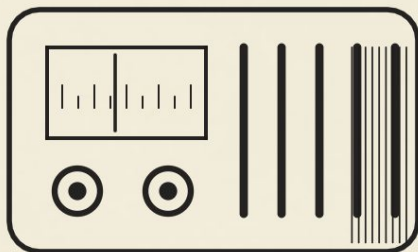


THE WIRELESS REPAIR HANDBOOK

R. H. LOWTHER

THE WIRELESS REPAIR HANDBOOK

A practical guide to finding and mending
faults in the domestic broadcast receiver



BY

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CONTENTS

I. Before You Start	1
II. The Bench and Its Tools	3
III. Using the Meter	9
IV. Resistors	14
V. Capacitors	17
VI. Valves	19
VII. Coils and Transformers	22
VIII. How a Wireless Works	25
IX. The AC/DC Set	29
X. Finding the Fault	31
XI. Lining Up the IF	38
XII. Taking Parts Out and Putting Them In	40

CHAPTER I

Before You Start

A wireless set is a pleasant thing to work on, but it runs from the mains, and parts of it carry several hundred volts. The rules in this chapter are simple. Keep to them on every job and they soon become habit.

The mains

Pull the mains plug out before your hands go into a set. The set's own switch is no guarantee, because it may break only one side of the supply. A plug in your hand is the one switch you can be sure of.

You will often want the set running while you take readings, and that is what the meter's probes are for. Their handles are insulated, and your fingers stay on the handles. Take the back off with the plug out, and keep it out whenever you reach inside.

The charge left behind

The two big electrolytic capacitors in the power supply, the reservoir and the smoothing capacitor, can keep their charge after the set is switched off. While the valves are still warm they draw most of it

away within a few seconds, and if there are resistors across the HT, a screen divider say, they go on draining it. But weak valves draw it slowly, and in a set with nothing across its HT except the valves, what is left once they have cooled stays for many minutes. It can be well over two hundred volts, and it gives a nasty bite. Before you put a hand in, switch off and hold the discharge tool across each of them in turn. The service sheet shows you which they are.

Sets with a live chassis

A set built to run on either AC or DC mains has no mains transformer, and its chassis is joined to one side of the mains. Plugged into the wall, that chassis may be live even with the set switched off at its knob. The maker's service sheet will warn you, and there is often a label inside the back as well.

Work on these sets through an isolating transformer. It feeds the set from a winding of its own, with no connection to the mains, so the chassis is safe to handle while the set is running. If you have no transformer, treat the chassis as live and keep the plug out whenever you touch it.

Heat

Valves run hot, the output valve and the rectifier hottest of all. Give a valve a few minutes to cool before you pull it out. The soldering iron is hotter still, so put it back in its stand when you have finished with it.

CHAPTER II

The Bench and Its Tools

A repairer needs surprisingly little, but each thing on the bench has a job of its own. They are described here roughly in the order you will reach for them.

The multimeter

The meter shows the voltage between its two probes. Clip the black probe to the chassis, touch the red one to a pin or a tag, and the needle gives you the voltage at that point. Set the range switch before you touch anything, choosing a range higher than the voltage you expect. The next chapter goes into it properly.

The signal tracer

The tracer is a small amplifier with a loudspeaker of its own. Touch its probe to a point in the set and you hear whatever signal is there. Start at the aerial coil and work along the set stage by stage. Where the programme is clear at one point and missing at the next, the fault lies between the two.

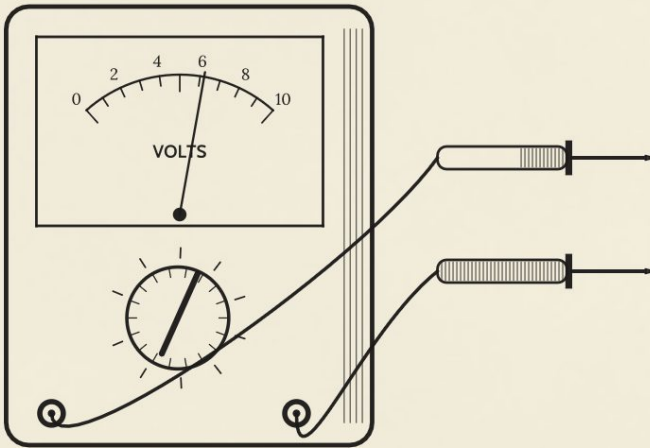


Fig. 1. The multimeter, with its range switch and its two probes.

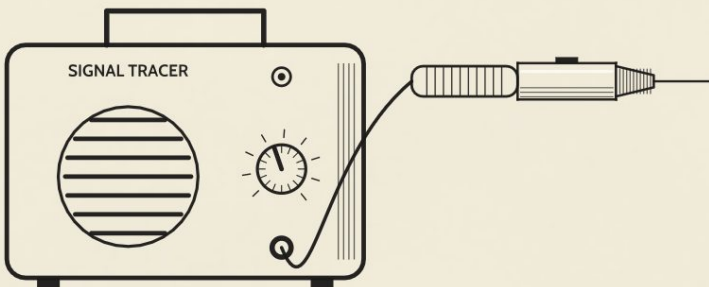


Fig. 2. The signal tracer and its probe. The knob sets how loud it plays.

The trimming tool

The IF transformers are tuned by turning the iron dust cores inside them. A steel screwdriver would upset the very tuning you are trying to set, so the

trimming tool is made of plastic. Turn a core slowly, a little at a time, and listen as you go.



Fig. 3. The trimming tool: a blade at one end, a hexagon key at the other.

The tapping stick

A set that cuts out now and then usually has a dry joint, a soldered joint that looks sound but only makes contact when it feels like it. With the set playing, tap round the parts with the stick. When you touch the guilty one, the sound crackles or drops out.

