The Latest

RADIO INSIDE OUT

COMPLETE MANUAL for the Radio Technician, divided into three sections

Invaluable Servicing Hints
Useful Radio and Electrical Data
Comprehensive List of Service Replacements for Popular Receivers

By
THE TECHNICAL STAFF
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Chapter 1

The Art of Radio Servicing

RADIO servicing today has become a specialised profession ; the diagnosis of faults in modern receivers and amplifiers calls for the intelligent use of various measuring instruments, signal oscillators and cathode-ray oscillographs, condenser and resistance bridges, which a few years ago could only be found in the radio set manufacturer's laboratory. The present-day wireless enthusiast, whether amateur or professional, is assumed to possess some means of measuring the voltages and current produced in a wireless receiver, and also to know how to use these instruments quickly and effectively.

For those assembling a kit of instruments we would say a multi-range meter should be the first consideration. A means of measuring voltages up to 1,000 v. A.C. and D.C. should be provided, preferably in four steps—0 to 10 v., 0 to 100 v., 0 to 500 v. and 0 to 1,000 v. (with rectifier for A.C.). The best meter movement is essential, a resistance of 1,000 ohms per volt, moving-coil type. A cheap iron meter draws too much current for deflection ; the resultant reading is anything but true. Provision is also necessary for the reading of valve anode currents ; therefore the meter must provide for milliamperes in several ranges, 0 to 1, 0 to 10 and 0 to 100, with extension up to 500 mA if possible. The measurement of A.C. current is not often required in ordinary service work.

The methods of approach to wireless servicing problems as described in this book may seem rather intricate to some, but it must be emphasised that the only satisfactory way of fault finding in modern apparatus is the careful and systematic method of voltage and current measurement and circuit testing, and to do this the engineer must have the necessary tools for his trade.

Unfortunately, it is not possible in a book of this size to embrace a treatise on electricity and magnetism, some knowledge of which is essential if the reader is to follow word for word the articles in this book. We have therefore assumed the reader to have obtained a familiarity of wireless principles beyond the stage of the elementary textbook, and also to have had some practical working experience in the use of the various testing gear mentioned.

Valve testers and cathode-ray gear and expensive oscillators may be out of the reader's reach, but other probable means of tests will suggest themselves as familiarity of methods are gained. These roundabout tests in the absence of the proper gear, although taking appreciably longer, can be made to serve the same purpose in the end.

This book is written for the man with a moderately equipped workshop and the average knowledge of radio and its principles. The remarks and descriptions in the following pages are culled from some of the largest service stations in the country. Methods and opinions may differ, but the fundamental principles remain the same.

Chapter 2

Fault Finding. Stage by Stage Testing

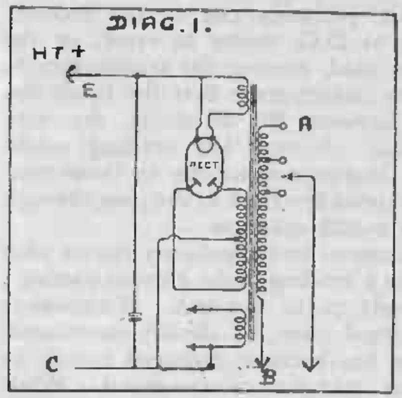
An ordinary A.C. mains-operated receiver has been selected for our example, the chassis having been removed from the cabinet, the speaker remaining connected.

POWER SUPPLY

The Mains Transformer

Remove the valves from the set and with an ohmmeter measure the resistance across the transformer primary winding from the common mains input connection to the highest voltage tapping (Points A and B in Diagram 1). This reading will be found to be somewhere in the region of 20 to 40 ohms. Test the tappings in turn for continuity back to the common tapping. No reading will indicate an open circuit, probably due to the receiver having been connected to D.C. mains in error, or the wrong voltage tap being used, causing the transformer to become overheated, with consequence that the insulation has become impaired between the windings, the wire being actually burnt out. A very low reading would indicate a short circuit between turns due to those conditions. Test the mains input flex back to the plug through the on/off switch, check switch contacts.

Insert an A.C. milliammeter in the primary circuit with the mains switch on, take a reading of the current passing ; this will be approximately 70 to 150 mA. If excessive, cause is likely to be shorted turns, as already mentioned. If the primary winding has become damaged it will be necessary to have the transformer re-wound. When removing, some method of colour coding the connections will aid a speedy replacement. If the primary is found to be in order, proceed with the secondary winding, with the test meter set to 1,000, or 500 volts A.C., measure the voltage from the centre tapping on the H.T. secondary winding to the anode pins on the rectifier valve socket. This will differ according to type of set, but should be within a range of 200 to 350 volts with the average set and up to 500 volts with larger sets. No voltage from one anode to point C in Diagram 1 shows an open circuit in half the secondary H.T. winding, probably due to an internal short in the rectifier valve, causing that half of the winding to short to earth. Check condition of rectifier valve in a valve tester, test for internal shorts and open circuits to pins. Measure the heater to cathode insulation in the case of indirectly heated valves; poor insulation results in intermittent reproduction and noise. The voltage at each anode pin should be approximately equal. Check heater voltages applied to each valve socket. These again will depend on the types of valves used, and although usually 4 v. heaters are used, some manufacturers employ 6.3 v. and 13 v. heaters for valves. Trouble is rare in the heater windings, although a short circuit in valves will cause overheating and low insulation of turns.



Having satisfied ourselves that these A.C. voltages are correct, the next step is to replace the rectifier valve in its holder and check the D.C. volts from the heater to the chassis between the points E and C, as in Diagram 2. Tap the rectifier valve in case of intermittent short internally, which would cause a low or no reading. The D.C. voltage measured from these points should be approximately equal to A.C. voltage already measured between

anodes and point C. If this voltage is low, the emission of the rectifier can be suspected, so replace with reliable valve and check voltage again. Should the substitution not show an increase in voltage, examine the smoothing condensers for leakage or short circuit. As a check the condenser, if an 8 mfd. electrolytic, should show a reading on the ohmmeter of about 20,000 ohms to 30,000 ohms. A low-resistance condenser will provide a path for H.T. voltage to earth. Replace the valves in the chassis and trace along the H.T. line in the set. After the smoothing condenser in Diagram 2, a choke or the field winding of a mains-energised speaker is used to assist in smoothing the rectified voltage before applying it to the other valves in the set.

Smoothing Choke.

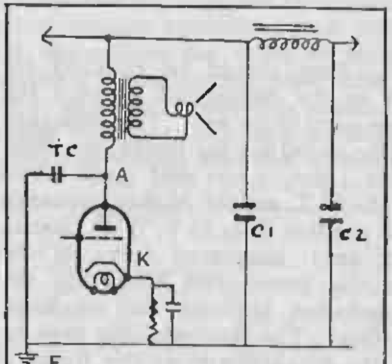
The choke or field winding should be checked for continuity, as any break in the circuit will prevent the supply from reaching other parts of the set. The resistance of a speaker field is usually stated on the frame, the most commonly used being the 1,500, 2,500 and 5,000 ohms for placing in series with the H.T. supply, higher resistance coils being connected in a position from H.T. + to chassis. Causes of open circuits are: misplaced turns of the winding fraying against the frame and fracturing the wire; breakdown of insulation between the windings, with consequent overheating. The field winding may be shorting to the frame of the speaker, and as this frame is often earthed, a direct short will result.

Smoothing Condensers.

As condensers as shown in the Diagram 2, placed before and after the choke or speaker field, are essential components in the modern set, each should be tested for internal short and for open circuits. Any fault in these components will affect the supply in two ways, namely, a short circuit will pass all or some of the current to earth, resulting in no or a low voltage being applied to the other valves in the set, or an open circuit in the condensers passes the current unsmoothed to the valves, resulting in hum.

If these condensers are found to be in order, measure the voltage applied to the anode of the last valve, across points A and E in Diagram 2. If there is no voltage at this point, the speaker output transformer should be suspected for open circuit. When fitting a replacement, care must be taken to obtain a transformer of like ratio, or alternately a multi-ratio model, so that the tapping can be varied to match the speaker to the output valve.

Assuming the primary of the output transformer is correct and there is still no voltage on the anode of the last valve, trace the anode circuit from the output transformer to the valve socket, as faults sometimes occur in tone control network from the anode pin to earth. A tone control condenser is the usual culprit here. The condenser in Diagram 2 is arranged to by-pass certain low frequencies, the amount of cut-off being varied by the potentiometer across



DIAG. 2.

it. This condenser, if fitted, has the full anode voltage to withstand as well as the A.C. modulation voltage developed across it, and should therefore be selected with care ; the highest possible test voltage type should be used. A breakdown in this condenser will short the H.T. to chassis and result in no reading being obtained at the output valve anode. An open circuit will allow the voltage to reach the anode, but the reproduction is likely, especially if a pentode is used, to be rather shrill, with over-emphasis of the higher frequencies.

OUTPUT VALVE

With the correct anode voltage applied to this valve, measure the bias voltage between the cathode (K) and chassis (Diagram 2). A resistor and large capacity condenser is connected from cathode to chassis, the voltage developed depending on the condition of the bias resistor, and if there is any doubt at this point, the resistor should be measured with the ohmmeter. If open circuited a replacement should be selected from a reliable make, the size being in accordance with the valve-maker's chart in respect of the valve used.

The bias condenser should be tested in a condenser analyser, as an open circuit will result in hum and distortion, and an internal short will naturally short the bias voltage back to earth.

The valve's anode consumption should be checked by inserting the milliammeter in the wiring from the anode pin back to the valve side of the output transformer. This current should compare with the makers' instructions of valve operation at the given anode and grid bias voltages. Check the screen voltage if a pentode is used, and if no reading, inspect decoupling resistor and by-pass condenser, usually a 0.1 mfd.

If all these points are found to be correct, check all valves in turn, following along the H.T. positive line, measuring from anode pin of valve holders to chassis. Should there be any deviation from normal the decoupling resistors should be measured, by-pass condensers checked for shorts and the primary windings of transformers for open circuits. Screen voltages of L.F. pentodes are sometimes taken direct from anode pins, and this may lead to erroneous readings of valve anode current. Although the screen takes very low current it is as well not to include this reading in with anode current.

L.F. transformers are not used to any great extent in modern sets, coupling between valves being effected with resistances and condensers. The parallel feed transformer sometimes used does not have to carry D.C. current, but nevertheless this transformer should be checked for continuity, together with the anode decoupling resistor. Smoothing and decoupling bypass condensers will have to be checked with one side disconnected from the circuit, as other resistors may affect the readings.

L.F. VALVES

Having tested all the applied voltages to anodes and screens to valves in the set, and also ascertaining that the correct bias voltages are being derived, the input from a L.F. oscillator can be applied to the grid of the first L.F. amplifying valve. Given all conditions as previously outlined to be correct, the set should now be working from the grid of the first L.F. valve and the speaker will be producing the signal from the oscillator, now greatly amplified. Disconnect the speaker transformer secondary from the speech coil, and join across the secondary an output meter or the low-range A.C. voltmeter. A gramophone pick-up can be employed if a signal generator is not available, and the output of the set can be measured on the output meter.

H.F. AND I.F. STAGES. TRIMMING

We have dealt with the output and amplifying stages ; next in sequence is the radio-frequency stages, and in the case of a superhet, signal-frequency stages. We now require a signal input from an R.F. signal generator, the output from which must be able to be varied over wide limits, a fairly large signal at the start gradually decreasing as the set is re-trimmed.

H.F. Stages. Connect the signal generator to the aerial terminal and inject a signal sufficiently strong to be heard in the loud-speaker or show a reasonable reading on the output meter, if complaint has previously been made regarding the sensitivity of the set. The H.F. stages may not be entirely in tune, and on rotating the trimmer condensers on the main tuning condenser until a peak is found, and reducing the signal input, so that the A.V.C. does not come into operation, each trimmer should have a peak position. If it is not possible to find a peak tuning point the associated coils and condenser should be

suspected, bad switch points on wavechange switches, etc. The A.V.C. voltage can be checked by placing a low-reading, high-resistance voltmeter in series with the A.V.C. load resistor, an increase in signal input should then give an increase in voltage.

SUPERHETS

Procedure is practically the same as the set with straight H.F. stages, with the exception of the introduction of an intermediate-frequency stage, which is tuned to a given frequency, and when lining up the stages this frequency must be produced by the signal generator.

With the signal generator set to the intermediate frequency as specified by the set makers, connect its output to the grid of the I.F. valve, usually top cap, and with smallest possible signal trim the I.F. transformer, first the grid sections and then the anode, as above. Any fault existing in these circuits will prevent a peak setting of the trimmers.

The frequency changer and the first I.F. transformer come next. Repeat the process as for the second I.F. already described, and align to the intermediate frequency from the grid of the valve. The frequency changer is usually a triode-pentode or triode-hexode, the triode being used as oscillator valve and the H.F. section as the frequency changer.

The first I.F. transformer is in the anode section of the signal-frequency section. With the I.F. transformers aligned, adjust the signal generator to the highest medium-wave frequency advised by the makers for alignment, and with the set switched to M.W. and the tuning dial at that frequency, apply the signal to the aerial terminal of the set. If the I.F. trimming has resulted in peak setting quite satisfactorily and still no signal is received with the signal generator in the new position, the oscillator section of the valve may not be working. Short circuit of the oscillator grid coil to earth should result in an increased voltage reading being obtained between that valve anode and chassis. Alignment being completed at this stage for M.W. the same adjustments must be carried out on the long wave band. Choose a frequency at top of the band, say 300 Kc., adjusting the trimmers for maximum reading on the output meter, keeping the input signal as small as possible. Set both tuning dial and signal generator to a frequency of about 160 Kc. and repeat the process as before.

The stages should now be in perfect alignment and every valve in the set received attention. Faults in components and accessories are dealt with elsewhere, but a receiver tested and adjusted as just described will now receive the broadcast signal. It must be remembered a set is only as good as its design and although the work described in alignment will improve reception, it may be possible by judicious adjustments to further improve to some extent, sometimes even better than when the set was new. Replacements fitted in a receiver often alter the working conditions. Valve replacements alter circuit values, and re-trimming becomes almost a necessity. Any replacements, therefore, must be as exactly alike as possible in type to those taken out of a set. Try to find out why a certain component failed to give good service, and let the replacement part have such quality and safety factor that the particular fault is not likely to occur again.

Chapter 3

Loud-speakers : Fault Finding and Remedies

FAULTS in speakers are comparatively easy to trace. Disconnection of the speech coil and open circuits in the primary and secondary windings of the output transformers can be traced with the aid of the ohmmeter. Foreign matter in the air gap may be difficult to trace, and if the speaker cone suspension is free should be the first question. Rubbing of the speech coil in the gap can sometimes be mistaken for dirt in the gap. The magnet assembly should be carefully dismantled if there are any doubts, and the pole piece of the magnet wiped with a rag moistened in thin oil. Gently wipe the speech coil former, examine the coil for scraped insulation, being extremely careful not to displace any turns of the coil, as they will rub the pole piece when re-assembled. Any loose turns should be cemented in position with a cellulose glue, waiting until dry and hard before replacing. Inspect the speaker centring device for fractures ; a new spider can be obtained from the makers of the speaker.

When re-assembling a speaker, use shake-proof washers for all bolts and screws, the centring of the speech coil being done when the framework is bolted up in position. Fit small thin strips of card around the pole piece to space the speech coil in the gap, tighten the centring nut, remove the packing pieces, and with a finger on each side of the cone gently press the cone in and out of the gap as far as it will vibrate in ordinary use. There should be clearance all around the coil, but if the former fouls the gap it is probable that the cone has become strained, and the fixing nut must be loosened and the cone pulled over from the side that touches, then again tighten the nut, and test for clearance. Speaker feeler-gauges can be purchased for use with speakers of varying widths of gaps. Speech coils can be obtained for replacement purposes, but care must be taken to replace with a coil of like resistance.

FIELD COILS

The field coil of a mains energised speaker has to dissipate a certain amount of heat; if a short circuit has occurred in the H.T. supply of the set it is probable the speaker has had to pass more current than designed for. Overheating of the field windings will impair the insulation between turns. A short in a number of layers will result in an increased H.T. voltage being applied to the set, due to the lower resistance of the coil. The enamel insulation will eventually melt, the paper interleaving scorches and breaks up until the whole process of destruction is complete and the winding burns out.

