RADIO MAINTENANCE
Incorporating 'Trader' Service Sheets

THIS ISSUE INCLUDES :

Service Sheet No. 145—Burgoyne Battery Fury Receiver. Service Sheet No. 146—Philco 269 (and 444) A.C. Superhet.

FAULT FINDING IN RECEIVERS

Systematic Localisation Is Quicker Than Haphazard Testing.

THE problem of fault finding in receivers sent in for service is one which the inexperienced service engineer is rather at a loss to tackle. He probably knows all that he needs about test gear and its operation, and possesses, we will suppose, a good multi-range meter (with ohmmeter scales), valve adaptors, and a signal generator.

The latter, of course, is mainly for use in receiver alignment, and this has been covered fairly fully during the past few months in a series of fourteen articles which have appeared each week on this page. A signal generator, however, also has uses on the fault-finding side of service work, its modulated H.F. signal (or the L.F. modulation alone) serving as a very convenient source of input when testing circuit by circuit.

Localising Faults

It cannot be too strongly impressed on the beginner that the secret of speedy fault-finding is to localise the fault, beginning with the whole of the receiver circuits open to suspicion, and gradually eliminating the parts which are working properly, thus narrowing down the fault to a small section of the whole circuit, and eventually to one or two components which can be individually tested.

The painstaking method of starting at the aerial terminal, and gradually working through the set until the speaker is reached, testing component by component, and wire by wire, may eventually find the fault, but usually at a very heavy expenditure of time, which, in modern service work, can be ill afforded.

On the other hand, haphazard testing is equally to be avoided by the beginner. It is true that service engineers with experience can, from the symptoms, often diagnose the fault as being one of a few alternatives. In many cases, they may be lucky, and find the trouble in a few minutes. They probably know that the receiver in question is prone to certain faults, and so may unhesitatingly run the trouble to earth almost immediately.

These men, however, are exceptions, and we are not writing for their benefit. They " know all the answers," and it is to the beginners that this article is addressed, and to whom we would strongly advise fault-finding by localisation.

A Simple Example

Let us take a simple example to illustrate the method, which actually occurred in our laboratory a few days ago. An A.C. " straight " receiver gave absolutely no results on radio, though it was obvious that the set was " live," and there was the usual slight hum from the loud-speaker. The first test was to plug in a pick-up (the L.F. output of a signal generator would have been equally satisfactory) and switch the receiver to " gram." Results were quite good, except that the power output seemed a little below normal.

The obvious inference was that the main fault was in the H.F. or detector section of the receiver (the pick-up fed into the first L.F. valve).

The next step was to check up the valve anode and screen voltages, which proved to be satisfactory, if a little low, in the two H.F. stages. The detector anode voltage was, however, zero. The fault was thus narrowed down to the detector anode circuit. Now the absence of anode voltage on the valve might have been due to a break in one of the resistances in the anode circuit (there were two in series, one for decoupling and one used as an anode load), or alternatively it might have been caused by a short circuit from anode to chassis.

During the valve voltage tests we had checked up the output pentode, and found that the voltages were low. This rather pointed to a short circuit, rather than a break in the anode circuit of the detector, which would naturally tend to drop the voltage of the H.T. positive line. It was not a dead short in the H.T. circuit, for in this case the voltage on the H.T. line would have been zero (and evidence of serious burning would have been present). It was clearly a short from anode to chassis, the current flowing due to this being limited by the two resistances in the anode circuit.

On removing the chassis, both resistances showed evidence of having run hot, which bore out our theory. An examination of the circuit diagram showed that a small tubular condenser was connected from detector anode to chassis. This was removed and tested, revealing a dead short. It was replaced by a new one, and immediately the receiver worked correctly again. Furthermore, the output valve was now getting its full voltages, and the power output had regained its usual level.

Care In Interpretation

The foregoing example indicates roughly the method of localising faults. It does not always work out so simply, of course, but however elusive and difficult a fault may be, it always pays first to eliminate those parts of the circuit which tests show to be above suspicion, and then to concentrate on the section of the circuit which seems to be doubtful.

It must be borne in mind that with modern receivers the circuits are to some extent interconnected and a fault in one circuit may have an effect on some of the others. Thus in the above example, the detector anode short dropped the voltages on the output and other valves. Hence some care must be taken in interpreting the results of the various tests.

The service engineer has one advantage in looking for faults in a commercial receiver (providing it has not been tampered with). It presumably worked properly once, and therefore the connections and disposition of the components are all correct. Once the fault has been traced, the performance should be as good as it was originally.