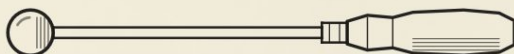


Fig. 4. The tapping stick. Its rod is fibre, so it is safe to tap round a live set.

The discharge tool

Two steel prongs with a resistor between them, on an insulated handle. Hold the prongs across a charged capacitor and the charge drains away through the resistor in a moment. Shorting the terminals with a screwdriver does the same job with a bang and a flash, and does neither the screwdriver nor the capacitor any good. Use the tool, with the set switched off, before any job that takes your hands inside.

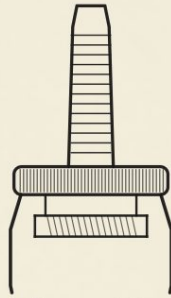


Fig. 5. The discharge tool. Its resistor is slung under the head, between the prongs.

The soldering iron

Most parts in a set are soldered to their tags, so the iron is how old ones come out and new ones go in. Hold it to a joint and the solder melts, freeing the wire. A new part goes in the same way, one joint at a time, and it is not properly in until every joint is done. The iron also mends a dry joint. Melt the solder afresh, let it set, and the joint will hold.

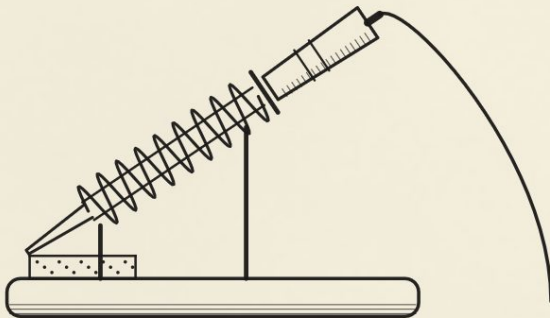


Fig. 6. The soldering iron, resting in the spring of its stand.

The screwdriver

For the screws that hold the back on and the chassis in, and for the grub screws in the knobs. The knobs have to come off before the chassis will slide out of its cabinet.

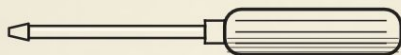


Fig. 7. The screwdriver.

The isolating transformer

It stands at the back of the bench, wired into the wall, with a red lamp to show it is on. Plug a set with a live chassis into its socket, not the wall's, and the chassis is safe to handle while the set plays. Because it is wired in, it feeds the set whatever the wall socket's switch is doing.

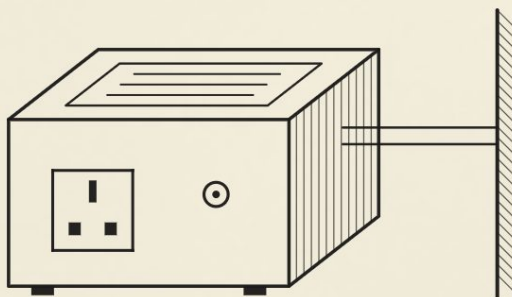


Fig. 8. The isolating transformer, wired into the wall.

The signal generator

Not every bench has one to begin with, but it is the instrument most worth saving for, and the trade list sells one. It puts a steady signal of its own into

whatever point of the set its probe is on: a radio frequency carrying a 400 c/s tone, or the tone alone, from a microvolt or so up to a good strong signal. Its earth clip goes on the chassis.

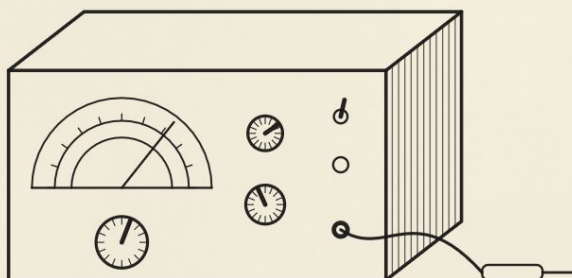


Fig. 9. The signal generator, its lead and its probe.

Put its probe on a stage and, if everything from there to the speaker works, you hear the tone. That makes it the tracer's opposite. The tracer listens along the set for where the programme stops; the generator feeds a signal in, and you step it back towards the aerial until the tone stops coming through.

The rest of the bench

New parts are kept in the parts cabinet on the bench, a drawer for each kind, and the trade list on the counter is where you order more. Old parts go in the scrap tin.

Keep the service sheet for the set by you as you work. It shows the circuit, gives the voltages a healthy set should read, and tells you how to line the set up. Nearly everything in this book comes down to comparing what you find with what the sheet says.

CHAPTER III

Using the Meter

Most faults show themselves somewhere as a wrong voltage, and the meter is how you find it. The service sheet lists what the maker's own set read at each of its test points, so the work is largely a matter of measuring the same points and seeing where yours differs.

DC and AC

The range switch has two sets of ranges. The DC ranges are for the HT and everything fed from it: the anodes, the screens and the cathodes. The AC ranges are for the mains and the heaters. The readings on a service sheet are DC unless it says otherwise.

Choosing a range

Each range is the voltage that sends the needle to full scale: 10, 25, 100, 250 or 1,000 volts. Start higher than you expect and come down. A needle hard against its stop tells you nothing except that you need a higher range.

Reading the scales

There are two scales on the face. Read the outer one, marked 0 to 10, on the 10, 100 and 1,000 volt ranges, multiplying as the range tells you. Read the inner one, marked 0 to 25, on the 25 and 250 volt ranges. Between them runs a strip of mirror. Look down at the needle until it hides its own reflection and you are reading it square on.