Field coils can be replaced, but again the resistance is the deciding factor. A lower resistance alters H.T. voltage to set, thus causing overheating. It is better to select a higher resistance if exact replacement cannot be obtained. If it is found possible to allow for more adequate ventilation of the coil it would be an asset. If any difficulty is experienced in obtaining an exact replacement for the field coil, a permanent magnet speaker can be used, but a smoothing choke must be inserted in the place of the speaker field, the resistance must be the same as that of the coil.

Permanent magnet faults are mostly to be found in the speech coil or transformer windings. Sometimes the magnet loses its strength, but it can be remagnetised at a speaker repair works. Old speakers that are beyond repair should not be discarded, but dismantled and the parts kept for future replacements.

TRANSFORMER FAULTS

Output speaker transformers when tested on an ohmmeter should show continuity on the primary and secondary windings. The resistance of the primary should be about 200 to 700 ohms, according to whether designed to match

pentode or power valve. Secondary resistance will be found around 0.05 to 20 ohms. Open circuits in the primary due to insufficient current carrying capacity can be ascertained. A replacement should be of the same ratio primary to secondary, or if the ratio is not known, a multi-ratio transformer can be used and the tapping selected that will give the best results. All bolts and screws used in fitting the transformer should be as tight as possible to avoid rattle. Use shakeproof washers.

BAFFLES

To get the best reproduction from a speaker and its associated amplifier a baffle is essential. In theory a flat plane forms the ideal baffle, in domestic receivers this is rarely possible, the flat baffle does not find favour owing to its appearance. A box baffle therefore, has to be resorted to, introducing resonance problems. A speaker fitted in a cabinet is actually a box baffle, as the front and sides are all reckoned in area when size of baffle is being estimated. The back of a speaker so placed should be as open as possible, or alternately large holes must be drilled in the bottom of the cabinet. Cabinets are often padded with slag wool or some such sound insulating material, so as to reduce box resonance. The depth of the box baffle should not be greater than half the length and width. The ideal flat baffle should be about 36 inches square, a box baffle could be 18 inches square by about 9 inches deep.

All woodwork used in speaker cabinet or wireless cabinet construction should be as stout as convenient, seven-ply wood about $\frac{1}{2}$ to $\frac{5}{8}$ inch thick, affording the best freedom from vibration.

No speaker will give the best results if not correctly matched to the output stage.

MATCHING THE SPEAKER TO THE OUTPUT STAGE

The loud-speaker is matched to the last valve in the set by means of a step-down transformer. The ratio of these transformers differ for the various types of valve, and is calculated from the square root of the valve load resistance divided by the impedance of the loud-speaker speech coil.

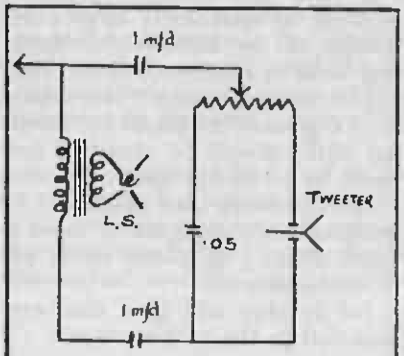
For valves used in push-pull connection, the valve load resistance is doubled, but in the case of parallel output valves, the valve load figure is halved. The valve load resistance can be ascertained from the valve makers' book. Impedance of the speech coil will probably have to be obtained from the makers of the speaker, as at present very few manufacturers state this on their products.

" Mismatching " can be tolerated to some degree in the case of small triode output valves, but pentodes require more careful attention.

Large-core transformers should be chosen whenever possible as small-core transformers saturate at low frequencies, causing distortion. For good clean bass reproduction use the largest transformer, and a sectional wound bobbin transformer is also superior.

PIEZO ELECTRIC TWEETERS

A tweeter can be used for the emphasis of high frequencies, connected as in Diagram 3. An improvement will be noticed in the quality of reproduction from the local stations and gramophone records. A gain control potentiometer is used to reduce the output from the tweeter. Suppression of the higher frequencies may be necessary on foreign reception, to avoid side-band splash and heterodyne whistles.



DIAG. 3

Chapter 4

FITTING EXTENSION LOUD-SPEAKERS

SMALL extension loud-speakers could be popularised to a greater extent in the summer months, providing a means of programme distribution to other parts of the building, to the garden or summerhouse, kitchenette, etc., without the necessity of having the main speaker working at full volume with its consequent annoyance to neighbours.

An extension unit can be purchased quite cheaply, an 8- or 10-inch permanent-magnet speaker with a multi-ratio matching transformer being most suitable.

Some set makers provide extension L.S. sockets on their sets, with a switch to silence the main speaker, the type of speaker required is then specified on leaflets given with the set.

Most manufacturers intend a low-resistance extension speaker to be used, and it will usually suffice to connect the additional speech coil direct to the external sockets, the multi-ratio transformer not being required. For the set specifying a high-resistance extension unit it will be best to use the transformer and match to the best tonal quality by use of the variable tappings.

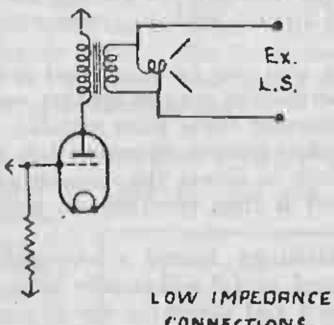
Speech coils of lower impedance than 2 ohms, should not be used for extensions on very long lines, owing to the losses in the lines, but should have a transformer matching the speaker to the line and another transformer to match the line to the set speaker.

Whenever an additional speaker is added, the output valve matching is upset, but whether this change is drastic enough to introduce distortion, depends on the amount of mismatching.

When adding speakers to a set or amplifier the following calculations are necessary if the matching is to be effected accurately. Assuming a total of three speakers are to be added and each of their speech coils is 5 ohms, each unit to work at the same volume, the speech coils should be connected in parallel, the ratio of the output transformer is then :—

$$\text{Transformer ratio} = \sqrt{3\ \frac{\text{Valve load resistance}}{\text{Speaker impedance 5 ohms}}}$$

For other data regarding output transformers refer to "Radio-Electrical Data Section."



DIAG. 4.

Diagram 4 shows how extension speakers may be connected to an existing set or amplifier.

Chapter 5

Valve Testing : When to Replace

VALVE faults form quite a large percentage of the service troubles in modern receivers, many testing instruments have been devised for the quick and efficient testing of valves, and although it is often sufficient to know that a valve is "good, bad, or indifferent," it sometimes becomes necessary to check the actual working characteristics. A means of measuring the mutual conductance of the valve, the amplification factor, and anode resistance is essential to the set designer. These characteristics can only be checked by a repetition of the working conditions as set up by the valve makers.

For the repair man there are many valve testers on the market sold at reasonable figures. The type mostly favoured is an instrument containing a range of valve holders and a small meter, on one panel. The circuit of this instrument is mostly based on emission only, the valve under test is supplied with a known voltage, and providing the milliampere meter in series with the anode supply passes a given point the valve is reckoned fit for further service.

A good valve tester should give indication of the condition of insulation between electrodes, particularly heater to cathode. The resistance should be measured while the valve is hot, provision should also being made for some method of continuity testing of valve heaters. This refinement is also useful for testing coils and transformer windings when the ohmmeter is not available. Continuity from valve pins to electrodes in valves should also be ascertained.

This type of tester will not always show up every fault in a valve. Where a multi-electrode valve is being tested it is quite common practice to join several of the electrodes together in the instrument to obtain the total reading.

A fault can exist in one of the sections, and will not be revealed, for example, with a valve containing two or more anodes and grids, a grid or anode can become disconnected from its pin and the resultant change in current as shown on the meter may be too small to give indication.

To design a valve tester which will analyse the characteristics of valves, all the types must be taken into consideration, as there are many shapes and sizes of valve bases, and these are still being added to, for reasons best known to valve manufacturers. There are many types of combination valves where the placing of the grids, anodes, and cathodes do not keep to the conventional pin numbering.

To make this clearer it can be said that if the anode is pin No. 2 in an H.F. pentode with seven-pin base, that pin can also be found to be grid, when the anode is connected to the top cap, in place of the former connection of grid to top cap, both valves having the identical base and physical appearance.

MUTUAL CONDUCTANCE VALVE TESTING

The measurement of mutual conductance gives to the radio engineer something tangible that can be compared to the makers' charts, used for the calculation of other statistics, and is an accurate indication of the state of the valve tested.

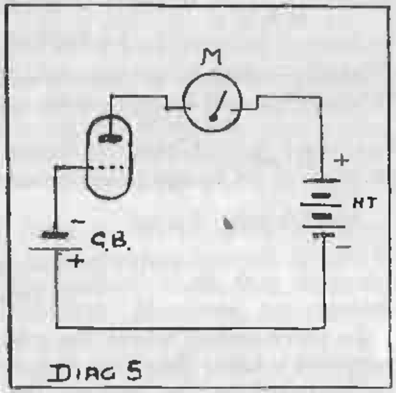
The operation of a valve is to transfer a change of grid voltage into a change of anode current, rectifiers and diodes excepted. This change of current is quite easy to obtain outside of the receiver, if the valve is connected to a supply of heater, anode, and grid voltage.

Reference to the makers charts show that columns are drawn up stating the operating conditions the valve was subjected to in order to obtain the figure of mutual conductance. These conditions are usually based on anode volts 100, grid volts 0, and must be duplicated if a correspondingly accurate test is required. Screens of pentodes must have a similar voltage to that used by the valve makers for their published curves.

For a valve tester to duplicate these conditions it must

supply a variable heater voltage to suit the requirement of all valves likely to require testing, heaters in modern valves ranging from 2 to 40 volts. Some universal receivers also have valves with 200 volt heaters. Provision for applying 100 volts to the anodes and taking the resultant reading of anode current, and also a voltage must be applied to the valve grid in order to bring about the change in anode current for the given grid voltage. This change is the mutual conductance based on a change of 1 volt in the grid circuit.

To effect this test without a valve tester necessitates an H.T. battery, grid bias battery, and a filament supply (Diagram 5). The anode has a meter in series with the H.T. battery, the grid battery voltage of $1\frac{1}{2}$ negative is applied to the valve grid. If the anode current, without the bias plug in, shows 10 mA, and with the bias connected the current changes to 8 mA, the mutual conductance for a change of $1\frac{1}{2}$ volts on the grid is therefore



$$10 - 8 = 2.$$

It will be seen that for commercial valve testing the instrument will naturally be rather complicated to allow for the variance in positions of valve electrodes in respect of pins. The testing of a valve as just described is quite simple with an ordinary triode or pentode, but becomes more involved when multi-electrode valves require examination.

VALVE CURVES

Valve curves as published in valve booklets are quite easy to reproduce if the service man has the apparatus available for supplying the valve with the different anode and grid voltages. Taking a reading of the valve with 100 volts on the anode and at 0 on the grid we will assume a current of 5 mA. Comparing with the makers' curve we see that the valve when operated at these voltages should give a reading of 7 mA and that if we increase our anode volts to 150 (or decrease to 50) and find that at these figures our current reading still does not agree with that of the makers' at those voltages, it is evident that our valve has lost its emission and should be replaced.

The Mutual Conductance Formula.

$$\text{mA/V} = \frac{\text{Change in anode current (mA)}}{\text{Change in grid volts}}$$

Anode resistance in ohms is calculated from the change in anode current resulting from a change of anode voltage.

$$R = \frac{\text{Change in anode volts} \times 1{,}000}{\text{Change in anode current in milliamps}}$$

Amplification Factor.

$$A = \frac{\text{mA/V} \times \text{anode resistance}}{1{,}000}$$

In valve testing where the grid voltage applied for test purposes is lower than that in normal working, care should be exercised not to prolong the tests unnecessarily, the excessive anode current may prove detrimental to the valve.

FREE REPLACEMENT CLAIMS

The faults and failures of valves are usually due to ageing low emission, burnt-out heaters and poor insulation between electrodes is most prevalent when valves have been in use a year or so. Mechanical faults occur on new valves at times, helped, no doubt, by the vibration in the set. A grid or anode becomes misplaced, disconnected from the lead wire at the welding, and bases have a habit of becoming loose. The British valve manufacturers are very considerate when claims are put in for free replacement, if

the fault complained of is genuine, and has occurred within the guaranteed period, so no anxiety need be felt. Nevertheless the valve manufacturers can always tell a "try-on," as they have their own code markings, and carefully examine the claim for their own protection. A form supplied by the dealer must be completed and returned to the manufacturers together with the faulty valve.

EFECTS CAUSED BY VALVE FAULTS

Poor heater-to-cathode insulation will give rise to hum.

Low emission will have effect of reduced amplification and distortion.

Misplaced electrodes give noisy and irregular reception. Faults in multi-electrodes show up in the respect that the set has erratic performance due to one section of the valves and its associated circuit being out of action.

Output pentodes become soft introducing hum and amplitude distortion, excessive blue glow in the bulb being the usual indication.

A rectifier and diode valve cannot be given a mutual conductance test, but the emission of each anode should be compared with that of the makers' chart, any deviation showing a decrease in efficiency. Moreover, the emission of anodes should be equal.

Chapter 6

How to Gang a Straight Set

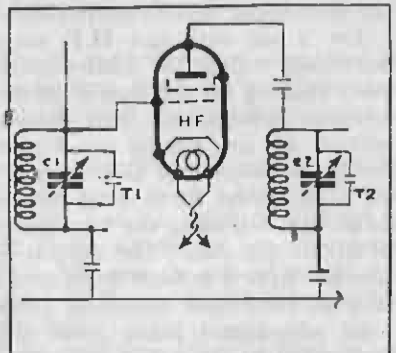
THE alignment, or bringing into tune of the various tuned circuits in a receiver, is loosely termed "ganging." The expression has probably been brought about by the fact that the circuits have their tuning condensers ganged to the same spindle, and can be controlled from one knob. Ganging is rather feared by the engineer until its mysteries are revealed to be mysteries no more, but the logical balancing of all the circuits that are connected to the one control knob.

In the straight receiver taken as an example there is an H.F. pentode or screened grid valve, with its associated tuning coil, a triode detector with tuned grid control. Both of these coils are tuned with a conventional 0.0005 condenser and are ganged on one spindle (see Diagram 6).

It is elementary knowledge that if this tuning knob on the condenser is rotated, both condensers tune from maximum to minimum and vice versa, each being mechanically coupled. Assuming the coils and valves to be correctly connected, and the tuning knob set to say, 400 metres, each tuning coil and condenser is supposed to be tuned to 400 metres, and this being so, a station on that wavelength will be tuned in by each condenser and the receiver will be producing that broadcast. However, for the sake of argument, suppose that in bringing the set from the drawing-room to the workshop it was accidentally knocked or jarred, and the tuning condenser was affected in one section only, the H.F. section, a plate of the rotary vanes was bent, altering slightly the capacity of that section, it will be obvious that with the set tuning knob set to 400 metres the grid section is tuning accurately, but owing to the altered capacity of the H.F. section, the circuit is tuning at 405 metres. Even if the set is tuned

to half-way between these two wavelengths it is not possible to receive the station clearly. Both of the sections of the tuning condenser must tune to exactly 400 metres to obtain perfect reception. Both sections of the condenser must be altered to the same capacity as before, either by bending back the damaged plate to its original position, or by adjusting the capacity of a small preset type of condenser T1 fitted on the main condenser frame and connected in parallel with it.

In practice it is the capacities of valves and circuit conditions that alter electrically, even though the set is carefully looked after.



Diag. 6.

The replacement of a valve may alter the capacity. Fixed condensers used for coupling, resistors, etc., may vary slightly, thus putting the two circuits slightly out of tune. To bring both of these circuits into tune all that is necessary is to rotate the trimmer condenser T1 until the station is received clearly and loudly at the one point on the dial. Both of the tuning condensers are then tuning in line with each other.

This sounds very simple, but as there are sets with several H.F. stages, or a bandpass stage, the process becomes rather more complicated; the receiver may be so sensitive in tuning that no broadcast signal can be picked up if the tuning circuits are not correctly aligned. It is then necessary to employ an artificial signal, the H.F. signal generator. The output from this generator should be variable over wide limits, starting by ejecting a strong signal into the set and reducing the strength as the set is brought into alignment. The ear is not a very satisfactory method of judging the output from a loud-speaker. The connection of an output meter or low-reading A.C. voltage moving-coil meter across the output transformer secondary, will give an indication of the strength of the signal being produced by the loud-speaker if it was connected.