RADIO MAINTENANCE

Incorporating 'Trader' Service Sheets

THIS ISSUE INCLUDES :

Service Sheet No. 147—G.E.C. A.C. Super 4. *Service Sheet No. 148—Ultra 101 A.C. Superhet (and 96 Radiogram).*

FAULT FINDING IN RECEIVERS—2

More Hints on Systematic Trouble Tracing.

LAST week the advantages of tracing faults in receivers in a systematic manner, as against haphazard testing, were stressed. It was pointed out that methods of localisation form the only logical way in which a beginner can hope to discover faults without waste of time.

External Faults

The first thing to do when a set is received for service is to make sure that the fault is not external to the set. It should be tested on the dealer's aerial-earth system (broken aerial or earth wires still account for a good many " receiver " faults) and on the correct mains supply or with batteries of the correct voltage.

Faulty mains switches or plugs, D.C. receivers plugged in the wrong way round, batteries of low voltage or high internal resistance, and similar faults are thus eliminated. Sometimes leaking extension speaker wiring at the customer's house has been known to cause a receiver to be suspected of being faulty.

Having made certain that the fault does actually lie in the receiver itself, the next thing to do is to discover whether it is occurring in the H.F. or L.F. end of the receiver. This can often be done by feeding the output from a pick-up (or the L.F. note of an oscillator) into the gramophone pick-up sockets of the receiver, or, if these are not fitted, between the grid of the first L.F. valve and chassis.

It may be necessary to apply a small external bias voltage, particularly if testing for the source of bad quality rather than a complete breakdown of the receiver. In the latter case, there is no need to worry about a little distortion, since if any results at all are obtained, it is safe to assume that the original fault lies in a part of the circuit prior to the point where the pick-up is being fed in.

Assuming that the pick-up test, either by the absence of results, or very poor output, indicates a fault in the L.F. end of the receiver, the next thing to do is to concentrate the tests on this part of the set.

Valve and Circuit Voltages

At this stage in the proceedings it is a good plan to start checking valve and H.T. line voltages, since this test gives an idea if there is a fault in any part of the circuit carrying the valve D.C. supplies. Use a high resistance voltmeter, with the negative clipped to the chassis, and the positive connected to an insulated test prod which can be quickly applied to various parts of the circuit for voltage reading.

If all the valve supplies seem correct, one can generally eliminate things such as decoupling resistances, grid bias resistors, anode load resistances, transformer primaries, L.F. coupling condensers, decoupling and by-pass condensers, and so on.

One must be careful not to assume that this test also eliminates every other component carrying the screen or anode currents, however. A low resistance anode H.F. stopper, or a small choke may, even if it is dead shorted, make so little difference to the anode voltage that it would not be noticed.

Further, short circuits, or partial shorts in components in the grid circuits of the L.F. valves will generally make no difference to the static valve voltages or currents, unless grid current happens to be flowing, which is usually not the case. Open circuits in coils or resistances here will have an effect, since the bias voltage is thereby removed, and the grid becomes " free."

It is impossible in an article such as this to indicate the effect of faults in every type of component on the valve voltages, and it is strongly recommended that the service engineer should work from a circuit diagram, noting which components are carrying D.C., and generally getting an idea of the effect of faults in any particular part of the circuit.

When, for instance, it is found that the voltage on the H.T. positive line is roughly correct, but the anode voltage of one particular valve is high, one naturally looks for a short or partial short in one of the components in the anode circuit.

Voltage Drop

The next step is to measure the voltage drop across each of the components in this circuit, by connecting the voltmeter across them in turn. Any component which has no voltage drop across it must be suspected of being short circuited.

It is a good plan to get a rough idea of the voltage drop to be expected, and for this a milliammeter inserted in series with the anode circuit is necessary. Suppose the current flowing proves to be 5 mA and that there are two resistances in the anode circuit, a decoupling resistance of 10,000 O and an anode load resistance of 20,000 O. Since the current flowing is 5 mA, the voltage drop across the 10,000 O resistance should be 50 V, and across the 20,000 O resistance, 100 V. This is obtained from the usual Ohm's Law relationship, voltage equalling current multiplied by resistance. Consequently if, say, the voltage drop across the 20,000 O resistance is only 25 V, it may be assumed that this resistance is faulty, and it should be removed for a proper resistance test.

In this way components known to be carrying direct current may be quickly checked by means of a voltmeter without removing them from the chassis.

RADIO MAINTENANCE
Incorporating 'Trader' Service Sheets

THIS ISSUE INCLUDES:

Service Sheet No. 149—Ferranti Parva A.C. (1936-7). Service Sheet No. 150—Pye T20 Transportable A.C. Superhet.