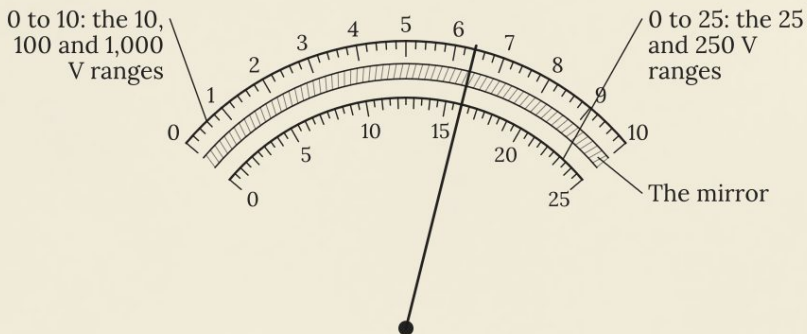


Fig. 10. The meter's scales, the needle reading 6.4 on the outer scale and 16 on the inner.

To the chassis, and across a part

With the black probe clipped to the chassis, the red one reads the voltage at any point against the chassis, which is how a service sheet's readings are taken. Move the black probe off the chassis onto another point and the meter reads the difference between the two. With the probes at either end of a resistor, you read the voltage dropped across it.

The meter's own load

A meter has to take a little current to move its needle. This one takes very little: it is rated at 20,000 ohms per volt, so on the 250 volt range it looks to the set like a resistance of five million ohms. Even so, at a point fed through a large resistor, such as the anode of the first audio valve, it pulls the voltage down a little while it reads, and more so on a lower range.

The maker took the sheet's readings with a meter of the same kind on its 250 volt range, with the tuning turned right down and no station coming in. Use that range wherever the reading allows, turn the tuning right down before you compare, and your figures will agree with theirs. On a strong station the automatic gain control turns the first two valves down, and their screens and cathodes read quite differently. A few volts either way is nothing to worry about. Look for readings that are well out, or missing altogether.

Take the readings with the set switched on and warmed up, which takes half a minute or so, and tuned to the home station, as the sheet's were.

Measuring resistance

A meter with ohms ranges measures resistance as well, using a small battery of its own, and has a third scale for it, inside the other two. Use it only with the set switched off and unplugged, and its capacitors discharged. Any voltage left in the set throws the needle hard over, and the reading means nothing. On these ranges it is the black probe that is positive, not the red.

The ohms scale runs the other way from the volts. With nothing joining the probes the needle rests at the left, at infinity, and a dead short sends it right over to nought. Each range reads its own figure at the middle of the scale: 30 ohms on the first, 3,000 on the second, which is times a hundred, and 300,000 on the third, times ten thousand. Choose the range that brings the needle nearest the middle, where the scale is easiest to read.

What resistance tells you

Across a resistor the meter reads its value, and across a burnt-out one it reads nothing at all, the needle staying at infinity. A part still wired into the set is measured together with everything else joined across it, so a reading lower than the part's value may only mean another path round it. One that reads higher than it should, or not at all, is the surer sign.

A good paper or mica capacitor passes no steady current, so across one on its own the meter settles at infinity, and a leaky one settles at a resistance instead, which is its leak. In the set, though, the meter finds the other ways round as well. Anything joined to the HT has a way to the chassis, through any resistors across the HT and through the electrolytics, which leak a little even when they are good, a few megohms' worth. So across a good coupling capacitor in the set you can expect anything from under a megohm to a few, rather than infinity, and a leaky one is hard to tell from a good one that way. A positive voltage on the grid it feeds settles the matter.

On the highest range, an electrolytic kicks the needle up as the meter's battery charges it, and the needle falls back, more slowly the bigger the capacitor, to whatever else is across it: with resistors across the HT, perhaps only tens of thousands of ohms; with nothing else, a few megohms, its own small leak. One that has dried out kicks only briefly. A small paper capacitor charges too quickly for the needle to show it. The charge the meter leaves on an electrolytic stays there when the probes come off, unless something across it drains it: put them back the same way round and the needle hardly stirs, but the other way about, that charge and the battery together throw it hard over.

CHAPTER IV

Resistors

A resistor does what its name says and resists the current through it. Push a current through one and a voltage appears across it, in proportion to the current. This is Ohm's law, and nearly every reading you take depends on it.

Ohm's law

The voltage across a resistor is the current through it times its resistance. Ten milliamps through ten thousand ohms drops a hundred volts. So a resistor feeding a valve drops more volts the more current the valve draws, and the point it feeds sits lower. Draw less current and the point rises.

That is what makes the readings mean something. A valve drawing less current than it should lets the voltage on its anode or screen rise towards the full HT. A part drawing too much pulls the HT down.

Values and the colour code

Resistance is measured in ohms. A small resistor has no room for figures, so its value is painted on in colours, each colour standing for a figure. On the

older pattern found in most sets, the colour of the body gives the first figure, the colour of one end gives the second, and a spot in the middle says how many noughts follow. A yellow body with a violet end and an orange spot is 4, 7 and three noughts: 47,000 ohms.

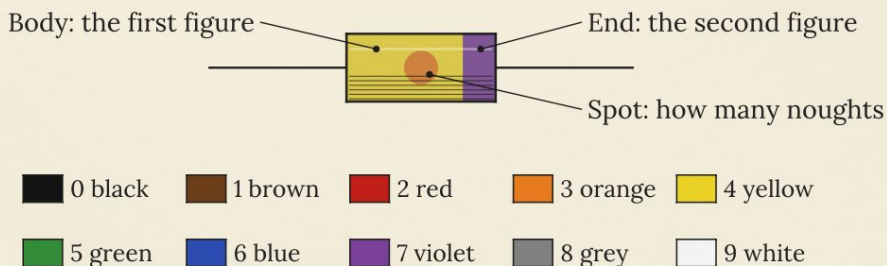


Fig. 11. The colour code, and a resistor of 47,000 ohms.

Watts

A resistor also has a rating in watts, which is how much heat it can get rid of without harm. Most in a set are half-watt carbon resistors. One carrying a good deal of current needs to be bigger, and from about five watts they are wound with resistance wire on a ceramic tube. Replace a resistor with one of the same value and the same rating, as the trade list sells them.