Poor selectivity, interference between stations, or low amplification is generally caused by misalignment of the tuning circuits. To align the straight set, the output from the generator is taken through a screened lead to the grid of the last H.F. valve, V1. Set the oscillator or signal generator to 1,300 Kc. or near frequency and adjust the set tuning dial to correspond.

For a set with one H.F. stage or two H.F. without bandpass, adjust the centre section of the condenser for peak reading on the output meter, by slowly rotating the trimmer condensers. The trimmer on the detector stage section of the tuning condenser is adjusted next and finally the aerial or first section of the condenser. The set is trimmed for a peak setting by switching over to L.W. and adjusting the trimmers with an input frequency of about 300 Kc. The output from the signal generator can be clipped to each valve grid in turn and each section of that condenser trimmed, working back to the aerial, final adjustment being given with the oscillator output connected to the aerial terminal.

If the receiver is not calibrated in wavelengths a station must be selected on the dial near the 1,300 Kc. setting and the signal oscillator tuned to that frequency, the set aerial, of course, being disconnected from the receiver while ejecting a signal. With no signal generator available, the receiver will have to be trimmed using a broadcast station, choosing a transmission around the top of the M.W. band first, repeating at a reception near the bottom of the band, finally tuning to a long-wave station. Always use a station with small signal.

Chapter 7

How to Gang a Superheterodyne Receiver

THE alignment of a superhet is similar to that of the straight set, with the exception that there is an intermediate-frequency stage working at a fixed determined frequency. Any variation of this frequency results in the loss of amplification at the frequency-changer valve.

Proceed as before with an output meter connected to the output transformer secondary, short the aerial terminal of the set to earth, or the grid of the oscillator valve to cathode.

Disconnect the frequency changer grid and apply the output from the signal generator to it. Alternately the output from the generator can be applied through a dummy aerial (a small fixed condenser) to the aerial terminal of the set. This, however, is not so satisfactory due to the load introduced by the generator effecting the matching of the I.F. amplifier.

The signal output of the generator must be kept as low as possible as too large an input signal will operate the A.V.C. of the set, giving misleading results on the output meter. The smallest possible input signal giving sufficient indication on the meter must be used, and as the circuits are brought into alignment the strength of that signal must be reduced.

Set the signal generator to the intermediate frequency used by the set maker, increase the signal strength until a reading is obtained on the output meter. Trim the I.F. circuits for a peak setting (highest reading on meter) by adjusting the trimmers in the I.F. transformers, starting with the one nearest the second detector. Adjust the other I.F. transformers in turn, working back to the frequency-changer valve, with the anode transformer last.

If no signal is obtained on the meter with the generator connected to the grid of the frequency changer, the I.F. transformers are badly out of alignment ; the signal should then be applied to the grid of the I.F. valve preceding the transformer to be trimmed, the process being repeated for all the I.F. transformers.

Some manufacturers use two or more tuned frequencies for the I.F.s ; therefore, each transformer must be trimmed at the specified frequency.

Having trimmed the I.F. stages, the next to receive attention are the radio-frequency stages, the process being the same as that for ganging the straight set, except that modification has to be made to the oscillator of the receiver first.

Disconnect the shorting lead originally placed between the oscillator valve and earth or cathode, and line up the bandpass and R.F. circuits as for a straight set. The oscillator section must be attended to first, as this is the most sharply tuned circuit. Adjust the trimmers at a frequency around 1,300 Kc., ensuring that the calibration of the tuning dial is correct, bringing into alignment the bandpass and other H.F. circuits. Check at another frequency on the M.W. band, say at about 600 Kc., altering the generator to that frequency. Switching over to long waves, the padding condenser can then be adjusted to correct calibration on that waveband.

The intermediate frequency used by manufacturers in superhet design in this country is mostly 465 Kc., although frequencies of 110 and 360 Kc. have been favoured in the past.

Chapter 8

H.F. Instability. Oscillation and Whistles Accompanying Signal

IT so often happens that when a set has been correctly aligned reception is accompanied by high-pitched whistles, and is often mistuned in order to get some reception as free as possible from the annoyance.

The cause of H.F. instability is nearly always due to interaction between H.F. circuits. If a receiver is very sensitive, or has two H.F. stages, it is found to be difficult to " hold down " when tuned to the exact resonance point of a station. This fault may be noticed when realigning a receiver ; as the circuits are brought into alignment the sensitivity increases and all kinds of extraneous noises are heard from the loud-speaker.

Precautions to take in instances of this nature are to ensure all screening is as perfect as possible, that screen cans and leads are making low-resistance connections to earth ; also earth leads are as short as possible ; the earthing of a tuning condenser at one point only maybe one cause. A set with the " one point " earth system, where all earth potential leads are brought to one spot naturally has some very long leads, so try earthing these straight to chassis.

The metal braiding used for screening leads makes ideal earth connectors, soldered to frames of switches and condensers, and anchored direct to chassis.

The grid leads to wavechange switches are a common cause of instability. Resort to low-capacity screened cable if the leads cannot be shortened.

A dodge many set-makers put into practice is to erect a small metal screen around the underside of a valve socket, as this effectively screens the valve wiring to the pins.

Never run parallel wires to switches or condensers when wiring, but keep the circuits as far apart as possible. Avoid the slightest coupling between circuits by bad wiring. Every wire in H.F. circuits should run direct to its point even at the expense of neatness.

Where small variable condensers are to be used, or volume controls, keep them to the circuit in which they are associated, using extension spindles for operation from the front of the set, as this avoids trailing H.F. wires.

Battery receivers are rather prone to high-pitched whistling when the H.T. voltage is dropping. The fitting of a 2 mfd. fixed condenser across the high-tension supply will often effect a cure.

Another point to watch is the mounting of a ganged condenser; vibration of this sometimes emits a sound like a whistle or high-pitched "dither." Mounting the unit on rubber buffers will effect a cure.

A heterodyne whistle will be found rather more difficult to eliminate. This is a tunable whistle, meaning to say, when the set tuning dial is altered the whistle varies in strength and pitch and disappears. Heterodyne whistles are only experienced when attempting to receive certain stations, due to the receiver being tuned to one frequency while broadcasting station is on a close frequency and is fairly powerful, the result known as a beat frequency is being produced between the two stations and reproduced by the receiver. Whistle filters can be obtained, tuning out the unwanted frequency, but unless these are carefully designed a cut-off is likely to occur in the higher frequencies reproduced by the set. This can sometimes be offset to a degree by accentuation of the high frequencies in the L.F. amplifying stages of the set.

Chapter 9

Hum Reduction in Mains Sets. Tracing the Causes of Hum

THE mains hum in a receiver cannot be entirely eliminated, but the level of audibility should be such that when the listener is out of a range of three or four feet from the speaker very little can be heard. If the mains hum or ripple of a set is considered objectionable the cause can usually be detected by carrying out a few simple tests in a methodical sequence.

THE LOUD-SPEAKER

In trouble tracing the best plan is to start investigations at the loud-speaker end of the set and work towards the aerial; in this instance the speaker again comes in for close examination. A mains-energised speaker not fitted with a humbucking coil is sometimes causing hum through magnetic interaction with the output transformer mounted on its frame; earthing the frame, or a fresh mounting for the transformer should be tried. Inspect the field coil windings for loose turns, as these sometimes vibrate in unison with the frequency of the mains and can be mistaken for a hum.

SMOOTHING

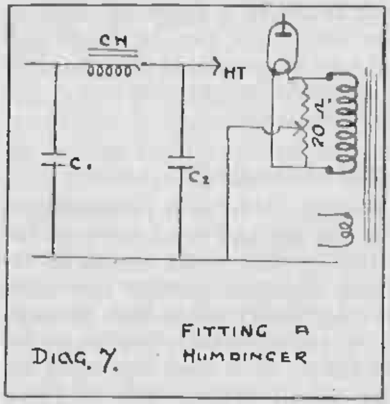
Insufficient smoothing is perhaps the greatest cause of mains hum. The field coil of the speaker is often used as a smoothing choke. A large capacity electrolytic condenser is connected both before and after the field winding, to smooth out the mains ripple. The capacity of these condensers should be increased, an additional smoothing choke could be tried, using a low resistance, in order to avoid voltage drop, as the inductance of the field winding may not be sufficient (see Diagram 7).

OUTPUT TRANSFORMER

Inspect the output transformer for loose turns in the primary. If this transformer is mounted on the chassis, interaction often takes place with other transformers and chokes in close proximity. Rotate the transformer on its axis, until the best position is found.

OUTPUT VALVE

Hum in the output stage can be traced by shorting the grid of the valve to earth ; if the hum still persists it is being produced somewhere between the grid and the speaker. Common cause likely to induce hum in this stage is incorrect centre tapping to the heater windings. Disconnect the centre tapping of the heater circuit, connect a variable resistor of 10 or 20 ohms across the heater winding and use the variable arm as centre tap. Devices known as humdingers can be obtained for this purpose (see Diagram 7). Test the output valve for heater-to-cathode insulation in a good valve tester, as poor insulation between these electrodes causes a hum to be produced.



DIAG. 7. FITTING A HUMDINGER

Having carried out these modifications and thoroughly testing the output stage and should the hum still persist, disconnect the shorting lead from the valve grid and proceed with the next stage of the set.

CONDENSERS

All decoupling and smoothing condensers should be tested for open circuits, the capacity of smoothing condensers increased if necessary to eliminate hum.

L.F. STAGES

A hum produced in these stages is mostly due to magnetic interaction of transformers, long grid connections, open-circuited grid couplings, or proximity of flexible leads carrying the mains supply to other parts of the set, such as to gramophone motor or the on/off switch. Test all condensers, etc., screen grid leads with a low-capacity screened cable. Shorting the valve grid to earth in the same way as previously will indicate if the hum is being produced in this stage.

H.F. STAGES

The H.F. stages of a set are not so liable to produce a hum as the output and low-frequency stages already dealt with. By shorting the grid of each valve in turn it can easily be ascertained in which stage of the receiver the hum is being picked up or induced. One most particular point to watch with the modern set is the lead to the volume control and on/off switch, the wiring carrying the mains to the front of the set, passing other circuits through perhaps several stages in their passage to back of the set. A grid circuit of any stage which is near these wires will almost certainly pick up a certain amount of the mains hum ; it may be necessary to completely screen the mains leads, or fit a separate switch in another position to cure this.

MAINS FILTERS

A mains filter may be found necessary in the mains lead, especially if any appliance in the vicinity radiates interference ; this may be borne into the set along the mains wiring, and although usually found to be produced as crackle and static, a hum can sometimes be caused. Various suppression units can be purchased to cure this ; an article on their use will be found elsewhere in this issue.

Chapter 10

Testing for Intermittent Faults

An intermittent fault in a receiver can cause the serviceman a lot of wasted time. On test everything seems to work perfectly normal, but when returned to the owner the fault again shows itself, sometimes in the form of crackles, hum, drop in volume, poor quality of reproduction, often complete stopping of the broadcast (to come in again at intervals), music accompanied by loud crackles and whistles, distortion.

Probably the only way to trace an intermittent fault is to keep the receiver working on the bench and carry out the tests mentioned below. It is very rarely that the fault will occur when the engineer is looking for it, but rather reappear as soon as the chassis is left alone for a time. Systematic voltage and current testing, resistance and condenser checking, leaving the set on one side afterwards for the fault to occur again. A procedure often used is to leave the set working in some convenient position, so that it can be instantly examined when any irregularity is noticed. If the speaker is left on the programme of the workroom may be upset; an ordinary flashlamp bulb can be connected across the speaker output transformer secondary. The set should have a steady R.F. signal applied to the aerial from a test oscillator, and any difference in glow of the lamp is a signal for inspection of the chassis.

In actual testing of the receiver great care should be taken to examine all wiring for dry joints. These will not always show up during a continuity test with the ohmmeter, as the two surfaces may be in contact, but not actual bonded. Suspected joints and connections to switches, coils, condensers, should be resoldered.

Probe and shake the wiring well with an ebonite rod, test condensers in a capacity bridge for open circuits, carefully examine and measure the resistance of all coils and wire type resistors, the anchoring points of flex connections. Speech coils are apt to become partially disconnected from their anchorage, due to vibration of the speaker.

The speech coil itself should be inspected for loose turns and impaired insulation due to the rubbing of misplaced turns against the pole piece. An insulation test between the speaker field and the frame of the speaker will often reveal a short circuit. Valve contacts must be cleaned, all switch contacts likewise attended to, as vibration of the receiver when working often causes a movement which cannot be observed but will affect the reproduction. The levers of switches and couplings of condensers often cause a crackle due to their dryness; a spot of good thin oil should be applied to these. A preparation known as "Servicol" will be found invaluable to the serviceman for switch contacts.

VALVE TESTING

Test all valves in a good valve tester for emission. Heater-to-cathode insulation must be checked while the valve is hot. Gently tap the valve while under test, making certain that the electrodes are in contact with their respective pins. Shorts between the valve electrodes also cause intermittent faults, most prevalent being a valve grid coming in contact with heater, shorting the signal to earth. Internal valve shorts generally only occur when the valve is hot, and when faults of this nature are suspected the valve should be left on longer than usual when testing, as the condition is perhaps apparent only at a certain temperature.

If the examiner makes it a law that these points mentioned are given attention the fault can be traced very much more quickly than by hit-and-miss testing. Most servicemen have their own sequence of testing, gained from experience. Some of the tests outlined he will skip, mainly because he has his own idea as to where the trouble is occurring, but to the man without the knowledge from experience it is advisable to list a sequence of tests or components to be tested. A method must be used if attempt is to be made to trace any fault in radio in the shortest possible time.

Chapter II

Concerning Electrical Interference and " Man-made " Static

UNFORTUNATELY there is no legislation in this country in respect of man-made static. Many electrical appliances are being fitted with suppressors during the course of manufacture, but the amount of interference set up by lifts, signs and various machinery still seems unabating. The radio engineer can do a lot to eliminate interference at the receiving end, but cannot always get to the actual source of interference for the purpose of silencing. Co-operation between the owner of the offending apparatus and the listener is not always possible.

A good aerial of the anti-interference type should be erected as high as possible from the source of trouble. Mentioned elsewhere in this book are the various advantages of an efficient aerial system. Attention in this chapter is given to the suppression of static received over the mains, or taken into the set via the mains house wiring.

Most condenser firms today market a range of mains interference suppressors. There are various sizes and types, each suited to a particular need. Man-made static can be likened to atmospherics in character. The receiver emits a constant barrage of crackles and bangs, " frying noises " as they are sometimes described. This static can be picked up by the set aerial or carried into the set amplifying stages by the mains, or radiation of mains wiring, etc.

As explained in the chapter on aerials, it is essential to pay attention in respect of height. It is often possible to erect the aerial outside the zone of interference, or use the anti-interference types. The signal applied to the grid of the first valve should be as large as a good aerial will permit; this reduces valve hiss, mush, etc., to a very great extent owing to the set not having to work at its most sensitive point in order to receive the programme.

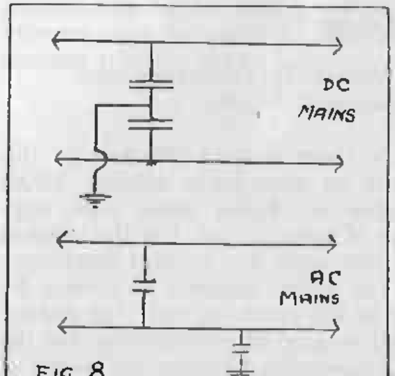
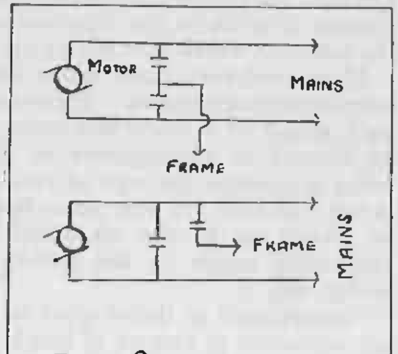


FIG. 8.

Mains-carried interference will have to be dealt with at the mains entry into the building. There are special filters available for the suppression of static on both A.C. and D.C. mains. These suppressors take the form of condensers of high working voltage to withstand the mains supply, and as will be seen from Diagram 8 are best fitted at the main switch or distribution box.

Two types of filters are shown, one type for D.C. and the other for A.C. mains. It will be found advisable to fit fuses rated at 2 or 3 amperes in the event of a condenser breakdown, when the mains would be short-circuited. Keep the connecting leads as short as possible; run the earth lead to the nearest point.



DIAG. 9.