FAULT FINDING IN RECEIVERS—3

Voltage, Resistance and Condenser Tests.

IN the last article we saw how voltage tests in various parts of a receiver could be used to trace faulty resistances or other components carrying D.C. It must be stressed, however, that such tests should always be used with discretion, otherwise incorrect deductions may be made.

In a modern receiver, resistances and condensers are so much inter-connected in some parts of the circuit that it is not safe to judge a component by the resistance test unless one is sure that no other components are influencing the test.

Study the Circuit

The only way for a beginner to be sure of this is to study the circuit diagram very carefully. Having found a supposed fault in, say, a certain resistance, the diagram should be studied to see whether any other faulty component in the same circuit could produce the same symptoms

An example of this was given in the first article on fault finding, in the issue of September 26. Here it was found that there was no voltage on the detector anode. This might have been due to a break in one of the resistances in the anode circuit, but on examining the circuit diagram it was seen that there was a fixed condenser connected from anode to chassis. Obviously, a short-circuit in this condenser would also result in zero anode voltage.

Examination of the resistances showed that they had been running hot, and were scorched. This clue pointed to the condenser being at fault, as was indeed the case.

If we had adhered blindly to the resistance test, we should probably have wasted time by unsoldering the resistances and checking them, and should have found them quite normal. As it was, we saved time by examining the circuit diagram first.

Another simple example is the case where a valve is getting a low, or zero, bias. A shorted bias resistance is probably suspected, and a voltage rest across it shows zero. The bias resistance is removed, checked up, and found to be correct. Why is this? Referring to the circuit diagram, it is seen that there is an electrolytic condenser across the resistance, and a test on this shows a short circuit, which, of course, also shorts out the resistance.

This shows the result of jumping to conclusions in service work, and the necessity for taking a section of the circuit into account, rather than an individual component, unless it is definite, from a study of the circuit diagram, that a particular component cannot be influenced by any others.

Paralleled Components

In the case of a paralleled resistance and condenser, the only satisfactory way of testing them is to separate the two, by unsoldering one connection of one of the components, and make individual tests. In the example above, if the removal of the condenser had resulted in the voltage drop across the resistance rising from zero to an amount equal to the correct bias voltage, the obvious inference would have been that the condenser was shorted. If, on the other hand, the voltage still remained zero, it would have been fairly safe to assume that the resistance had dropped to zero. This is an unusual fault, however, and we should immediately have started looking for another source of short circuit in the same circuit as the resistance, for example, in the wiring.

Resistor tests in a receiver are fairly easy, working on the voltage drop method, and using an ohmmeter for verification after the suspected faulty resistance has been removed.

Condenser Tests

Condenser tests are not quite so simple. Short-circuits, or partial shorts are detected by the voltage test in cases where there is a D.C. voltage across the condenser of known value. For instance, a decoupling condenser obviously has a voltage across it equal to the voltage between the bottom of the decoupling resistance and chassis.

If the decoupling resistance is O.K., and the voltage from its lower end to chassis is zero, or low, the decoupling condenser is immediately suspect.

Where there is no D.C. voltage across the condenser, it is probably best to disconnect one end, and apply an ohmmeter test, a good condenser indicating infinity on the scale. A battery in series with a milliammeter would be equally suitable for indicating the absence or presence of leakage, but should the condenser be shorted, a perfectly good milliammeter will probably be burned out. Hence use a series resistance to limit the current flowing in case of a fault of this nature.

Although most condenser faults are due to short circuits and partial shorts, there are still some due to loss of capacity or open circuit. All our tests so far will indicate that a condenser with this type of fault is O.K., and the only way to discover the fault is by a test which measures the capacity. A capacity bridge is best for this, but is not owned by every service engineer.

Another test, which is quite satisfactory, except, perhaps, for very low value condensers, is to apply a known A.C. voltage (of known frequency) and measure the alternating current flowing through the condenser. Some multi-range meters are provided with graphs from which the capacity can be read off directly, but if not, a simple calculation will give the result. This will be described in the next article.

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Incorporating 'Trader' Service Sheets

THIS ISSUE INCLUDES:

Service Sheet No. 151—Ekco AD37 A.C./D.C. Receiver. Service Sheet No. 152—Invicta AW57 All-Wave A.C. Superhet.

FAULT FINDING IN RECEIVERS—4

Simple Measurement and Testing of Condensers.