How they fail

A resistor that has been overloaded burns out and goes open, passing no current at all. The point it feeds then reads nothing, while the end it is fed from reads much as usual. The full voltage at one end of a resistor and none at the other is about the surest sign there is.

RESISTORS

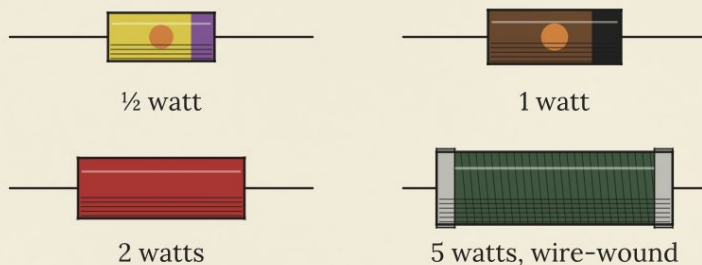


Fig. 12. Carbon resistors of half a watt, one watt and two watts, and a five-watt wire-wound one.

One that has been made to carry far too much often shows it: its paint browned or blackened and blistered, or burnt right through, and while it is going it smokes. Don't stop at changing it. A resistor doesn't char by itself; something beyond it has been drawing far too much through it, most often a capacitor that has broken down into a short. Fit a new one with the short still there and it chars again, smoking as soon as the set has warmed up. Not every open resistor shows it, though: one that has simply gone open can look as good as new.

A resistor can also be let down by a dry joint at one of its ends. Then it comes and goes, and the tapping stick will find it.

Or it can go high with age and heat, its value creeping up until it is several times what its bands say. In a valve's cathode that shows on the meter: the cathode reads higher than the sheet, the valve draws less and the stage gives less. Unsolder one end and the ohmmeter reads its value on its own.

CHAPTER V

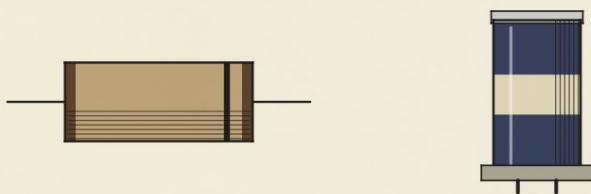
Capacitors

A capacitor, or condenser as many still call it, is two metal foils kept apart by a thin insulator. It will not pass a steady current, but it lets a changing one through, and it stores a charge. A set makes use of both.

The reservoir and the smoothing capacitor

The rectifier turns the mains into direct current, but it comes out in bursts, fifty or a hundred times a second. The reservoir capacitor fills up on each burst and holds the HT up between them. After a resistor, the smoothing capacitor takes out most of the ripple that is left. Both need a great deal of capacitance, measured in microfarads, so they are electrolytics, sealed in aluminium cans standing on the chassis.

Electrolytics dry out with age and lose their capacitance, and then the ripple gets through as hum. A dried-out reservoir hums and pulls the HT down as well, because it can no longer hold the voltage up between bursts. A dried-out smoothing capacitor hums with every voltage still correct, so a set that hums but measures right is pointing straight at it.



Paper

Electrolytic

Fig. 13. A paper capacitor, and an electrolytic in its can.

Coupling capacitors

Between one valve and the next, the programme passes through a coupling capacitor, usually a paper one, a tube of waxed paper with a wire at each end. It lets the programme through and keeps the high voltage on one valve's anode off the next valve's grid.

When one becomes leaky it lets some of that voltage through. Into the output valve this is serious. Its grid goes positive and it draws far more current than it should, running hot enough to smell, the sound harsh and its anode sometimes glowing red. That grid should read nothing at all, so any positive voltage there settles the matter.

Cathode bypasses

Across a valve's cathode resistor there is often a small electrolytic, which holds the cathode steady while the programme passes through the valve. When it dries out, every voltage still reads as the sheet says, but the stage gives less, and the bass goes first. The set sounds thin and a little weak, and nothing on the meter shows why. Change the capacitor and the body comes back.

CHAPTER VI

Valves

A valve is a glass bulb with the air pumped out and a few electrodes inside. A heater warms the cathode until it gives off electrons, and the anode, held positive by the HT, draws them across. Between the two is the grid, a fine spiral of wire, and a small voltage on the grid controls a large current to the anode. That is all amplifying is.

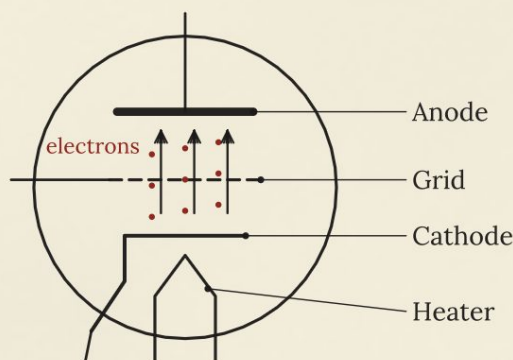


Fig. 14. Inside a valve. The grid sits between the cathode and the anode and controls the stream of electrons.

Most valves have more grids than one. A screen grid, held at a steady voltage through a resistor of its own,

makes the valve a better amplifier, and the readings at the screens are among the most useful on the sheet. Some bulbs hold two valves in one: a triode and a hexode for the frequency changer, or two diodes and a triode for the detector and the first audio stage.

A valve is known by its type number, printed on the glass, and a new one must be the same type. The first letter tells you about the heater: E for 6.3 volts, as used in a set with a mains transformer, U for a hundred milliamps, made to go in a chain. The base matters too. These sets' valves are Rimlocks: eight pins in a ring, with a pip on the glass to show the way in.

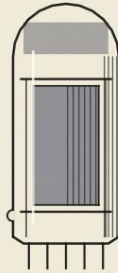


Fig. 15. A Rimlock valve.