Messrs. Belling and Lee have made a comprehensive survey of the interference problem and market a range of suppressors to suit every need. Chokes and condensers can be used as in the diagram. Low resistance air-cored chokes,

wound with stout-gauge wire and well screened, are necessary.

Small electric motors can be silenced by the earthing of the frames, and also fitting small suppressors as close to the brushes as possible (Diagram 9).

If the static is being picked up from an outside source, the aerial should be disconnected. The noise will almost cease, indicating that the interference is being picked up by the aerial along with the required signal. Steps should be taken to modify the aerial system.

Chapter 12

Aerials. Doublet Systems, Transposed Feeders and their Advantages

IN these days of highly sensitive receivers, there is a tendency to overlook the aerial and earth system. In the earlier days it was considered the right thing to do to erect a mast with its 100-foot aerial, leading to the house chimney-stack and being nursed down the wall with porcelain spacers. The earth wire came in for just as much care ; heavy wire, the shortest path, were in every wireless text-book. Lightning protecting devices formed a large part of the sales of the shops, especially during a stormy period.

Today in most households the aerial takes the form of a piece of flex around the picture rail. The earth wire is taken to the earth pin of the power plug. Anything else is considered unnecessary and unsightly.

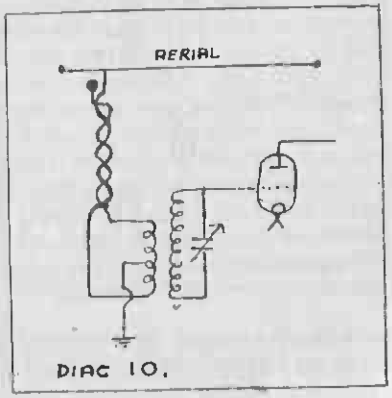
A three- or four-valve receiver today will almost certainly bring in a number of stations with a makeshift system. The public and some radio dealers alike seem to forget that without a reasonably large input signal, the receiver will tend to work at its most sensitive point, valve hiss and many extraneous noises will be amplified at the same level as the station the set is tuned to. The result can almost be enlikened to a " fairground " performance.

Many wireless users would be astonished if their receivers were to be connected alternately to a good and a makeshift aerial and earth system. The most noticeable effect would be greater volume, clearer reception of foreign stations, a reduction in background noises. Hum and static would be greatly decreased, the set would be found to tune far more easily than before.

The erection of a good aerial will help to duplicate the conditions the actual set designer had in mind with that

particular circuit of receiver. No manufacturer expects the home user to have as efficient an aerial as the laboratory from whence the design came, but it is supposed the set buyer will want to obtain the best value for his money when it comes to performance. This can only be obtained if the set is worked in accordance with the makers' suggestions. A good copper wire should be used for any type of aerial proposed. Ex-government wire jobbed to the unsuspecting public for this purpose is seldom satisfactory, the insulation being perished, or the metal may possibly be steel instead of copper.

For a good conductor use copper, braided or stranded, erect an aerial as high as possible, the higher it can be placed the further out of reach from electrical interference. The field radiated from electrical signs and appliances rarely extends over 30 feet in height. For the down lead we would recommend the special low-loss screen cable designed for the purpose. Another wire wrapped around the down lead, but not connected to it, is sometimes advised, connections as in diagram No. 10.



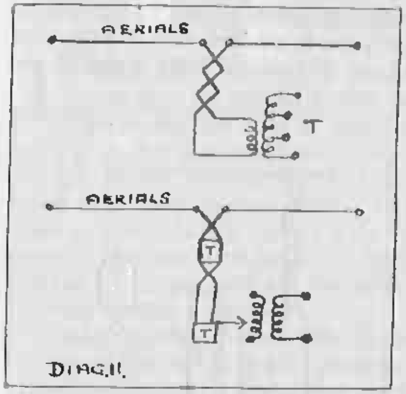
DIAG 10.

THE DI-POLE AERIAL

Perhaps the most commonly used anti-interference aerial used today is the di-pole, consisting of two lengths of stranded copper (seven strands of 22 s.w.g.) cut to a predetermined length to resonate at a certain frequency, and suspended horizontally, each being brought down by twisted leads to a transformer near the set. The secret in the elimination of interference is that each down lead picks up the interference equally, but in opposite phase ;

the effect is therefore cancelled out. A diagram of a di-pole aerial is given in Fig. 11. Two methods are used. One method entails the use of a transformer to match the aerial to the down leads and another transformer to match the down leads to the set.

The more common commercial method is to employ one transformer at the set end, matching the aerial to the set by means of variable tappings on the transformer. This type of aerial will be found most effective on short-wave reception, as the aerial is usually designed to resonate around 14 metres. Screen cable introduces a loss making it unsatisfactory for S.W. reception. An aerial as described, if erected outside the range of electrical interference, i.e., above 30 to 40 feet will be found most efficient.



EARTHS

A good direct earth as already mentioned will go a long way to reduce hum and interference. The conductor should be as stout as possible, an earth pin or buried plate should be used, the surrounding earth kept moist in dry weather, copper sulphate is sometimes buried at the same time as the earth-plate to retain moisture.

The earth connections of the electrical power plug may be a satisfactory medium, but it must not be forgotten that this may entail a considerable length of travel before earthing proper. The greater the travel, the higher the resistance of the lead becomes, and the aim should be to keep this figure as low as possible.

Chapter 13

ELECTROLYTIC CONDENSERS

THE development of the electrolytic condenser has enabled receivers and amplifiers to be constructed very much cheaper and in a much more compact form than when paper dielectric condensers were used.

The original paper condenser was expensive to manufacture. Its very size would prohibit the design of the present-day domestic receiver, especially when one considers the number of stages in our modern set that are filtered, decoupled, etc., from a multi-condenser block containing four or five units scarcely exceeding the dimensions of a single 2-mfd. unit of earlier manufacture.

Electrolytics used in the wireless receiver are to be found in two forms ; a cardboard carton, or tube, and the metal can type. In a single condenser unit there are two electrodes of aluminium, known as the anodes. The cathode is the electrolic solution or paste.

Construction of the cardboard case type is similar to that of the metal can with the exception that the container in the metal type is invariably used as one anode (negative). This method of construction is not adhered to if the can is to be neutral. Manufacture is then the same as the card-case type, where leads from the two anodes inserted in the can are brought out individually.

The anodes take the form of rolled or folded aluminium foil. In the cardcase types the foil is separated by a specially made paper. The whole is immersed in an electrolytic solution. With metal can construction, where the can forms one anode, a rod of aluminium with foil attached to it is rolled and suspended in the can, again surrounded by solution. The rod forms one connection, the positive anode, and is extended from the can in the form of a terminal.

There are two forms of metal can condensers, the dry or paste electrolytic and the wet type. The dry type can be mounted in any position, the wet type must always be mounted upright to allow the gases to extricate from the container. Wet types of condensers may be stored and handled in any position, but always keep the chassis in correct position when the set is on. A vent is provided at the top of the can—a rubber membrane with small hole pierced is usual. The solution can be heard to move in the can like ordinary liquid in a tin. The solutions used in the construction of these condensers are closely guarded secrets, borax, boracic acid, ammonium borate, in proportional quantities according to formulas favoured by individual manufacturers.

Great care is taken in the production of electrolytics to ensure all ingredients used are to a set standard of purity. The reliability of the finished unit depends on the correct choice of materials.

After construction as outlined the condenser is subjected to a process known as the " Forming." This is the building up of a film on the anodes, forming the dielectric, and is effected by connecting the unit to a direct-current supply for a definite period.

LEAKAGE CURRENT

Leakage current passing through the circuit of a condenser is great at first, due to the imperfections of the dielectric film. The leakage will reduce as the film reforms. This effect will be found most noticeable when a new condenser is used or the receiver has been idle for some while.

VOLTAGE RATINGS

The voltage marking of the electrolytic condenser differs from the grading used in the early paper condensers, in the respect that a test voltage is not stated. Condensers so marked were assumed to have a working

voltage of half the stated figure. With the electrolytic type a *Volts Peak Working* is used to denote the voltage which must not be exceeded in normal working.

A standard marking of 500 volts peak working is used for the reservoir and smoothing type of condenser block. The normal working voltage is reckoned to be 450 volts, this figure combining the applied D.C. volts and A.C. ripple voltage.

Sizes and working voltages commonly used :—

	Capacity	V.P.W.
A.C. receivers, reservoir or smoothing condensers, before and after smoothing choke of field. ..	4, 8, or 16 mf.	500 v.
Universal A.C./D.C. receivers ..	16 or 32 mf.	500 v.
Output stages and L.F. decoupling	4 or 8 mf.	500 v.
Output stages and L.F. decoupling	4 or 8 mf.	350 v.
Bias condensers L.F.	25, 50 or 100 mf.	50 v.

CONDENSER BREAKDOWNS

Usual cause of breakdown is open circuit due to corrosion of internal connection of leads to anodes, or short circuit between the anodes, breaking up of the film, or drying up of electrolytic. Test a condenser in capacity bridge for leakage, if excessive, replace with known good one.

Should a condenser analyser bridge not be available, an electrolytic can be tested by applying H.T. volts from battery with a milliammeter in series and noting the leakage current. The meter should preferably have a high and low range. Start off at 500 mA in the event of very heavy leakage or dead short. Switch reading to lower scale as the film of the condenser builds up.

Alternately the condenser can be tested in the set, by connecting the meter in the suspected positive lead. Switching the set on or applying H.T. the current passing may be as much as 100 mA. As the film builds up on the anodes this current should reduce to about 1 mA in the case of a 4 mfd., and 2 mA for an 8 mfd. As a guide, any condenser showing a greater leakage current than a ¼ of a milliamp per microfarad should be replaced.

A shorted condenser is sometimes the outcome of a fault in the receiver, a higher voltage than normal having been applied to its anode. Always check the voltage before replacement is effected. The removal of the loud-speaker plug causes a voltage surge ; the pentode left out momentarily or the receiver connected to wrong voltage, all these defects would be detrimental to the condenser.

To test open circuits the serviceman should carry a small selection of good condensers 4 and 8 mfds. The connection of a good condenser in parallel of a suspected fault unit should bring the reception back to normal.

In a condenser pack containing several units it is not practicable to replace the whole pack if one unit is faulty. A cardcase or tubular unit of correct capacity and working voltage can always be added. Take the lead removed from the faulty unit and connect to the positive lead of the replacement ; the negative can be anchored to chassis direct.

Common positive condenser packs are becoming more popular, the leads of each unit being internally connected, and only the negatives are brought out. Be very careful not to confuse the polarity of condenser blocks. A standard code is now being used by all British manufacturers to denote the polarity and capacity of the units contained in one case. A reproduction of this code will be found at the back of this book. not now

Bias types of electrolytics rarely need have a higher working voltage than 50 V.P.W Capacities are not always critical ; a 50 mfd. will take the place of a 25 mfd. if the exact replacement is not at hand. These condensers are packed in smaller cardboard cases or tubes than the smoothing types. Again polarity must be observed.

When testing allow current leakage readings as above to guide the condition. Before replacement check bias voltage ; the working voltage of the replacement can be higher with advantage. An open-circuit condenser will induce a *hum* in the set. A short-circuit condenser will most likely stop reception altogether, or give very badly distorted

output. A blue glow from the rectifier valve is sometimes caused by short-circuited bias condenser increasing the voltage surge and also breakdown of a smoothing or reservoir condenser. A shorted bias condenser often results in failure to obtain a bias voltage on a valve grid.

Chapter 14

SMALL FIXED CONDENSERS: SIZES COMMONLY USED

SMALL fixed condensers are used to a great extent in the radio-frequency stages of a receiver; although used in L.F. stages as well, the capacities are usually larger. For tone control circuits, L.F. bypass coupling, and grid decoupling, the sizes are from 0.01 to 0.5, as will be seen from the table at the conclusion of this chapter.

H.F. Stages. Condensers used for these purposes are sometimes fitted into bakelite mouldings and mica is used as dielectric. Some very small capacities are used; although working voltages rarely exceed 500 v., the condensers are of 1,000 v. test.

The paper type of condensers are fitted into cardboard tubes sealed at the ends with wax or pitch.

Tone control condensers should have a higher test voltage, about 3,000 v. is recommended, as this condenser has to withstand the applied D.C. with addition of the A.C. modulation voltage.

Small fixed condensers can be tested for shorts with ohmmeter or continuity tester. Ability to hold a charge for any length of time will indicate poor insulation; connect to a D.C. voltage for few minutes and short circuit. The resultant spark shows goodness of condenser (60 v. H.T. or a bias battery is sufficient). Very small capacities can be discharged across a voltmeter. The needle will kick up the scale, returning to zero when discharge is complete.

Position of Condenser.	Capacity.
Bias resistor by-pass H.F.	0.1 mfd.
H.F. valve by-pass	0.1 mfd.
Grid decoupling	0.1 mfd.
Tone correction L.F.	0.002 to 0.05 mfd.

Position of Condenser.	Capacity.
Intervalve coupling (sometimes mica)	0.01 to 0.1 mfd.
Hum suppressor across valve heaters to earth	0.01 to 0.1 mfd.
Parallel feed transformer coupling	0.1 to 1 mfd.

Fixed condensers of capacities in the order of 0.00001 to 0.0001 are used in the radio frequence stages for H.F. coupling of circuits.

Chapter 15

PRESS-BUTTON TUNING EXPLAINED

RECENT popularity given to press-button tuning has resulted in almost every set manufacturer marketing at least one model employing something of this nature instead of the conventional tuning dial.

The idea is rather an old one, but recent development in the construction of preset condensers and multi-bank switches has enabled a thoroughly reliable job to be designed.

Years ago it was the aim of every set designer to make sets with a minimum of controls. This was not easy with the limited knowledge of the day, and the few components available. Condensers were not ganged, several tuning dials had to be used to tune the ordinary four-valve set, rheostats were used for varying filaments, etc., and sets were often fitted with as many as four to six controls. It was then that the constructor was called upon to furnish the home with a set on which the uninitiated members of the household could receive at least one programme by the manipulation of one control. This was eventually effected by means of a preset type of condenser in place of the usual variable type ; the condenser was connected across the coil and switched in or out of circuit as desired.

The preset condenser paved the way for the press-button tuner of today. Sets now have a range of seven or eight switches, each connected with a number of preset condensers and tuned to the same number of stations as there are switches. Basic principles are the same, a preset condenser tuned to the station wavelength is switched into circuit. In the construction of the set employing more than one tuned stage it is necessary to use a switch and preset condenser for each stage, and it must be understood the condenser can only be tuned to the one frequency.

To simplify matters of operation the switches are ganged. To take the example of a popular T.R.F. set with a selection of six programmes, there is the on/off switch combined with volume control, a row of six push-buttons on a decorated plate. Each of these buttons operates two switches connecting two presets. One preset is across the H.F. coil and the other across the grid coil, each tuned to the same frequency.

Preset condensers used in these systems are specially tested for high insulation ; mica dielectric is used and the unit is constructed on steatite or porcelain. They also have to be as far as possible immune from change of capacity due to temperature variation.

The above procedure is not so simple when superhet design is considered ; a fault to be overcome is frequency drift in the oscillator section. Attention to ensure greater stability is necessary.

When a press-button set is first installed it must be re-trimmed to the conditions brought about by the user's aerial system. These sets are all tuned to a selected number of stations which can be received at the manufacturers' premises, and on that type of aerial. It may happen a customer in the North of England buys a set trimmed in the South ; the stations he requires are not to be found on the press-buttons. Most receivers are supplied with a printed sheet of station names. It is necessary for the engineer to select the required station name, observe a station which cannot be used on the set and adjust the associated trimmer to the required station wavelength, fitting the name in the slot provided on the button-plate.

Removal of the back of the set gives access to the trimmers ; they are usually numbered in respect of which switch they are connected with, and the wavelength coverage is also stated. When first setting up, trim each of the condensers to receive the station at peak volume, first the H.F. stage and then the detector stage. A signal generator can be used, tuned to the frequency of each station required to be received. This will be found an advantage on the weaker settings.

MOTORISED TUNING

Motorised tuning closely resembles the press-button tuner in appearance, but the method used is very much different. An electric motor is used to drive the ordinary variable condenser unit, and can be likened to the standard superhet or T.R.F. receiver with a motor to drive the tuner, which can be stopped at a given point by means of switching off the motor and applying a brake. The buttons marked with the station names operate a lever which is connected to switches in the form of discs; a segment of the disc is insulated; a brush makes contact with the outside edge. While the brush is picking up the voltage from the disc the motor revolves the drive; at the instant of the insulated segment coming in contact with the brush the motor stops. These discs and segments are so arranged that the motor is brought to rest when the tuning drive is at a station.