AT the conclusion of the last article we were discussing the measurement of the capacity of condensers in a receiver which were suspected of being faulty. It was stated that a capacity bridge was the best solution of the problem, but this was not owned by every service engineer, and a simpler method was the measurement of the alternating current flowing through the condenser when a known A.C. voltage, of known frequency, was applied.

Simple Capacity Measurement

In a measurement of this nature, we do not need great accuracy, but rather an indication as to whether the condenser is much down on its rating, or is open circuited. In the latter case, of course, no A.C. will flow through it.

If E is the applied A.C. voltage as measured by the ordinary type of A.C. voltmeter (i.e., the R.M.S. voltage), f the frequency of the supply in cycles per second (usually 50), I the measured alternating current flowing through the condenser (in amperes) and C the capacity in *farads*,

then $I = 2\pi fCE$

or $C = \frac{I}{2\pi fE}$

From this equation the capacity can be calculated, but care must be taken to see that all the quantities involved are expressed in their correct units. For instance, the current flowing is usually measured in milliampères, while the value of the capacity is required in microfarads. The constant π is 3.14 approximately. Converting the equation to these values we get

$$C \times 10^{-6} = \frac{I \times 10^{-3}}{6{\cdot}28 \times f \times E}$$

where C is now in microfarads, I in milliampères and E in volts (R.M.S.).

If the supply has a frequency of 50 c.p.s. (or any other fixed value) the equation can be further simplified by substituting for f. In the case of a 50 c.p.s. supply,

$$C = \frac{20}{6{\cdot}28} \times \frac{I}{E} = \frac{3{\cdot}18 \times I}{E} \text{ approx.}$$

Consequently, if, with a 50 c.p.s. supply we multiply the current flowing (in mA) by 3.18 and divide by the applied voltage, the answer is the capacity of the condenser in microfarads.

Further simplification can be made by applying always the same A.C. voltage (say from 4V secondary of a mains transformer). Then the capacity will equal the current flowing multiplied by some constant (in the case of a 4 V input, 0.8).

This method will give results quite accurate enough for ascertaining whether a particular condenser is up to standard. It should be noted, however, that it is only correct with paper, mica or air dielectric types. Electrolytic condensers need to be polarised with D.C. before they can be measured in this way, and this involves a more elaborate set up.

Substitution Method

Those who do not wish to go to the trouble of measuring or checking the capacity of doubtful condensers can adopt the simpler method of substitution. The suspected condenser is disconnected from the circuit (one connection only need be broken) and a good condenser of the same capacity is connected in its place. If the fault is cleared, the original condenser was obviously the cause of the trouble, and can be discarded.

To save a certain amount of time, if the substitution method is adopted, it is not a bad plan to keep a range of condensers of various values at hand. These should be fitted with short leads terminating in crocodile clips, so that they can be quickly connected into circuit without soldering. After the faulty condenser has been found by the substitution method, the test condenser is removed, and a replacement type connected up permanently.

The capacities most often required are 0.0001μF, 0.0003μF, 0.0005μF, 0.001μF, 0.005μF, 0.01μF, 0.05μF, 0.1μF, 1.0μF, 2.0μF, 4.0μF, 8.0μF and 16.0μF. The last four should be of the electrolytic type.

In some cases, condenser faults are of the intermittent type, and may cause failure of the component when it is working in the receiver with a voltage across it, yet under test when disconnected from the receiver it may be apparently quite sound. The only way to cause the fault to show up is to apply a high voltage when testing.

The Insulation Tester

This can be most conveniently carried out by means of a "megger," which is a small hand operated generator, delivering 500 or 1,000 V D.C., and indicating on a calibrated scale the insulation resistance between the two points to which its output leads are applied.

The use of this instrument is not limited to insulation tests on condensers. It will indicate faulty insulation of any kind, both in the receiver, and outside it. For instance, the insulation of aerials, extension speaker wires and even the electric wiring of a house can readily be checked with it. After a good multi-range test meter, and a signal generator, a small "megger" insulation tester is one of the most useful instruments a service engineer can have.

Even a "megger" will not show up that most elusive fault in a condenser, namely, an intermittent open circuit. Substitution of a new component is practically the only way of dealing with this.

RADIO MAINTENANCE
Incorporating 'Trader' Service Sheets

THIS ISSUE INCLUDES:

Service Sheet No. 153—Ever Ready 5014 A.C. Superhet. Service Sheet No. 154—Ferguson 378 All-Wave A.C. Superhet.

FAULT FINDING IN RECEIVERS—5

Coil Faults—Tracing the Cause of Crackles.

As has been explained in earlier articles, tests for continuity, open circuit and insulation, and measurements of voltage, current, resistance and capacity, form reliable methods of tracing faults in receivers, provided they are used systematically and logically.