How valves fail

A heater can burn out like the filament of a lamp. The valve then stays dark and cold, and nothing passes through its stage. In a set with a mains transformer the other valves still glow, so the dark one is easy to see. In an AC/DC set one heater gone puts them all out, as the chapter on those sets explains.

More often a valve simply wears. Its cathode loses its emission, it draws less current than it should, and its stage gives less gain, so the set grows weak. On the meter a tired valve shows itself by drawing less. Its cathode reads lower than the sheet, and its screen higher, since less current means less dropped across the screen's resistor.

A tired rectifier is a case of its own. It can no longer supply the current the set needs, so the whole HT sits far below the sheet and the set takes an age to come on.

Pull a valve straight up out of its socket, gently, and only once it has cooled. A new one goes in the same way.

CHAPTER VII

Coils and Transformers

A coil of wire resists any change in the current through it. Put a coil and a capacitor together and they make a tuned circuit, which answers strongly at one frequency and hardly at all at others. Tuned circuits are how a wireless picks one station out from all the rest.

The aerial coil and the tuning

The aerial coil and one section of the tuning capacitor make the first tuned circuit. Turning the tuning knob turns the gang, its vanes sliding in and out between each other, and the circuit tunes across the band. A second section tunes the oscillator at the same time, so the two keep in step.

The IF transformers

An IF transformer is a pair of small coils, each tuned by a little fixed capacitor to the set's intermediate frequency of 465 kilocycles. One coil takes the signal from a valve's anode and the other passes it on to the next grid. Tuned like this, it lets the 465 kilocycle

signal through and turns everything else away, and that is what makes the set selective.

On the chassis an IF transformer is a square aluminium can, about an inch and a quarter across and two and a half inches tall. The coils are inside, wound on a former, and each has an iron dust core screwed into it. Where the core sits in its coil sets the tuning, and you reach each core through a hole in the top of the can. A set has two of them, one after the frequency changer and one after the IF amplifier.

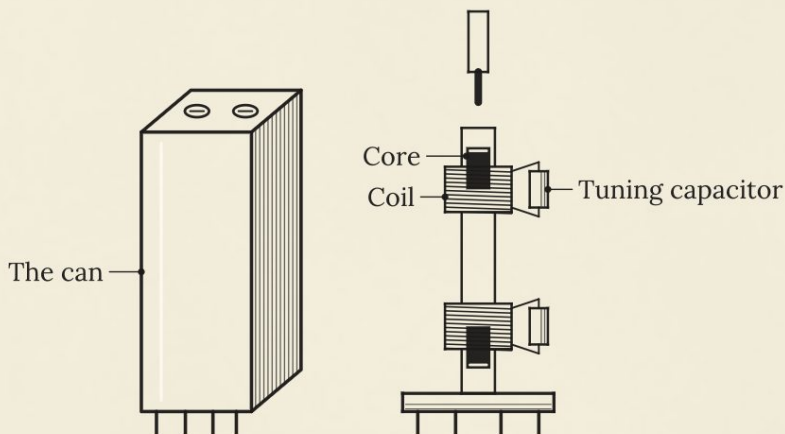
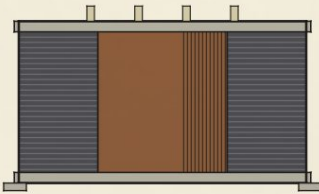


Fig. 16. An IF transformer, and what is inside its can: two coils on a former, a core in each and a tuning capacitor across each.

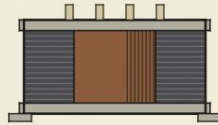
IF transformers seldom fail outright, but their cores can drift with time and knocks. With each one a little off, the signal passes less well and the set grows weak, though every voltage reads right. Lining them up again has a chapter to itself.

The mains and output transformers

The mains transformer, the heavy one with the laminated iron core, steps the mains up for the HT and down for the heaters. An AC/DC set has none. The output transformer is smaller and sits between the output valve and the loudspeaker. The valve works at a high voltage and a small current, the speaker at the opposite, and the transformer matches one to the other.



Mains



Output

Fig. 17. A mains transformer and an output transformer.

CHAPTER VIII

How a Wireless Works

Almost every set you meet is a superhet, short for supersonic heterodyne. Rather than amplify each station at its own frequency, it changes every station to the one fixed intermediate frequency, where most of the amplifying is done by circuits that never need retuning. Follow the signal through from the aerial to the speaker.

The frequency changer

The aerial coil picks out the station and passes it to the frequency changer. Its triode section is an oscillator, running 465 kilocycles above whatever the dial is set to. The hexode section mixes the two, and out of its anode comes the station moved to 465 kilocycles, programme and all.

The IF amplifier

The first IF transformer takes that and hands it to the IF amplifier, a pentode, which builds it up. The second IF transformer passes it on to the detector.

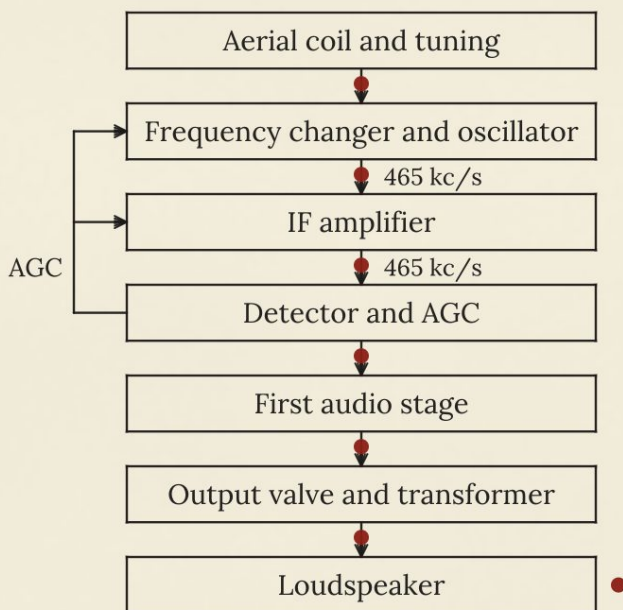


Fig. 18. The superhet, stage by stage. The dots are where the signal tracer listens.

