that is partially shorted and leaky. Very important for proper tube performance is the correct bias. Therefore, all bias resistors should be carefully checked, also the bypass condensers. A grounded resistor or leaky condenser may completely change the bias on a tube and cause distortion. In a single-tube output stage the value of the bias resistor and bypass condenser is very important. If the condenser has lost some of its capacity or initially was too small, unpleasant distortion results.

Improper alignment of the R.F. or I.F. amplifier can also cause distortion, or oscillation may result from bad alignment and cause distortion. (See later bulletin for detailed alignment instructions.) Sometimes distortion is due to natural causes over which the set owner can have no control. For example, if one or two distant stations are operating on the same wave length as a nearby or local station, disagreeable gurgling distortion will often be heard, especially with very sensitive sets. A defective condition in the power supply, such as a broken down voltage divider resistor or filter condenser, can upset the electrical stability of the circuit system and cause distortion.

In the loud speaker distortion can be caused by the voice coil being off center or touching the walls of the magnetic gap. Loose turns in the coil or dirt in the gap can also be the cause. A partially shorted field coil causes distortion at low volume. If the speaker cone loses its stiffness or the spider ages and becomes fatigued, or the permanent magnets weaken, distorted reproduction may result. Replacement cones are now available for practically every make

and model speaker used, and replacing a cone is frequently the cure for the distortion.

Distortion that appears only at low volume may also be due to an open field coil, to insufficient signal excitation for the power tubes, to improper sockct voltages, or to an incorrect detector grid lead. Distortion at high volume is often caused by the receiver not being tuned properly. It may also be due to the speaker not being able to handle the strong signal, or the detector or output tube being overloaded. The A.V.C. system may not be functioning correctly and be the cause of distortion, due to a gassy tubc or resistor that has changed in value.

The above outlinc gives the common causes of distortion in the order of their importance and frequency of occurrence; and if a receiver is checked accordingly, the seat of the disturbance can usually be located quite readily.

COVER PHOTO

The Triplett Model 625-N Long-Scale Volt-Ohm-Mil-Ammeter is shown on the cover of this lesson. This instrument as well as the Triplett Model 2413 Tube Tester shown at the right are typical units used by servicemen everywhere.