Shorted Turns

There are some faults, however, that do not yield to these methods of attack. Take, for instance, the case of coil faults. Admittedly, one can check whether each winding is continuous, or broken. Suppose, however, that one winding has a short-circuited turn, which may cause quite sufficient trouble to prevent the coil from operating correctly in a receiver.

If we measure the D.C. resistance of the coil, the effect of one short-circuited turn in reducing the value of the resistance will not be appreciable.

It is doubtful even if an inductance measurement on an audio-frequency bridge would show sufficient alteration in inductance to make it obvious that the coil was faulty.

The only type of measurement which would show the fault would be a measurement of the high frequency resistance of the coil, but unfortunately this is not within the capabilities of the average service workshop.

If the coil is one which is tuned by a pre-set or other variable condenser, it is sometimes possible to spot a fault due to shorted turns by feeding in a signal within the range of the coil and condenser, and gradually tuning through it, noting the effect on an output meter or valve voltmeter. If the tuning seems to be much flatter than usual, the coil is faulty.

The above remarks, of course, apply to tuning and H.F. choke coils. Short-circuited turns in a winding of a mains transformer will result in overheating and low output.

Crackling Noises

Crackling noises, with or without other manifestations, are some of the most difficult faults the service engineer has to contend with.

With this type of fault it is very important first of all to make sure that it is due to trouble in the receiver, and not to some external disturbance.

The chassis should first of all be shaken and tapped in various places to see whether the fault can be produced at will. Loose joints, badly earthed screens, faulty valve contacts, dirty or badly adjusted switches, loose scale lamps, and similar troubles can be traced this way.

Once it has been found that the fault can be produced at will, one is well on the way towards running it to earth. Careful rocking of individual valves, pulling wires, prodding soldered joints (with an insulated prod), rotating switch units, pushing individual switches into firm contact, and similar operations will often give the clue to the actual fault.

Sometimes crackling is produced only when the tuning control is rotated. This may be due to many causes. First of all, there may be dust, dirt, or small pieces of foreign matter between the condenser vanes.

This can often be dislodged by blowing—preferably with a motor-driven blower if one happens to be available. Suction from a vacuum cleaner is usually not particularly effective for this type of work, but it should not be forgotten that many vacuum cleaners may be converted into blowers quite easily.

If the dirt will not yield to this treatment, the more laborious but effective method using a pipe cleaner to dislodge it must be employed.

Another cause of crackling when the tuning knob is rotated is a dry and dirty slow motion drive. The obvious remedy is to clean it, and refill with vaseline (if it is of the ball reduction type).

Earthing the spindle of the tuning condenser to chassis through a pigtail will sometimes cure a troublesome crackle which will not yield to other treatment.

We have heard of many cases of crackle associated with flickering scale lamps. A scale lamp with a minute break in the filament will often arc across the break and remain alight, producing a bad crackle in the process.

Scale lamp leads should be carefully examined, particularly where they pass close to any rotating or moving parts of the tuning condenser drive. Many cases have been reported where some part of the drive has, through constant use, worn through the insulation of the scale lamp leads, producing crackling noises.

Faulty Components

There are many sources of crackling noises in a receiver which are not due to bad joints or other causes which we have been considering. These are mostly due to faulty components.

Resistances used to be a prolific source of trouble, and old receivers should therefore be carefully examined to see whether doubtful resistances are present.

We have found that a quick way of tackling this (which will probably be frowned at by the purists) is to short out the suspected resistance momentarily to see whether the crackle stops. If the crackle does stop, the resistance is probably faulty.

Of course, the receiver may cease to function, become unstable, or produce a loud hum, but this does not matter if the crackle ceases. In any case, the shorting must only last a second or two, otherwise damage to the set may occur.

Sometimes the source of crackle may be localised by connecting a meter to read the various valve voltages and currents, watching carefully to see if any flickering of the pointer of the meter occurs. If so, the trouble may be due to a faulty component in the supply circuits of the valve in question.

Similarly, a meter in series with other components through which D.C. is passing will often reveal a fault by flickering. In the case of components not carrying D.C., e.g., the secondary of an L.F. transformer, an ohmmeter will sometimes reveal the fault in a similar manner.

Intermittent faults in a receiver are a great trouble to service engineers, particularly when the fault cannot be caused to appear when required, and only lasts for a second or two, or else disappears immediately any tests are made on the chassis. An article was published on this subject in the issue of *Radio Maintenance* for May 23, 1936, so no more need be said about it here.