The detector and the AGC

The detector is a diode. It lets the signal through one way only, and what comes out is the programme itself, separated from the carrier that brought it. The detector valve has a second diode, fed with a little of the signal from the IF amplifier's anode, which gives a steady voltage, negative, that grows with the station's strength. This is fed back to the earlier valves as automatic gain control, turning them down on a strong station and up on a weak one, so the set doesn't blare on the home station and fade on the far ones. It leaves weak stations alone: the valve's cathode

stands a volt or so above the chassis, and the second diode passes nothing until the signal is stronger than that. On a strong station the AGC line reads a few volts negative, and between stations next to nothing. Being negative, it is read with the probes the other way about, the black on the line and the red on the chassis: the usual way round, the needle only knocks back against its stop. It is fed through a megohm, so read it on the 250 volt range: on a low range the meter itself drags it down to a fraction of that.

The audio stages

The volume control passes as much of the programme as you want to the triode of the same valve, the first audio stage, which amplifies it. The coupling capacitor carries it on to the output valve, which drives the loudspeaker through the output transformer.

Where to listen

Those are the points the signal tracer listens at, in order: the aerial coil on the frequency changer's grid, the first IF transformer, the second, the detector, the first audio valve's anode, the output valve's anode and the speaker. Go along them with the tracer and the programme should be at each one, louder as you go. Where it stops, or goes wrong, you have found the stage.

The power supply

The HT that feeds all this comes from the mains. In a set with a mains transformer, the HT winding feeds a full-wave rectifier, a valve with two diodes, which turns both halves of each cycle into bursts of direct

current a hundred times a second. The current goes through the HT fuse to the reservoir, which holds the voltage up between the bursts, and a resistor and the smoothing capacitor take out the ripple. That gives two HT lines: the first straight off the reservoir for the output valve, the second, smoother, for the rest.

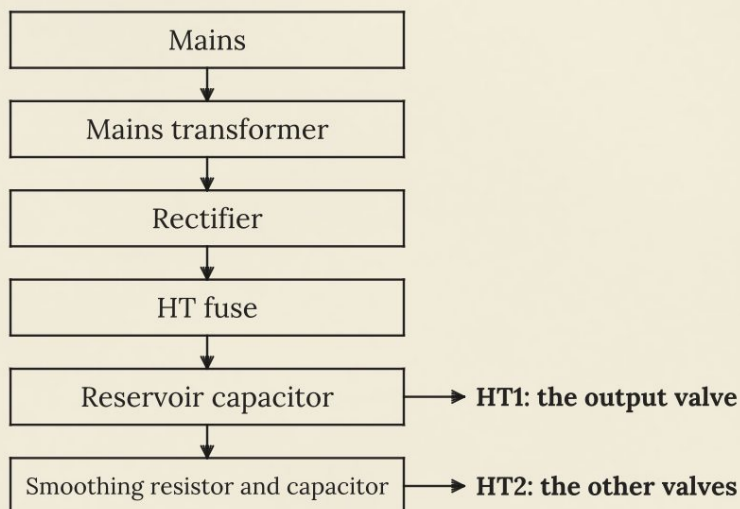


Fig. 19. The power supply of a set with a mains transformer.

Any ripple left on the lines comes out of the speaker as hum. The second line matters most, since it feeds the early stages, where every trace of ripple is amplified along with the programme.

CHAPTER IX

The AC/DC Set

A set with no mains transformer can run from AC or DC mains alike, which is why these are sold as AC/DC, or universal, sets. They are cheaper and lighter, and they work differently in three ways you must know about.

The heater chain

With no transformer to give a low heater voltage, the heaters are wired one after another in a chain across the mains, with a dropper resistor at the live end to take up the volts the heaters don't. Every valve in such a set is made for the same heater current, which is what the U in their type numbers means.

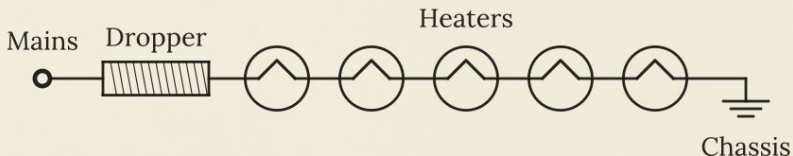


Fig. 20. A heater chain. Every heater carries the same current, and one break stops it in them all.

Like old Christmas tree lights, one heater gone puts the whole chain out. Every valve goes dark, and there is no HT either, since the rectifier's heater is in the chain too. To find the break, switch on and read the AC volts from the chassis to each point along the chain in turn, starting at the live end. Up to the break you read the full mains. Past it you read nothing. The dropper can fail the same way, and so can a valve that is out of its socket.

With a meter that reads ohms you can find the break with the set off instead. Read along the chain a link at a time. Each heater reads a few tens of ohms cold, the dropper its own value, and the broken link reads open.

Half-wave rectifying

The rectifier is a single diode and uses only one half of each cycle, so the bursts come fifty times a second and the HT is lower than in a transformer set. A small surge limiter resistor in its feed protects it from the rush of current at switching on. Any hum the set makes is at the lower pitch of fifty cycles.

The live chassis

The chassis is joined to one side of the mains. Read the first chapter again before you start on one of these sets, and use the isolating transformer.

CHAPTER X

Finding the Fault

Work the same way every time and most faults give themselves up quickly. Start from what the owner told you, then listen, look, measure and trace, in that order.

Listen

Before anything comes apart, switch the set on in its cabinet and hear it as its owner did. Tune to both stations. Notice whether it hums, whether it is weak, whether it crackles or cuts out, and whether it takes a long time to come on.