Motor noise between stations is avoided by quelch circuits, making the set dead until a station is tuned in by the motor, or silenced by means of a switch arranged to trip as soon as the motor moves, switching off the L.F. amplifier.

Remote control of receivers on one or the other of these principles is becoming popular; units are also available for the adapting of ordinary receivers to press-button operation.

The service faults likely to be met with in a press-button receiver are the same for an ordinary condenser dial set, with perhaps more switch failures to be suspected.

Clean contact of switches, adjust the pressure of wiping contacts, ease stiffness of levers and like mechanical devices with a good oil. A point to watch is the clearance of the button protruding through the escutcheon; this has been known to stick, preventing the operation of the switch.

Trimmer condensers sometimes " drift " with vibration. If this is found to happen, tune in the station accurately and seal the trimmer with wax so that it cannot turn.

Many sets are fitted with a manual tuning control as well as press-button. A noticeable difference between

manual tuning and button tuning of a station indicates the button is not trimmed to peak setting; there is a slight drop in volume when changing from one to the other, due to the added losses introduced by the wiring of the small condensers. This cannot be avoided, but the drop should not be of a drastic nature in a well-designed receiver.

When fitting press-button units to existing sets, keep the leads to the grid circuits as short as possible; do not run parallel wiring likely to introduce unwanted coupling.

Chapter 16

CAR RADIO

CAR radio faults can be traced in the same manner as ordinary receivers. The laws governing current and voltage testing are the same. In addition, great care should be taken in the examination of circuit wiring for opens and breaks, due to the vibration of the car.

VIBRATOR

The vibrator can be likened to an electric buzzer. There are contacts for breaking up the D.C. voltage from the car battery into a pulsating voltage. This is stepped up to somewhere in the region of 500 v. by means of a transformer. The voltage is applied to the anodes of the valves through the field winding of the speaker or by smoothing choke, smoothed with reservoir and smoothing condensers in the same way as a mains set. A vibrator may have two sets of points for the make and break of current. It is essential that these points are kept clean and adjusted to the correct spacing as specified by the makers of the vibrator unit.

Use a magneto file for the points, wiping after filing with rag moistened with petrol. Repairs to a vibrator are not a rush job; care is needed when dismantling and adjusting. Breaks in internal connections are quite common.

It is advisable to keep a few spare vibrators as service stock; a new unit can be plugged in and the old one repaired at a more convenient time. Always allow for this when "costing" a job. Vibrators are now fitted with bases similar to valves and have the appearance of metal can electrolytic condensers; they can instantly be removed and replaced into their sockets.

Voltage Tests. The voltage rating of the units are marked; a glance at the receiver will give an indication of what voltage to expect on the anode of the last valve. If this is low, measure the voltage of the car battery on load, lamps and set switched on; if this voltage is lower than 1.8 v. per cell the battery must be put on charge. Ascertain if the dynamo of the car is charging at sufficient rate to cope with additional discharge of the car radio. Alteration of charging rate is effected by rotating the third brush in the direction of the arrow-mark on the case, or with dynamos not marked, alter the position of the brush with the engine running at a steady speed. An assistant should be watching the ammeter to signal when the rate is increased or decreased.

All condensers in the smoothing pack should be tested as in usual receiver practice if voltages and current are not normal.

Examine speech-coil for continuity to anchoring points.

When bolting up the case of a car radio, always make certain every valve is well home in its socket, that all parts are bonded, screens (speaker frames are sometimes earthed), all metal objects, should be earthed and free from vibration.

INTERFERENCE

Interference from spark plugs can be recognised by the crackles set up in the speaker as the radio is working, the car stationary. Fit special car suppressors on the sparking plugs, a 0.5 mfd. condenser from generator to earth (chassis of car).

Shielding all ignition wiring in a car system with metal braided cable prevents radiation. Screen the aerial leads. Connect a mica condenser about 0.005 to primary contact breaker points on the main distributor.

Static. Interference set up similar in nature to atmospherics, but due to the metal parts of the car collecting a charge of electrical energy from the air and discharging it at contact with another part of the car, or swinging of metal parts collecting energy. To overcome these effects it will be necessary to search through the construction of the car, bonding all metal panels, accessories, doors, mudguards, in fact all metal bodies not directly connected to chassis. The use of the braiding from screened sleeving will facilitate this ; all parts should be flexibly connected to earth potential.

Interference is often set up by the car aerial swinging. If the under-running-board type, use stiff fibre suspenders. The aerial should be well insulated from the car, but unable to swing any appreciable amount.

Brake Drum Noises. These can be traced with the set working and the car coasting downhill without engine. Apply the brakes and the noise will cease ; release the pedal and the sounds will build up again. The fitting of internal earthing springs to the inner hubs or some other form of bonding the metal parts to chassis must be devised.

While service to a car radio is being undertaken, see that the car lighting is in good order ; chafed wires should be replaced, lamps made good, contacts in wing lamps cleaned, indicators adjusted, etc.

Chapter 17

What to Take on Urgent Service Calls

"SERVICE." The word implies repairing and adjusting receivers, but the meaning to the public can be expressed as the ability of the dealer to run along to the customer's residence at the shortest notice, and get rid of this crackle or that hum. To make matters worse the dealer's engineer must be able to wave the magic wand and "Hey Presto," the set is working again. A man may not use a set for a week, but if it does not function correctly at the moment of switching on the engineer is expected to put the matter right in a few minutes at no expense.

On these "come at once calls" it is very rare that any worthwhile information can be obtained as to the type of set, or the trouble arisen, both of these facts would help the engineer greatly in ascertaining what replacements are likely to be needed and the type of gear for him to take in order to track down the fault.

It is not possible for the service engineer to take the workshop equipment with him every time he is called out, but a separate bag should be packed containing replacements likely to be needed. Three or four sizes in electrolytic condensers should be included in this kit, a box of small tubular types, a box of resistors, most commonly used values and ratings. A smoothing choke, output transformer, volume controls, say three sizes, mainly switched type. If there are any midget receivers around the district a line cord should be kept in the kit.

Tools would consist of the usual pliers, a hand-drill, several bits, screwdrivers, insulated sleeving, wire, box of bolts, nuts, wood screws, a tin of lubricating oil or vaseline. Most important point : do not forget the soldering iron (electric) and small copper bit type for heating on the gas where no mains are available.

Valves. A few spare valves should be separately packed.

Instruments. If the engineer is to go on foot he already has a good load to carry, so space cannot be taken up with too many testers and instruments. The multi-range type of meter will have to suffice, adaptors for anode current measurement and split electrode types must be included.

The "come at once call" is often taken by the office staff over the telephone, the engineer is simply told that Mrs. Brown of The White Cottage has asked for her set to be fixed, go at once.

The engineer would probably get into conversation with the person phoning and get a few particulars, such as type of set, mains or battery, and if very old?

What has happened? Symptoms? Has that trouble occurred before? If the type of trouble is explained the engineer can make some hazard as to the likely fault, how it can best be overcome, how long the job will take, what replacements are most likely needed.

The office staff should be impressed that this information is necessary for the service man. An attitude of sympathy can be extended in the course of the conversation, which will tempt the customer to expand a little with his or her complaint. Valuable details like those mentioned will probably save the cost of an hour's work to the customer.

Service records should always be methodically kept, preferably in some sort of easy reference system. The faults of this or that particular set can be looked up at a moment's notice. One more word about the serviceman's outside kit. This should not be tampered with at the shop, any articles taken from the replacement or tool bags should be replaced. Nothing is more annoying to find that the drill has been used by the boy and left lying on the bench, or the sales have taken this or that part and not mentioned it. An inventory should be made of the stock carried by the engineers and each article used for customers' work should be charged up on the job sheet, and replaced to the service kit immediately it has been used.

A few leaflets of the modern range of receivers, accessories,

latest releases of gramophone records should be carried by the serviceman. A customer gained for service work on an old set is a prospective buyer of a new one.

The serviceman employed by the dealer for service work only should have a little encouragement in the way of commission on anything he may be able to sell and install, not forgetting aerials, extension speaker units, etc.

INDEX TO APPENDIX

USEFUL RADIO AND ELECTRICAL DATA

OHM'S LAW AS APPLIED TO D.C. CIRCUITS

$$I = \frac{E}{R} \qquad E = IR \qquad R = \frac{E}{I}$$

Power.

Power (watts) = E.M.F. (volts) × Current (amps.).

OHM'S LAW AS APPLIED TO A.C. CIRCUITS

Current in A.C. circuit containing Inductance (L) only :—

$$I = \frac{E}{\omega L} \qquad \omega = 2\pi f.$$

Current in circuit with Capacity (C) only :—

$$I = \omega CE.$$

Current in circuit containing Resistance, Capacity and Inductance in series :—

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{I}{\omega C}\right)^2}}$$

Impedance.

$$\text{Impedance } Z = \sqrt{R^2 + \left(\omega L - \frac{I}{\omega C}\right)^2}$$

Reactance.

$$\text{Reactance } X = \left(\omega L - \frac{I}{\omega C}\right)$$

$$\textit{Power Factor} = \frac{\text{True Power}}{\text{Apparent Power}} = \frac{EI\cos\phi}{EI}$$

OUTPUT TRANSFORMERS

The ratio of an output transformer is calculated from the following formula :—

$$\sqrt{\frac{\text{Optimum load resistance required by valve}}{\text{Impedance of speech coil of speaker}}}$$

The load resistance of valve can be ascertained from the makers' valve catalogue and speaker impedance from the manufacturers.
For Valves working in PUSH PULL, the Valve Resistance is doubled.
" " " PARALLEL " " " halved.

Formula for the calculation of output transformer ratio when adding external loud-speakers :—

$$\text{Ratio} = \sqrt{n \times \frac{\text{Optimum valve load}}{\text{Impedance of 1 speaker}}}$$

Where all speech coils are of equal impedance, n is the number of speakers to be used.

In the case where different impedances of speech coils are to be used for extensions, each speaker unit must have its own transformer ; the ratio for correct matching is calculated from the following :—

$$\text{Ratio} = \sqrt{n \times \frac{\text{Optimum valve load}}{\text{Impedance of the speaker being used}}}$$

Where n is number of speakers.

This equation is similar in appearance to the first ; the Impedance of the speaker being used is the quantity that differs, affecting the resultant ratio of each transformer for the individual extension units.

COLOUR CIRCUIT USED IN G.E.C. CIRCUIT WIRING

White ..	.. High-potential connections to the aerial circuits, first section of the bandpass circuit and non-earthy side of speech-coil.
Green ..	.. Grid connections and high-potential ends of signal circuits.
Blue ..	.. Screening grid circuits.
Pink ..	.. Cathode connections.
Orange	.. Connections to valve anodes.
Black ..	.. Earth wiring.
Slate ..	.. H.T. negative when not connected to earth.
Red ..	.. H.T. smoothed.
Red/White	.. H.T. unsmoothed. Where smoothing choke is in positive leg.
Green/White	.. Grid decoupling and A.V.C. circuits.
Heaters	.. Black/Red. Black/White.
Black/Red	.. L.T. positive in battery sets.

COLOUR CODE USED IN BRITISH MAINS TRANSFORMER CONSTRUCTION

PRIMARY WINDING ..	Common.	Black.
	210 V.	Black and Yellow.
	230 V.	Black and Red.
	250 V.	Black and Brown.
SECONDARY H.T. ..	Red and Red, with Yellow as centre tap.	
RECTIFIER HEATERS ..	Green and Green, with Green/Yellow tracers as centre.	
VALVE HEATERS ..	Brown and Brown, with Brown/Yellow tracers as centre.	

BATTERY CORD COLOUR CODE

Highest Positive Voltage ..	Red
2nd Positive Voltage	Maroon and Red
3rd Positive Voltage	Maroon
Negative H.T.	Black with Red Tracer
Positive L.T. Voltage	Yellow
Negative L.T. Voltage	Black with Yellow Tracer
Positive Bias Voltage	Green
Maximum Negative Bias.. ..	Black with Green Tracer
2nd Negative Bias	Black and Green
Loud-speaker Connections ..	High Potential, Brown Black with Brown Tracer

COLOUR CODE FOR MOVING-COIL SPEAKERS

Output Transformer—	Primary ends of winding.	Green (outer end)
,, ,,	Primary ends of winding.	Brown (inner end)
,, ,,	Primary centre tap.	Red
,, ,,	Secondary end—inside.	Maroon
,, ,,	outside.	White
Field Winding—	Outside end.	Yellow
	Inside end.	Black

COLOUR CODE USED IN FIXED CONDENSER BLOCKS

Multiple condenser blocks use the following colour code in order to denote the highest capacity (Red) and other units in their order of merit.

Red ..	Highest Capacity Positive
Yellow ..	2nd Highest ,, ,,
Green ..	3rd ,, ,, ,,
Blue ..	4th ,, ,, ,,
Violet ..	5th ,, ,, ,,
Black ..	Principal Negative Lead
Brown ..	2nd ,, ,, ,,
Grey ..	3rd ,, ,, ,,

The colour code arrangement is such that if two condensers in a pack are of same capacity, the unit with the highest working voltage is marked with the colour highest in order of merit.

Where units in a pack are internally connected, the following symbols are used to denote the method of connection :—

Common Positive junctions are marked	+	(e.g.)	8 + 8
Common Negative junctions are marked	—	,,	8 — 8
Series Connections are marked	±	,,	8 ± 8
Unconnected units are marked	&	,,	8 & 8

(two separate units)

WANDER PLUG COLOUR CODE

Red	..	Highest Positive H.T.
Yellow	..	2nd ,, ,, ,,
Green	..	3rd ,, ,, ,,
Blue	..	4th ,, ,, ,,
Pink	..	L.T. Positive
Black	..	Negative L.T., G.B., H.T.
Brown	..	Highest Negative G.B.
Grey	..	2nd ,, ,, ,,
White	..	3rd ,, ,, ,,

FUSE COLOUR CODE

Black	..	60 mA	Dark Blue	..	1 amp.
Grey	..	100 mA	Light Blue	..	1½ amps.
Red	..	150 mA	Purple	..	2 amps.
Brown	..	250 mA	White	..	3 amps.
Yellow	..	500 mA	Black/White	..	5 amps.
Green	..	750 mA			

RESISTORS. BRITISH STANDARD COLOUR CODE

Body	*Tip*	*Dot*
0 Black	0 Black	None Black
1 Brown	1 Brown	0 Brown
2 Red	2 Red	00 Red
3 Orange	3 Orange	000 Orange
4 Yellow	4 Yellow	0000 Yellow
5 Green	5 Green	00000 Green
6 Blue	6 Blue	000000 Blue
7 Purple	7 Purple	
8 Grey	8 Grey	
9 White	9 White	

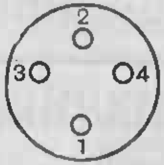
(e.g.) A resistor with a Body coloured Green .. 5
Tip ,, Black .. 0
Dot ,, Orange .. 000
equals 50,000 ohms