Look

With the back off, see that every valve's heater glows, and look at the silvering inside the top of each one. If it has gone milky white, the glass is cracked and air has got in. Its heater may still be whole, keeping the others in a chain alight, but nothing glows red inside it and it does no work at all; only a new valve will do. Watch the output valve too. If its anode is glowing red, it is drawing far more current than it should.

Measure

Begin with the HT, at the reservoir and the smoothing capacitor. If the HT is wrong, the whole set is wrong, and the fault is in the supply or in something loading it. If the HT is right, go round the sheet's test points stage by stage, anode, screen and cathode, and look for the reading that stands out. With a meter that reads ohms, you can then switch off and measure the part the readings point to.

Trace

If the voltages are right and the set is still poor, follow the programme through with the tracer from the aerial coil to the speaker. The stage where it fades or vanishes is the one to look at.

Tap

A fault that comes and goes is nearly always a dry joint. Let the set play and tap round the parts with the stick until the sound crackles or drops out.

Inject

With a signal generator you can work the other way. Start at the output valve's grid with the tone, then the first audio stage's grid, then, on range A at 465 kc/s, the IF amplifier's grid and the frequency changer's anode. Each time the tone should come through, a little louder for every stage it has to go through. Where it stops, the stage you have just stepped back past is the one at fault.

— WHAT THE OWNER SAYS, AND WHERE TO START —

It hums

Hum is ripple from the power supply getting through to the speaker. If the owner heard a bang first, look at the cans on top of the chassis: one that has burst has its seal gone and its top torn open, with a white crust round the tear and stains down its side. Most of what was in it has gone, so it hardly smooths at all, and it leaks a little. Fit a new can of the same value. Look at the parts whose job is to hold the HT steady, and see whether the HT itself has suffered along with them.

It has gone quiet

Something has stopped a stage working, or stopped the programme getting from one stage to the next. See that the valves are alight, then go round the sheet's readings looking for one that is badly out, or missing altogether.

The oscillator's grid tells you whether it is going. While it oscillates, its own swing is rectified at its grid and holds it several volts below the chassis; read it with the probes the other way about, the black on the grid and the red on the chassis, or the needle only knocks back against its stop. If it reads nothing, the oscillator has stopped, and no station can come through, however good the rest of the set. A stopped oscillator also leaves its anode lower than the sheet, since its valve then draws more. Look at its valve first: a worn frequency changer often keeps going at the top of the dial and gives up at the bottom, where its tuned circuit is weakest. Then its anode's feed

resistor, the two small capacitors that carry the swing round, and its grid leak, which if it has burnt out leaves the grid nowhere to put its charge and stops it dead.

If the detector valve's cathode reads well above the sheet's figure, read the AGC line too, on a low range. A volt or two positive there, with the probes the usual way round, means HT is leaking through the little capacitor that feeds the AGC's diode. The diode passes it on to the cathode it shares with the first audio stage, and the cathode climbs until that stage shuts off.

If the output valve's anode reads nothing at all while the HT it is fed from is there, look at the output transformer. The anode is fed through its primary winding, and a winding broken inside leaves the valve nothing and the speaker silent. With the set off and discharged, a meter that reads ohms across the primary's two tags shows it: a good one reads a few hundred ohms, a broken one nothing at all. The cure is a new transformer. Don't leave the set switched on meanwhile: with nothing on its anode, all the output valve's current goes to its screen grid, which soon glows red and spoils the valve.

If the valves light but the HT reads nothing, read the rectifier's cathode, on the other side of the fuse. Full volts there and none at the reservoir means the fuse has blown, and a fuse only blows when something draws far too much, most often the reservoir broken down into a short. Don't just fit a new one: switched on with the short still there, it blows again as soon as the rectifier has warmed up. With the set off and

discharged, read ohms across the reservoir. A good one swings the needle up as it charges and then lets it fall back to a high reading; one that has broken down reads a few ohms and stays there. Change the can, then the fuse.

It is weak

The programme is getting through but losing strength somewhere along the way. A valve whose readings are a little out, or a stage where the tracer finds the programme thinner than it ought to be, will narrow it down. If nothing measures wrong at all, think about the parts whose tuning can drift, and the cathode bypasses, whose drying out the meter never shows: listen for whether the bass has gone too.

It takes an age to come on

Something in the supply is struggling to deliver. Compare the HT with the sheet, and remember which parts the whole of it has to pass through.

It keeps cutting out

Something is making poor contact, and only some of the time. Let the set play and go looking for it.

It sounds harsh, with a hot smell

A valve is being made to work far harder than it should. Find the one that is running hot, then work out what is driving it so hard. Its grid is a good place to start.

There was a smell of burning

Something has run far too hot, and stopped. Turn the chassis over and look before you switch on again: a resistor charred black is the usual place, often burnt right through. Then find what it was feeding. With the set off and discharged, read ohms from the resistor's far end to the chassis. A capacitor there that reads a few ohms has broken down into a short, and it took the resistor with it. Change the capacitor, then the resistor; the other way round, the new resistor goes the same way.

It blares on the home station

The automatic gain control has let go, and nothing is holding the first two valves back on a strong station. Tune to it and read the AGC line on the 250 volt range, the black probe on the line and the red on the chassis: it should read a few volts. If it stays at nothing, follow it back to the detector valve's second diode: the little capacitor that feeds it from the IF amplifier's anode, the resistor that carries its voltage on to the line, and the capacitor that holds the line steady, which can leak it all away to the chassis.