POWER RATING OF RESISTANCES

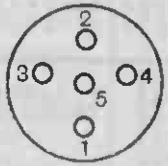
VALUE OHMS	0·25 WATT		0·5 WATT		1·0 WATT		2·0 WATT		3·0 WATT		5·0 WATT	
	MAX. CURRENT mA	MAX. VOLTAGE	MAX. CURRENT mA	MAX. VOLTAGE	MAX. CURRENT mA	MAX. VOLTAGE	MAX. CURRENT mA	MAX. VOLTAGE	MAX. CURRENT mA	MAX. VOLTAGE	MAX. CURRENT mA	MAX. VOLTAGE
100	50·0	5·0	70·0	7·0	100·0	10·0	141·0	14·0	173·0	17·0	224·0	22·4
250	31·5	8·0	45·0	11·0	63·0	16·0	89·0	23·0	108·0	27·0	141·0	35·4
500	22·5	11·0	32·0	16·0	45·0	22·0	60·0	32·0	76·0	39·0	100·0	50·0
750	18·0	13·5	25·0	19·0	36·0	27·0	51·0	38·0	63·0	48·0	82·0	61·0
1,000	16·0	16·0	22·0	32·0	32·0	32·0	45·0	45·0	55·0	55·0	71·0	71·0
1,500	13·0	19·5	18·0	27·0	26·0	39·0	36·0	55·0	45·0	67·0	58·0	87·0
2,000	11·0	22·5	16·0	32·0	22·0	45·0	32·0	63·0	39·0	77·0	50·0	100·0
2,500	10·0	25·0	14·0	35·0	20·0	50·0	28·0	71·0	35·0	87·0	45·0	112·0
3,000	9·0	27·5	13·0	39·0	18·0	55·0	26·0	77·0	32·0	95·0	41·0	123·0
3,500	8·5	29·5	12·0	42·0	17·0	59·0	24·0	84·0	28·0	102·0	38·0	132·0
4,000	8·0	31·5	11·0	45·0	16·0	63·0	22·0	89·0	27·0	110·0	35·0	141·0
5,000	7·0	35·5	10·0	50·0	14·0	71·0	20·0	100·0	24·0	122·0	32·0	158·0
6,000	6·5	38·5	9·0	55·0	13·0	77·0	18·0	110·0	22·0	134·0	29·0	173·0
7,000	6·0	42·0	8·4	59·0	12·0	84·0	17·0	118·0	21·0	145·0	27·0	187·0
8,000	5·5	44·5	7·9	63·0	11·0	89·0	16·0	126·0	19·0	155·0	25·0	200·0
9,000	5·3	47·5	7·4	67·0	19·5	95·0	15·0	134·0	18·0	164·0	23·5	212·0
10,000	5·0	50·0	7·0	71·0	10·0	100·0	14·0	141·0	17·0	173·0	22·4	224·0
12,500	4·5	56·0	6·3	79·0	8·9	112·0	12·6	158·0	15·5	194·0	20·0	250·0
15,000	4·1	61·0	5·7	86·0	8·1	122·0	11·5	173·0	14·2	212·0	18·0	265·0
17,500	3·8	66·0	5·3	93·0	7·5	132·0	10·7	187·0	13·0	229·0	17·0	296·0
20,000	3·5	70·5	5·6	100·0	7·0	141·0	10·0	200·0	12·2	245·0	15·8	316·0
25,000	3·2	79·0	4·4	110·0	6·3	158·0	8·9	224·0	11·2	273·0	14·1	354·0
30,000	2·9	86·5	4·1	123·0	5·7	173·0	8·1	245·0	10·0	300·0	12·9	388·0
40,000	2·5	100·0	3·5	141·0	5·0	200·0	7·0	283·0	8·6	345·0	11·2	447·0
50,000	2·2	112·0	3·1	158·0	4·4	224·0	6·0	316·0	7·7	385·0	10·0	500·0
75,000	1·8	137·0	2·5	194·0	3·6	274·0	5·1	387·0	6·3	474·0	8·2	612·0
100,000	1·6	155·0	2·2	220·0	3·1	310·0	4·4	440·0	5·5	550·0	7·1	707·0
150,000	1·3	187·5	1·8	270·0	2·5	375·0	3·6	540·0	4·5	670·0	5·8	867·0
200,000	1·1	220·0	1·5	320·0	2·2	440·0	3·1	630·0	3·9	770·0	5·0	1,000·0
250,000	1·0	250·0	1·4	350·0	2·0	500·0	2·8	700·0	3·5	860·0	4·5	1,120·0
500,000	0·7	350·0	1·0	500·0	1·4	700·0	2·0	1,000·0	2·5	1,200·0	3·2	1,580·0

ABBREVIATIONS USED IN THE TABLES

A = Anode.
C = Cathode.
DA = Diode Anode.
DC = Diode Cathode.
Dr = Driver.
G = Grid.
H = Heater.
HCT = Heater Centre-Tap.
IG = Injector Grid.
M = Metallising and metal-shield.
OA = Oscillator Anode.
OG = Oscillator Grid.
R = Resistance.
SG = Screen Grid.
Sup. = Suppressor Grid.
TC = Top-cap.



4 PIN

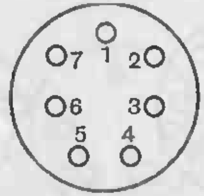


5 PIN

BRITISH VALVE BASE CONNECTIONS

4-Pin Bases Valve Type	T.C.	Pins 1	2	3	4
D.H. Triode	—	A	G	F	F
D.H. Screen Grid	A	SG	G	F	F
D.H. Screen Grid	G	A	SG	F	F
D.H. Rectifier HW.	—	A	—	F	F
D.H. or I.H. Rectifier FW.	—	A	A	F	F
D.H. Output Pentode	SG	A	G	F	F
I.H. Diode	—	A	C	H	H
D.H. Triode	G	A	—	F	F
Barretter	—	—	—	R	R
I.H. Diode	DA	C	—	H	H

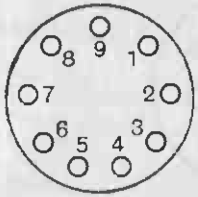
5-Pin Bases	T.C.	1	2	3	4	5
I.H. Triode	—	A	G	H	H	C
I.H. Screen-grid	A	SG	G	H	H	C
I.H. Duo-Diode	—	DA	DA	H	H	C
I.H. Duo-Diode	DA	DA	M	H	H	C
D.H. Duo-Diode-Triode	G	A	avc DA	F	F	det DA
D.H. Pentode	—	A	G	F	F	SG
I.H. Pentode	SG	A	G	H	H	C
I.H. Rectifier FW.	—	A	A	H	H	C
I.H. Rectifier HW.	—	A	—	H	H	C
D.H. Tetrode	—	A	G_1	F	F	G_2
I.H. Pentode	A	SG	H	G	HC	Sup.



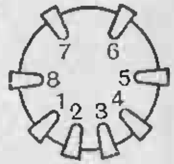
7 PIN

BRITISH VALVE BASE CONNECTIONS

7-Pin Bases Valve Type	T.C.	Pins 1	2	3	4	5	6	7
D.H. Frequency Ch.	G	OA	OG	SG	F	F	M	A
I.H. Frequency Ch.	G	OA	OG	SG	H	H	C	A
D.H. Screened Pen.	A	M	G	Sup.	F	F	—	SG
I.H. Screened Pen.	A	M	G	Sup.	H	H	C	SG
I.H. Screened Pen.	G	M	A	Sup.	H	H	C	SG
I.H. Triode	G	M	—	—	H	H	C	A
I.H. Duo-Dio-Tri.	G	DA	M	DA	H	H	C	A
I.H. Single Dio-Tetrode	A	—	G	SG	H	H	C	DA
I.H. Duo-Dio-Pen. Output	G	DA	A	DA	H	H	C	SG
I.H. Pentode	—	—	G	SG	H	H	C	A
D.H. Class B	—	G_2	G_1	A_1	F	F	—	A_2
D.H. Q.P.P.	—	G_2	G_1	A_1	F	F	SG	A_2
I.H. Rectifier FW. and VD.	—	HCT	A_1	C_1	H	H	C_2	A_2
D.H. Screen Pen.	G	M	A	Sup.	F	F	—	SG
I.H. Pentode	—	Sup.	G	SG	H	H	C	A
D.H. Driver and Class B.	DrA	BG_2	BG_1	BA_1	F	F	Dr.G	BA_2
I.H. Pentode	G	—	—	SG	H	H	C	A
I.H. Triode	—	—	G	—	H	H	C	A
I.H. Double Triode	—	—	G_1	A_1	H	H	C	A_2
I.H. Pentode	G	HCT	—	SG	H	H	C	A
CR Tuning Indicator	—	—	TG	Tar.	H	H	C	TA
I.H. Split Anode Pentode	—	A	G	SG	H	H	C	A
I.H. Duo-Diode	—	M	DA_2	C_2	H	H	C_1	DA_1
I.H. Duo-Diode-Output Pentode	G	DA	C	DA	H	H	A	SG
VD Rectifier	—	—	A_1	F_1	F_1	F_2	F_2	A_2
I.H. Split-Anode Tetrode	G	M	A	A	H	H	C	SG
VD Rectifier	—	—	—	H_1	H_1	H_2	H_2C_2	A_2



9 PIN



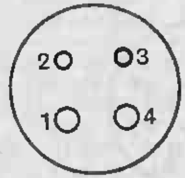
Ct. 8

9-Pin Connections Type of Valve	T.C.	Pins 1	2	3	4	5	6	7	8	9
D.H. Freq. Ch. ..	G	SG	A	Sup.	F	F	—	OA	OG	M
I.H. Freq. Ch. ..	G	SG	A	Sup.	H	H	C	OA	OG	M
I.H. Duo-Diode RF Pentode ..	G	SG	A	—	H	H	C	DA	DA	M
D.H. Q.P.P. ..	—	G_1	A_1	SG_1	F	F	—	SG_2	A_2	G_2
I.H. Triple-Dio-Triode	G	DA_2	DA_3	—	H	H	C	A	DA_1	M

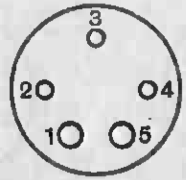
British 8-Contact Type Valve Bases Type of Valve	T.C.	Pins 1	2	3	4	5	6	7	8
Frequency Changer ..	G	M	H	H	C	OA	OG	SG	A
R.F. Pentode	G	M	H	H	C	Sup.	—	SG	A
Triode	G	M	H	H	C	—	—	SG	A
Output Pentode ..	G	—	H	H	C	—	—	SG	A
H.W. Rectifier	—	—	H	H	C	—	—	—	A
F.W. Rectifier	—	C_1	H	H	C_2	A_1	—	—	A_2
Duo-Diode-Triode ..	G	M	H	H	C	DA	DA	—	A
Barretter	—	—	—	—	—	R	—	—	R
CR. Tuning Indicator	—	—	H	H	C	—	TG	Tar.	TA
Hexode	G_1	M	H	H	C	G_3	G_4	G_2	A
Duo-Diode	—	M	H	H	C_1	DA_1	—	DA_2	C_2

Ostar-Ganz Connections Type of Valve	T.C.	Pins 1	2	3	4	5	6	7
I.H. Frequency Changer	G	C	H	H	SG	OG	OA	A
I.H. Screen-grid ..	A	C	H	H	SG	G	—	—
I.H. RF Pentode ..	G	C	H	H	SG	Sup.	M	A
I.H. Duo-Diode ..	DA	C	H	H	M	—	—	DA
I.H. Triode	—	C	H	H	—	G	—	A
I.H. Pentode	—	C	H	H	SG	G	Sup.	A
I.H. Rectifier	—	C_1	H	H	C_2	A_2	—	A_1

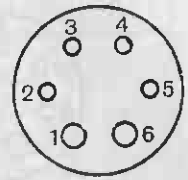
New Type Mazda Octal Base	T.C.	Pins 1	2	3	4	5	6	7	8
Popular Types	G	H	C	A	SG	SG	Met.	SG	H



4 PIN



5 PIN



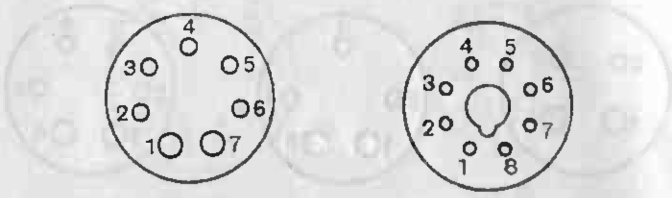
6 PIN

AMERICAN VALVE BASES AND CONNECTIONS

4-Pin Bases Type of Valve	T.C.	Pins 1	2	3	4
D.H. Triode ..	—	F	A	G	F
D.H. Screen-grid	G	F	A	SG	F
D.H. Rectifier HW.	—	F	A	—	F
D.H. Rectifier FW.	—	F	A	A	F
I.H. Rectifier HW.	—	H	A	C	H

5-Pin Bases Type of Valve	T.C.	Pins 1	2	3	4	5
I.H. Triode ..	—	H	A	G	C	H
I.H. Screen-grid	G	H	A	SG	C	H
D.H. Pentode ..	—	F	A	G	SG	F
D.H. Tetrode ..	—	F	A	G_1	G_2	F
I.H. Pentode ..	G	H	A	SG	C	H
I.H. Rectifier ..	—	H	A	A	C	H

6-Pin Bases Type of Valve	T.C.	Pins 1	2	3	4	5	6
D.H.Freq.Changer	G	F	A	OA	OG	SG	F
I.H. RF Pentode	G	H	A	SG	Sup.	C	H
D.H. Duo-Diode-Triode ..	—	F	A	DA	DA	G	F
I.H Duo-Dio-Tri.	G	H	A	DA	DA	C	H
I.H. Duo-Triode	—	H	A_2	A_1	G_1	C_2	H
I.H. Duo-Triode	G_1	H	A_2	G_2	C	A_1	H
D.H. Duo-Triode	—	F	A_2	G_2	G_1	A_1	F
I.H. Pentode ..	—	H	A	SG	G	C	H
I.H. Pentode ..	G_1	H	A	G_2	G_3	C	H
I.H. Rectifier FW.	—	H	A_1	C_1	C_2	A_2	H
D.H.Duo-Dio-Pen.	G	F	A	SG	DA	DA	F



7 PIN

8 PIN (OCTAL)

7-PIN BASES Type of Valve	T.C.	Pins 1	2	3	4	5	6	7
I.H. Freq. Changer	G	H	A	SG	OA	OG	C	H
I.H. Duo-Dio-Pen.	G	H	A	SG	DA	DA	C	H
I.H. Single Dio-Pentode ..	G	H	A	SG	DC	DA	C	H
I.H. Duo-Triode	—	H	A_2	A_1	G_1	G_2	C_2	H
I.H. Duo-Triode	—	H	A_2	G_2	C	G_1	A_1	H
I.H. Pentode ..	—	H	A	G_2	G_1	G_3	C	H
I.H. Pentode ..	—	H	A	SG	G	C	HCT	H

8-PIN BASES Type of Valve	T.C.	Pins 1	2	3	4	5	6	7	8
I.H. Freq. Changer	G	M	H	A	SG	OG	OA	H	C
I.H. Mixer ..	G	M	H	A	SG	IG	—	H	C
I.H. RF Pentode	G	M	H	A	SG.	Sup.	—	H	C
I.H. Duo-Diode	—	M	H	DA_2	C_2	DA_1	—	H	C_1
I.H. Duo-Dio-Triode	G	M	H	A	DA	DA	—	H	C
I.H. Triode ..	G	M	H	—	A	—	—	H	C
I.H. Triode ..	—	M	H	A	—	G	—	H	C
I.H. Pentode ..	—	M	H	A	SG	G	—	H	C
I.H. Rectifier FW.	—	M	H	—	A	—	A	—	HC
I.H. Rectifier FW.	—	—	M	H	A_2	C_2	A_1	—	H & C_1
I.H. Rectifier FW.	—	M	H	A	—	A	—	H	C
Gaseous Rect. FW.	—	M	—	A	—	A	—	—	C
I.H. Triode ..	G	M	H	A	—	—	—	H	C
I.H. Duo-Triode	—	M	H	A_1	G_1	G_2	A_2	H	C
I.H. Single-Dio-Triode	G	—	H	A	—	DA	—	H	C
I.H. Tetrode ..	—	—	H	A	SG	G	—	H	C
D.H. Freq. Changer	G	—	F	A	SG	OG	OA	F	—
D.H. RF Tetrode	G	—	F	A	SG	—	—	F	—
I.H. Duo-Dio Pen.	G	M	H	A	DA	DA	SG	H	C

8-PIN BASES Type of Valve	T.C.	Pins 1	2	3	4	5	6	7	8
D.H. Duo-Diode-Pentode ..	G	—	F	A	DA	DA	SG	F	—
D.H. Duo-Diode-Triode	—	—	F	A	DA	DA	G	F	—
D.H. Triode ..	—	—	F	A	—	G	—	F	—
I.H. Duo Triode	—	M	H	A_2	A_1	G_1	—	H	C
D.H. Duo Triode	—	—	F	A_1	G_1	G_2	A_2	F	—
D.H. Pentode ..	—	—	F	A	SG	G	—	F	—
D.H. Double Pen.	—	—	F	A_1	G_1	G_2	A_2	F	SG
I.H. Double Triode	G_1	M	H	A_1	C_1	G_2	A_2	H	C_2
I.H. Tuning Indicator	—	—	W H	TA	Tar.	TG	—	H	C
D.H. Rectifier HW.	—	—	F	—	—	A	—	F	C
I.H. All-stage ..	G_1	H	C	A	G_5	G_4	G_3	G_2	H

RADIO SETS DATA

ABBREVIATIONS

Volume control " W." = with on-off switch.
Tone control " D.P." = with double pole switch.
" " " L." = less switch.
" " " G." = ganged on one spindle.
Various controls " L.N.S." = less switch, noise suppression control.
" " " L.S.T." = less switch sensitivity control.
" " " L.V.A." = less switch variable input control
" " " H.M." = hum adjuster.
" + " = two or more capacities contained in one case with a common negative lead.

" & " = two or more capacities contained in one case with four leads (not internally connected).

Smoothing condens. { M. = metal case, 500 V.P. working. C.C. = cardboard case, 500 V.P. working. T. = tubular type, 350 V.P. working.

Bias condenser " T." = tubular 50 V.P. working.

"C.P." = Common Positive.

Figures in Brackets (2) denote the number of separate condensers.

Although every endeavour has been made to insure the accuracy of this information, we cannot be held responsible for errors contained therein.

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds	Valves
AERODYNE							
63 AW4	AC	500,000 W	50,000 L		8 + 8 CC	—	FC4, VP4B, 2D4A, 7A3, IW3
67 ..	B	10.000 DP	—	—	(2) 1 T	—	VP2, PM2HL, PM22A
284 ..	B	10,000 W	—	—	1 T	25 T	VP2, PM2HL, PM22A
52	AC	10,000 L	—	—	8 + 8 CC	25 T	VMP4G, X41, VMPVG, N41, U12
54	AC	500.000 L	50,000 L	3.000 L	8 + 8 CC	25 T	VP4B, TH4. VP4B, TDD4, Pen 4VA. R2
Bluebird	A	8,000 W	—	—	8 + 8 CC	25 T	VPAB, 354V, Pen 4VB, R3
51	B	10,000 W	—	—	1 T	·1 T	VP2, PM1HL, PM22A
50	B	500,000 L	50,000 L	—	·25 T	—	FC2, VP2, TDD2A, QP21
49	B	8.000 W	—	—	·1	—	VP2, PM1HL, PM22A
Curlew	U	8,000 W	—	—	8 + 8 M	10 T	VP13A, SP13, Pen 26
296	B	—	—	—	8 CC	25 T	SP2, PM2HL, PM22A
285	B	10,000 W	—	—	8 + 8 M	50 T	VP413, AC2HL, 7A3, IW3
ALBA							
212 & 430	B	25,000 L	—	—	2 T	25 T	VP2, SP2, PM22A
310	B	25.000 W	—	—	2, 4 T	25 T	VP2, PM2HL, PM22D
870	AC	500,000 W	—	—	12 + 8 CC	25 T	TH4, VP4B, 2DA4, Pen A4, IW4

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
ALBA							
210 B	B	—	—	—	—	—	SP2, PM1HL, PM22A
540	AC	500,000 L	—	—	6 + 6 CC	25 T	FC4, VP4V, 2D4A, Pen 4VB, IW4
815	AC	500,000 W	—	—	8 + 8 CC	25 T	TH4, VP4B, 2D4A, Pen A4, IW4
52	AC	10,000 W	—	—	8 + 4 CC	·5 T	VP4, SP4, PT41
230	B	500,000 W	5,000 L	—	8 M	50 T	VP2, FC2, VP2, 2D2, PM22D
825	AC	250,000 W	—	250,000 L	12 + 8 CC	8, 12, 25 T	TH4, VP4B, TDD4, Pen B4, IW4
801	AC	25,000 W	—	—	12 + 8 CC	25 T	VP4B, SP4B, Pen A4, DW4
820	AC	500,000 W	—	—	6 + 6 CC	25 T	TH4 (7), VP4B (7), 2D4A (5), Pen A4 (7), IW4/350
330	B	500,000 W	—	—	—	50 T	FC2A, VP2B, TDD2A, PM22D
335, 320, 455.. ..	B	500.000 DP	50,000 L	—	8 T	50 T	VP2B, VP2B, PM2DX, VP2B, TDD2A, PM22D
805, 605, 905.. ..	AC	500,000 W	—	—	6 + 6 CC	25 T	TH4A, VP4B, Pen 4DD, DW4/350
98	AC	500,000 L	50,000 W	—	24 + 8 CC	50 T	EF8, ECH2, EF9, EB4, EBC3, EL3, EL3, AZ3
90	AC	500,000 W	50,000 L	—	12 + 8 CC	25 T	TH4B VP4B, Pen 4DD, DW4
ATLAS							
758	AC	500,000 W	10,000 L	—	10 + 6 CC	·1, ·5 T	FC4, VP4, TDD4, ACO44
BEETHOVEN							
P107	B	15,000 L	—	—	(3) 4 CC	—	VP2, PM2HL, PM2HL, KT2
BELMONT							
500 & 505	U	25,000 W	—	—	8 + 8, 4 CC	—	6D6, 6C6, 6C6, 43, 25Z5
746	AC	1,000,000 L	50,000 L	—	8 + 8 CC	·1 T	6L7, 6C5, 6K7, 6Q7, 6F6, 5X3
700	AC	1,000,000 W	50.000 L	—	8, 8 M	(2) ·1 T	6L7, 6C5, 647, 6Q7, 6F6, 5Y3
BRUNSWICK							
39/EH		500,000 L	50,000 L	—	8 + 8 CC	50 T	6P8G, 6U7G, 6K7G, 6V6G, 5Z4G

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
BURGOYNE							
AWSG & AWSG/RG	AC	500,000 W	10,000 L	—	12, 8, 2 CC	50 T	VO4, VP4B, DDT4, APV4
AW Port.	B	10,000 L	—	—	1 T	(2) 25 T	SP2B, SP2B, PP222
Dragon	AC	500,000 W	10,000 L	—	12 + 8 CC	25 T	FC4, VP4B, 2D4A, Pen VB, R3
Hollywood AC3 ..	AC	5,000 W	—	—	12 + 8 CC	25 T	HP4115, HL4, APP4C, APV4
AWTU & AWTUG	U	100,000 DP	—	—	20 + 20 CC	25 T	VP13B, SP13B, PP36, V30
BURNDEPT							
271 AW4	U	10,000 W	—	—	24 + 24 CC	—	VP1321, SP13C, Pen 13C, 1D5
274 SC Port. ..	B	—	—	—	8 CC	—	VP2B, VP213, PM22A
270 AW	B	—	—	—	8 T	50 T	VP2, HL2, Pen 22D
267	AC	500,000 W	—	—	16 + 8 CC	25 T	AC/TH1, VP4B, 2D4, Pen 44, R3
210	U	10,000 W	50,000 L	—	16 + 8 CC	50 T	FC13, VP13A, SP13, Pen 26
251	B	15,000 L	—	—	8 CC	50 T	VP2, HL2, Pen 231
290 & 303	AC	500,000 W	250,000 L	—	4 + 8 + 16 CC	(2) 25 T	6L7G, 6C5G, 6K7G, 6Q7G, 6C5G, 6L6G, 6L6G
BUSH							
SW43	AC	500,000 W	10,000 L	—	16+8, 2 CC	(2) 50 T	41STH, MVS Pen/B, TDD4, Pen 4B, DW4
4 v. 1934	AC	15,000 W	20,000 L	—	(3) 8 M	(2) ·1 T	SP4, VP4, 354V, PM24M
SB3	B	500,000 W	—	—	2 T	—	FC2, VP2, 2D2, PM22D
DAC21 } WUG21 }	U	500,000 DP	—	—	24 + 16 CC	(2) 25 T	FC13C, VP13C, Pen 3520
BA53	B	500,000 L	100,000 L	—	2 T	100 T	TP23, VP210, TDD2A, QP230
SB44	B	500,000 W	—	—	2 T	—	FC2, VP2, TDD2A, PM22A
PB53, SUG52, RG52, RG52G		500,000 L	25,000 L	—	16 + 8 CC	(2) 50 T	TH4B, MVS/Pen/B, TDD4, Pen B4, DW4
PB51	AC	500,000 L	50,000 L	—	16 + 8 CC	(2) 50 T	TH4A, VP4B, TDD4, Pen A4, DW4
CAMEO							
ABX	U	500,000 W	100,000 L	—	32 + 16 CC	(2) 50 T	TH2320, EF8, EBC3, Pen 3520, UR3C
CLIMAX							
TC11..	AC	10,000 L	—	—	8, 8 M	(2) ·1	MM4V, 354V, Pen 4V
TC111	AC	5,000 W	—	—	16 + 8 CC	(3) ·1	VP4A, 354V, Pen VB, IW3

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
COSSOR							
3864	AC	500,000 L	25,000 L	—	8 + 8 CC	(2) 25 T	MVS Pen, 41STH, MVS Pen, DDT, 42MP, 442BU
390U	U	10,000 L	—	—	8 + 8, 32 M 2 CC	10 T	13VPA, 13SPA, 4020T, 40SUA
363	B	50,000 L	—	—		—	210VPT, 210SPT, 220HPT
435	AC	10,000 W	—	—	8 + 4 CC	—	MVSG, MS Pen, MP Pen
357	AC	10,000 L	—	—	8 + 4 CC	50 T	MVSG, MS Pen, 41MP
364	AC	50,000 L	—	—	8 + 8 CC	—	41MPG, MVS Pen, DD4, 42MP, 442BU
535	AC	1,000,000 L	50,000 L	—	8 + 8 CC	25 T	41MPG, MVS Pen, DD4, 42MP
536	AC	15,000 L	—	12,000	8 + 8 CC	(2) 50 T	MVSG, MS Pen, PT41, 442BU
368	AC	10,000 L	—	—	8 + 4 CC	(2) 50 T	MVS Pen, MS Pen, 41 MP, 442BU
358	AC	10,000 L	—	—	8 + 4 CC	50 T	MVSG, MS Pen, 41MP
370U	U	12,000 L	—	—	8 T, 8 CC	50 T	13VPA, 13SPA, 402P, 4SUA
484 & 438	AC	10,000 L	—	—	8 + 8 CC	50 T	41STH, MS Pen B, 420T, 442BU
348 AW	AC	10,000 L	—	—	8 + 4 CC	50 T	41STH, MS Pen, 41MP, 442BU
338	B	50,000 L	—	—	2 T	—	210SPG, 210SPT, 220OT
484U	U	5,000 L	—	—	24, 16 CC	50 T	220STH, 13SPA, 4020, 442SUA
737	AC	500,000 } G 500,000 }	20,000 L	—	8 + 8 CC	·1 T	41MPG, MVS/Pen, DDT, 41M Pen, 442BU
376	B	1,000,000 L	—	—	2 T	25 T	210PG, 210VPT, 220DD, 220PA, 220B
3468	AC	12,000 L	—	—	6 + 2 CC	50 T	MVSG, 41MH, 41MH
379	U	12,000 L	—	—	8 CC, 8 M	50 T	13VPA, 13SPA, 402P, 40SUA
6864	AC	500,000 L	20,000 L	—	8 + 8 CC	(2) 25 T	MVS Pen, 41STH, MVS Pen, DDT, 42MP, 442BU
583	B	500,000 L	20,000 L	—	2 CC	—	210PG, 210LF, 210VPT, 210DDT, 240QP
3952	AC	500,000	20,000	—	8 & 8 CC	25, 50 T	41MPG, MVS Pen, DDT, AXP, 442BU
393	B	50,000 L	—	—	2 CC	—	210VPT, 210SPT, 220/O.T.
398	AC	500,000 L	—	1,000 LNS	16 + 16 CC	50 T	MS Pen B, 41STH, MVS Pen B, DDT, 2XP, 431U
71	AC	500,000 L	250,000 L	—	8 + 8 CC	10, 50 T	41STH, MVS Pen B, DDT, 2XP, 431U

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
COSSOR							
3864 & 3764	AC	500,000 L	25,000 L	—	8 + 8 CC	—	MVS Pen, 41STH, MVS Pen, DDT, 42MP, 442BU
485	B	500,000 L	—	—	2 CC	50 T	210PG, 210VPT, 210DDT, 240QP
388	AC	12,000 L	—	—	6 + 4 CC	(2) 50 T	MVS Pen, MS Pen, 41MP, 442BU
396	AC	500,000 L	100,000 L	—	8 + 8 CC	10 T	MVS/Pen, 41STH, MVS/Pen, DDT, 4XP, 431U
394	B	50,000 L	—	—	2 T	20 T	210PGA, 210SPT, 220/OT
439	B	500,000 DP	250,000 L	—	2 T	20 T	220TH, 210VPA, 210DDT, 220/OT
DECCA							
55 Trans.	U	500,000 W	—	—	16 + 8 CC	50 T	TH2320, VP13C, 10D1, 7D6, UR1C
6v, 934	AC	500,000 L	—	—	8, 8, M, 8, 2, 2, T	25 T	VP4, AC/SG, VP4, AC/HL/DD/AC/Pen
66	U	500,000 L	—	—	16 + 8 CC	50 T	TH230, VP13C, 10D1, 7DC, UR1
PT/ML	AC	500,000 W	50,000 L	—	8 + 8 CC	50 T	ACTH1, VP4B, 2D4, Pen A4, R2
PT/AC & PG/AC ..	AC	500,000 W	50,000 L	—	4, 8 + 8 CC	50 T	ACTH1, AC/VP2, 2D4A, AC/5 Pen, IW4
99	AC	500,000 L	500,000 W	—	16 + 8 CC	50 T	VP4B, TH4A, VP4B, 2D4A, AC4 Pen, IW4
PC/AW } PG/AW }	AC	500,000 W	50,000 L	—	8 + 8 CC	50 T	AC/TH1, VP4B, 2D4A, AC/5 Pen R2
PT/ML/B } PTB }	B	500,000					
EKCO							
UAW78	U	—	—	—	8+24+2 CC	(2) 50 T	TH21, VPU1, TDD13C, Pen36L, UR1C
AD38	U	10,000 DP	—	—	8+24+2 CC	50 T	VPU1, SP13C, Pen 36C, UR1C
AW88 & C88 } RG109 } ..	AC	1,000,000 L	1,500,000 L	—	2, 2, 8, 12 CC	(2) 50 T	TH4A, VP41, DT41, OP42, IW4
AC74	AC	5,000 L	—	—	4 + 4 + 4 CC	25 T	SP4, VP4, AC/HL/DD, AC/Pen
SH25	AC	7,500 W	—	—	8 M	—	MSG/LA, 354, MM4V, AC/HL, PM24M

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
EKCO							
B67 & BV67	B	1,000,000 L	250,000 L	—	10 CC	—	VP2, PM1HL, VP2, 2D2, PM22
AC97	AC	500,000 } 50,000 } G	—	—	8, 8 + 4 CC	4, 25 T	FC4, VP4B, TDD4, ACO42, IW4
ACT96	AC	250,000 W	—	2,000 LNS	8 + 8 + 2 CC	25 T	AC/VP1, FC4, AC/VP1, 2D4A, 354, Pen 4VA, UU3
AC76	AC	250,000 W	—	2,100 LNS	8 + 8 + 2 CC	(2) 25 T	FC4, AC/VP1, V914, AC2, Pen, UU3
AC86	AC	250,000 W	500,000	10,000 LNS	8 + 8 + 2 CC	10 T	FC4, AC/VP1, V914, 354V, AC Pen, UU3
AW60	AC	850,000 W	40,000	—	8 + 8 + 2 CC	25 T	TX41, VP41, DO42, R41
AW98	AC	1,000,000 L	1,500,000 L	—	2 CC, (2) 8 M	25, 50 T	TH4A, VP41, DT41, OP41, IW4
PB199	AC	500,000 W	—	—	8 + 12 + 4 CC	25 T	VP41, TX41, T41, VP41, 2D41, DT41, OP41, R41
P149	B	—	—	—	8 T	20 T	VP2B, PM2HL, PM2HL, PM22A
AW119	AC	1,000,000 L	1,500,000 L	—	(2) 2, 8 + 12 CC	(2) 50 T	TH4A, VP41, DT41, OP42, 321U
B30	B	1,500,000 L	—	—	10 T	—	VP2B, SP2, PM22A
BAW98	B	1,000,000 DP	1,500,000 L	—	10 + 4 + 2 CC	—	VP2B, 210HF, VP2B, TDD2A, QP230
PB170	AC	Special Gang	V.C. & T.C.		12 + 8 + 2 CC	—	TH4B, VP41, DO42, R41
EVER-READY							
5030	B	500,000 DP	50,000 L	—	2 CC	—	X22, K50N, K23B, K30E, K33B
5010	B	3,000 L	—	—	2 T	—	K50M, K30K, K30K, K70D
5101	B	500,000 L	50,000 L	—	(2) 2 T	(2) 50 T	K80B, K50N, K23B, K70B
5132	AC	500,000 W	2,000,000 L	—	16 + 12 + 8 CC	(2) 50 T	A36B, A50P, A23A, A70D, A11D
5117	AC	500,000 W	2,000,000 L	—	16 + 8 CC	(2) 50 T	A36C, A50P, A23A, A70D, A11D
FERGUSON							
378	AC	500,000 L	500,000 W	3,000 LST	8 + 8 M	5, 25 T	6D6, 6A7, 6D6, 75, 76, 42, 42, 80
378	U	500,000 L	500,000 W	—	20, 20 + 20 M	5, 25 T	6D6, 6A7, 6D6, 75, 76, 42, 42, 12Z3
350	AC	500,000 W	100,000 L	3,000 LST	(2) 12 M	5 T	6D6, 6A7, 6D6, 85, 76, 45, 45, 80
502	AC	500,000 W	500,000 L	—	8 + 8 M	25 T	6A7, 6D6, 75, 76, 42, 42, 80