It whistles as you tune

Something is feeding the IF amplifier's output back to its own grid, and the stage has started oscillating by itself. Its own signal reaches the detector and beats against every station: a whistle that slides down to nothing and back up again as you tune across one. Its strength works the AGC as a strong station's would, so the set goes weak as well. To tell, tune between stations and read the AGC line on the 250 volt range,

the black probe on the line and the red on the chassis: while it oscillates it reads a volt or more with nothing tuned in, and more the closer the wire runs, where a set that isn't reads next to nothing. Then look under the chassis at the IF valve's grid lead. At the factory it is screened, its braid earthed; a plain wire put in its place and run beside the valve's anode lead is enough to do it, and so is screened lead whose braid was never soldered to an earth tag. Move the wire well away from the anode wiring, or earth its braid, and the whistle stops.

Some sets come in with more than one fault, and one can hide another. Put the first right, then go round again.

CHAPTER XI

Lining Up the IF

Lining up, or aligning, means setting the cores of each IF transformer so that both its coils are tuned exactly to 465 kilocycles. The factory did it with a signal generator. On the bench you can do it well enough by ear.

Tune the set to a station and turn the volume to a comfortable level. The weaker station serves better than the strong one, because on a strong station the AGC holds the volume steady and hides the peak you are listening for.

Put the trimming tool in the first core's slot and turn it a little. If the programme grows louder, keep going until it starts to fall away, then come back to the loudest point. If it grows quieter, turn the other way. Do the same with each of the four cores, then go round them all once more, since each one moves the others a little.

You can listen on the set's own speaker, or put the tracer on the detector and listen there. Set right, the set should be as loud as the day it left the factory.

Lining up with a generator

A signal generator makes it quicker and surer. Set it to range A at 465 kilocycles, turn its output well down and put its probe on the frequency changer's anode. Then turn the set's dial to a quiet spot between the stations, so neither gets in the way.

For a reading rather than your ear, put the meter across the speaker on its 10 volt AC range: it becomes an output meter, and the needle rises with the tone. Turn each core for the highest reading, keeping the generator low enough that the needle stays well down the scale. A strong signal makes the AGC hold the level steady and hides the peak, just as a strong station does.

CHAPTER XII

Taking Parts Out and Putting Them In

Valves pull out. Nearly everything else is soldered in, on tags and valve pins under the chassis, and comes out with the iron.

Getting at the underside

Take the knobs off with the screwdriver, turn the set round, undo the back's screws and lift it off. Pull the speaker's plug out of the chassis, undo the two screws that hold the chassis in, and slide it out onto the bench. Plug the bench's own speaker in to hear it there, and turn the chassis over to reach its underside.

Out with the old

Pull the plug and discharge the electrolytics. Touch the iron to each of the part's joints until the solder runs and the wire comes free, then lift the part away and drop it in the scrap tin.

In with the new

Take a new one of the same kind from the parts cabinet and set it in its place. It is not in until every

one of its joints is soldered, so go round them with the iron. Then plug in, switch on and measure again, to see that the readings have come right.

Dry joints

A good joint is bright and smooth, the solder run into the tag and round the wire. A dry one is dull and lumpy, sitting on the wire without having taken to it. Touch the iron to it until the solder runs, take the iron away and let the joint set without moving it.

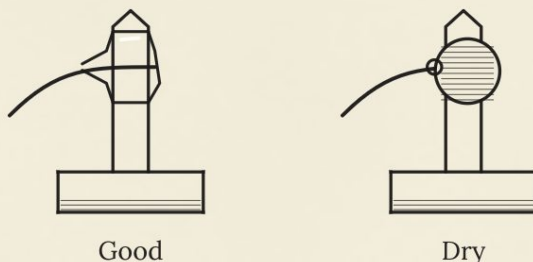


Fig. 21. A good joint, and a dry one.

The wiring

The wires under the chassis can go wrong too. Where something moves or gets handled, like the speaker's lead, the volume control's tags or the output transformer's, a wire can come off its tag or work loose in a dry joint. A wire can also break inside its covering where it has been bent, and still look as good as new.

With the set on, a broken wire reads volts at one end and none at the other. With it off and discharged, put the meter on an ohms range with a probe on each end

of the wire. A good wire has no resistance at all and sends the needle right over. A broken one leaves the needle where it is.

A wire off its tag goes back on with the iron. A broken one comes out: unsolder both its ends and lift it away. Then take a length off the reel of wire on the bench, lay it from the one tag to the other and solder each end.

Where a wire runs matters too. A wire carrying the mains, or the heaters' supply, puts a little of its hum on any wire that runs beside it, and on a grid's lead that hum is amplified with everything else. That is why the grids' leads and the detector's are run in screened lead, its braid earthed. To replace one, take a length off the reel of screened lead, lay it as you would plain wire, and solder its braid to the nearest earth tag: a braid left loose screens nothing. If you use plain wire instead, keep it short and well clear of the mains and heater wiring, and of its own valve's anode lead. Any wire can be moved, the heater and mains wiring too: take hold of it and drag it where you want it.

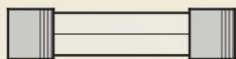
Knobs and dial lamps

A knob whose boss has cracked turns on its spindle without taking it round, so the dial or the switch never moves. Loosen it off with the screwdriver, drop it in the scrap tin, and push a new one from the parts cabinet onto the bare spindle. A dial lamp whose filament has gone stays dark while the other one lights. With the chassis out of its cabinet and the set

unplugged, unscrew it from its holder and screw a new one in.

The fuse

The HT fuse is a little glass cartridge held in two spring clips under the chassis, between the rectifier and the reservoir. It carries the set's own current for ever, but half as much again blows it at once, before a short on the HT can do any harm. Look at it through its glass: a good one has its fine wire straight through, a blown one only a stub at each end and the glass smoked. It isn't soldered in. With the set unplugged, pull it out of its clips by hand and push a new one in.



Whole



Blown

Fig. 22. A fuse whole, and one blown.

Putting it back

Everything goes back the way it came out: the chassis in, its screws done up, the owner's speaker plugged back in, the back on and the knobs on. Unplug it, and it is ready to hand back.