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
FERGUSON							
702 & 705 R.G. ..	AC	500,000 W	100,000 L	—	16 + 8 M	25 T	6A8G, 6U7G, 6Q7G, 6C5G, 6V6G, 6V6G, 5Y3G
772 & 775 R.G. ..	AC	500,000 W	100,000 L	—	16 + 8 M	25 T	6A8G, 6U7G, 6Q7G, 6C5G, 6V6G, 6V6G, 5Y3G, 6G5
FERRANTI							
1237	B	1,000,000 L	50,000 L	—	24 + 2 CC	—	VH2A, VP21, HD22, QP21
1737 & 2037	AC	1,000,000 W	—	—	8, 8, 6, 4 CC	—	VHT4, VPT4, H4D, LP4, R4, VFT4
1137 & 837	AC	1,000,000 W	—	—	4 + 4, 8 + 8 CC	—	VHT4, VPT4, PT4D, R4
Lancastria Parva ..	AC	1,000,000 L	—	—	8, 8 CC	·25 T	VHT4, VHT4, H4D, LP4
Gloria Consolette ..	AC	1,000,000 L	500,000 L	—	8 + 8 CC	(2) ·25 T	VPT4, D4, VPT4, VPT4, H4D, LP4
Lancastria	AC	1,000,000 W	50,000 L	—	8 + 8, 4 + 4 CC	—	VHT4, VPT4, PT4D
Una Battery	B	500,000 W	—	—	2 T	—	VS24, VS24, PT2
Una	AC	50,000 W	—	—	8 & 8 CC	25 T	VPT4, D4, PT4D, R4
Una	U	50,000 W	—	—	24 + 8 CC	25 T	W31, H30, N31
Nova	B	1,000,000 W	50,000 L	—	—	—	VH2A, VP21, HD22, QP21
Arcadia AW	AC	1,000,000 W	500,000 L	—	8 + 8 CC, (3) 2 T	—	VHT4, VPT4, H4D, LP4, R4
837	AC	1,000,000 L	—	—	8 + 8, 4 + 4 CC	25 T	VHT4, VPT4, PT4D, R4
AW Straight 3 ..	AC	15,000 L	—	—	8 + 8 CC	50 T	VPT4B, SPT4A, PT4D, R4
2337	AC	1,000,000 L	50,000 L	—	24 + 24 CC, (2) 4 T	(2) 50 T	VHT4, VPT4, H4D, AC2 Pen DD, R2
515 PB & 514 ..	AC	1,000,000 W	500,000 L	—	12 + 12, 4 + 4 CC	50 T	X63, 6K7G, 6Q7G, 6F6G, 5Y3G
617 PB	AC	1,000,000 W	100,000 L	—	12 + 12, 6 CC	—	X63, 6K7G, 6Q7G, 6F6G, 6F6G, 5Y3G
513 AM } 512 AM }	U	1,000,000 L	100,000 L	—	24 + 8, 8 CC	—	FC13C, VP1321, TDD13C, Pen DD4021, U4020
49 B	B	1,000,000 W	—	—	2T	200 T	FC2A, VP2, TDD2A, KT2
G.E.C.							
Trans. 5	AC	500,000 L	50,000 L	—	8, 8 + 8 CC	—	VPP4G, X41, VMP4G, D41, U12
BC3440, 1934 ..	AC	10,000 L	50,000 L	—	8, 8 M	(2) ·25 T	MS4B, VMS4, MS4B, MPT4, U12
AVC	AC	500,000 L	50,000 L	—	6 + 6 + 6 CC	25 T	X30, W30, DH30, N30
Fidelity SW5 ..	AC	500,000 L	50,000 L	—	6, 6 + 6 + 6 CC	(2) 50 T	W41, W42, MHD4, N41, U12
AC37	AC	7,000 L	—	—	3, 8 + 8 CC	·25 T	VMS4B, VMS4, N41, U12

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
G.E.C.							
AW6, BC3760 ..	AC	500,000 L	50,000 L	—	8, 8 + 8 + 8 CC	(2) 35 T	W42, X41, W42, DH42, N42, U12
AC, AW5	AC	1,000,000 W	—	—	4, 8, 8 + 8 CC	35 T	X41, W24, DH42, N42, U12
SP3	B	10,000 W	—	—	(2) ·25 T	35 T	W21, VP21, PT2
AW4	B	1,000,000 W	—	—	(3) ·25	35 T	X22, W21, HD22, PT2
Fidelity AW8 ..	AC	500,000 L	50,000 L	1,000 LST	(3) 8 M	(2) 25 T	VMS4, X41, VMP4, VMP4, MH4, MPT4, MPT4, 4U14
TRF3	B	50,000	—	—	—	35 T	VS24, VP21, PT2
AC/DC3 (1934) ..	U	—	—	—	8 + 8 CC	25 T	H30, N30K
BC3754	AC	500,000 L	50,000 L	—	(3) 8 CC	30 T	VMP4G, X41, VMP4G, D41, N41, U12
Universal AW Superb	U	1,000,000 L	1,000,000	—	(2) 4 CC, 24+8 CC	10, 20 T	W63, X31, W63, DH63, N30G, U30
QPP4	B	1,000,000 W	—	—	·25 T	—	X22, W21, HD22, QP21
GILBERT							
A63	AC	500,000 L	50,000 L	—	2, 16 + 8 CC	—	AC/TH1, AC/VP2, V916, AC/1HL, AC/Pen, UU4
A50	AC	250,000 L	50,000 L	—	8 + 8 M, 1, ·1 T	·1 T	FC4, VP4B, TDD4, Pen A4, IW4
BC3946	B	1,000,000 W	—	—	—	50 T	X22, W21, HD22, KT21
3950	AC	1,000,000 W	—	—	14 + 3 + 3	35 T	X65, KTW63, DH63, KT63, U50
3960	AC	1,000,000 W	55,000 L	—	14 + 3 + 3 + 7	35 T	X65, KTW63, DH63, KT63, U50
HALCYON							
A581, AW	AC	1,000,000 W	50,000 L	—	8 + 8, 2 CC	(2) 50 T	TX4, VP4B, DDT4, APP4C, APV
4501	U	250,000 L	—	—	24 + 24 CC	(3) 50 T	FC13, VP13A, HL1320, Pen 3520
U573	U	1,000,000 L	—	—	16 + 16 CC	50 T	TX21, VP13B, TDD13C, Pen 36C, V30
B691	B	1,000,000 L	50,000 L	—	4 + 8 CC	—	VP2B, PM2HL, VP2B, DDT2, PP222, PP222
H.M.V.							
166	B	500,000	—	—	2T	—	X22, VS24, HD22, PT2, PT2
650	AC	1,000,000	1,000,000 L	50,000 W	16 (2) 32, (2) 8 CC	25 T	W63, X64, Z63, W63, D63, Z63, KT63, U50
469 & 479 R.G. ..	AC	2,000,000 W	2,000,000 (Bass) 1,000,000 (Brilliance)	..	16 + 16 + 32 CC	(2) 25 T	W63, X64, Z63, D63, Z63, KT66, U50, 6G5 (T.I.)
653	AC	2,000,000 W	2,000,000 L	—	(3) 4, 16, 8, CC	50 T	X63, KTW63, DH63, KT63, U50

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
H.M.V.							
656, 657, 668	AC	2,000,000 W	—	—	4 + 4 + 4 + 8 CC	25 T	KTW63, X65, KTW63, DH63 KT63, U50, T165 (T.I.)
658, 665, 666	AC	2,000,000 W	2,000,000 L	—	8+16, 4+4+4 CC	50 T	X63, KTW63, DH63, KT63, U50
654	U	2,000,000 W	2,000,000 L	—	16 + 32 CC	50 T	X63, KTW63, DH63, KT32, U31
1102	AC	2,000,000 L	2,000,000 L	—	16 + 8, 4 CC	50 T	X65, KTW63, D63, KT63, U50, Y63 (T.I.)
INVICTA							
300 AW5	AC	500,000 L	50,000 L	—	8 + 8 CC	25 T	TH4, VP4B, TDD4, Pen 4B, IW3
340	B	50,000 L	—	—	(3) ·1 T	—	VP2B, PM2HL, PM22
CW 37/AC .. .	AC	10,000 W	—	—	8 M, 8 T	25 T	VP2, X21, SP2, PM22A
500	AC	1,000,000 W	—	—	8 + 8 CC	(2) 20 T	TH4A, VP4B, TDD4, Pen A4, IW4
420	B	50,000 L	—	—	·1	—	VP2B, PM2HL, PM22A
K.B.							
620 AW	B	10,000 W	—	—	2 CC	—	VP2, PM2HL, PM22A
610	B	500,000 L	—	—	2 CC	—	FC2A, VP2, TDD2A, PM22A
630	AC	500,000 L	50,000 W	—	2, 16 + 8 CC	25 T	TH4A, 9D2, 10D1, 7D8, R2
AC New Pup. ..	—	—	—	—	2, 8 + 8 CC	—	41MH, AC2/Pen
710	B	10,000 TW	—	—	2 CC	—	VP2, PM22HL, PM22A
430	U	10,000 L	—	—	8 + 8, 2 CC	25 T	9D2, HL/13C, 7D6, 1D5
444	AC	20,000 L	—	—	8, 8, CC	(2) 25 T	SP4, SP4, Pen 4VA, DW3
666	AC	500,000 W	—	—	6 + 6 + 6 CP, CC	(2) 25 T	VP4, SP4, VP4, TDD4, Pen 4VA DW3
888	AC	500,000 W	—	—	8 + 8 + 8 CP, CC	(2) 25 T	9A1, 8A1, 9A1, 11A2, 7A2, R3
365	AC	10,000 W	—	25,000 L	8 + 8 CP, CC	(2) 25 T	SP4, SP4, Pen 4VA, DW3
381	U	500,000 W	—	—	8 + 8, 4 + 4 CC	(2) 25 T	15D1, 9D2, 11D3, 7D3, 1D5
383	AC	500,000 W	—	25,000 LNS	12, 12, 8 CC	(2) 25 T	13PGA, 13VPA, 13DHA, 13SPA, 44PPA, 40SUA
422	U	500,000 W	—	—	4, 4, 8, 8 CC	(2) 25 T	13PGA, 13VPA, 13DHA, 40PPA, 40SUA
405 & 425	U	500,000 W	—	—	4 + 4 + 8 + 8 CC	(2) 25 T	13VPA, 13PGA, 13VPA, 13DHA, 40PPA, 40SUA
426	U	500,000 W	—	—	8, 10, 8 + 8 CC	(2) 25 T	13PGA, 13VPA, 13DD, Pen 352O, 40SUA

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
K.B.							
427	AC	500,000 W	—	—	10, 8, 8 + 8 CC	25 T	13PGA, 13VPA, 13DD, Pen 352O, 40SUA
428	AC	500,000 W	—	—	10, 8 + 8 + 8 CC	(2) 25T	13VPA, 13PGA, 13VPA, 13DD, Pen 4VB, IW3
580	B	500,000 L	—	—	2 T	—	FC2, TDD2A, PM22
560	AC	500,000 L	50,000 L	—	8 + 8 + 8 CC	25 T	TH4, 9D2, TDD4, 7A3, R2
590	AC	500,000 L	50,000 L	—	10, 8 + 8 CC	25 T	15D1, 9D2, 10D1, 7A3, R2
640	AC	500,000 W	—	—	16 + 8 CC	(2) 25 T	15D1, 9D2, 11D3, 7D5, R2
650	AC	500,000 W	—	—	8 + 16 CC	(2) 25 T	11D1, 9D2, 11D3, 7D5, R2
652 & 642 ..	U	500,000 W	—	—	16 + CC	TD22C,	9D2, 11D3, D6, 7D6, 1D5
660	AC	500,000 W	500,000 L	—	16 + 16 CC	(3) 25 T	TH4A, 9D2, 9D2, 11D3, Pen B4, R2, TV4 (T.I.)
735	U	500,000 W	50,000 L	—	16 + 16 CC	25 T	TH22C, 9D2, 11D3, 7D3, 1D3 202
740 P	AC	500,000 W	50,000 L	—	16 + 8 CC	25 T	20A1, 9D2, 11D3, 7D5, R2, TV4
730	AC	500,000 W	500,000 L	—	16 + 8 CC	(2) 25 T	X41, 9D2, 11D3, 7D5, R2
720	B	500,000 DP	500,000 L	—	2 T	50 T	FC2A, VP2, TDD2A, PM22A
750	AC	500,000 L	50,000 W	—	16 + 16 CC	(2) 25 T	9D2, 20A1, 9D2, 10D1, 11D3, 7D5, 7D5, R2
LISSEN							
Skyscraper 7 ..	B	50,000 L	—	—	1 T	—	SG215, HL2, SG215, AVC2, L2, B2, B2
8073	B	5,000 L	—	—	(2) 1 T	—	SG2V, L2, PT, 225
815	B	5,000 W	30,000 L	—	·1 T	—	K50M, K30D, K30B
8130	U	10,000 L	—	—	2T, 8 + 8 CC	·1 T	C50N, C30B, C70D, C10B
8169	B	500,000 L	20,000 L	—	·25 T	·1 T	K80A, K50M, K23B, K70B
8214	AC	250,000 L	—	—	8 + CC	50 T	A80A, A30D, A70C, A11B
2821	AC	20,000 L	—	—	16 + 8 CC	·1 T	A50P, A50B, A70D, A11D
8311	B	—	3,000 L	—	·1 T	—	K50M, K30C, K70B
8305	AC	20,000 L	—	—	8 + 8 CC	50 T	A50P, A30D, A70D, A11D
8302	AC	500,000 W	50,000 L	—	8 + 8 + 8 CC	50 T	A36B, A50P, A23A, A70D, A11D
8118	B	5,000 L	—	—	·1 T	—	K40N, K30C, K30E, K33B
8109	B	500,000 L		28 LST	—	—	K80, K50M, K23B, K70B
8319	AC	500,000 W	250,000 L	—	8 + 8 CC	25, 50 T	A36B, A50P, A23A, S30D, A11D, A39A
8321	U	500,000 W	—	—	16 + 8 CC	50 T	C36B, C50N, C20C, C70, C10B

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
LISSEN							
8216	AC	21,000 L	—	—	16 + 8 CC	50 T	A30P, A50B, A70D, A11D
8453 & 8417	AC	500,000 L	2,000,000 L	—	16 + 8 CC	(2) 50 T	A36B, A50P, A23A, A70D, A11D
8402	AC	500,000 W	2,000,000 L	—	8 + 8 + 8 CC	50 T	A50P, A36B, A50P, A23A, A70D, A11D
McMICHAEL							
371 AW	AC	500,000 W	100,000 L	—	8 + 8 M	25 T	AC/TH1, ACVP2, AC2 Pen DD, UU4
Supervox	AC	5,000 W	—	—	8, 8 M, 4, 4 CC	—	MS4B, MS4B, MH4, MPT4
361	AC	500,000 L	100,000 L	—	2 T, 8 + 8 CC	25 T	AC/TP, AC/VP1, AC/Pen, UU3
366 RG	AC	1,000,000 L	1,000 L	—	8 + 8 + 8 CC	25 T	AC/TP, AC/VP1, AC/HLDD/ AC/2, UU3
363 B	B	1,000,000 L	—	—	8 + 8 T	·1 T	VP210, TP22, VP210, HL21/DD QP230
362	AC	500,000 L	100,000 L	—	8 + 8 CC	25 T	AVCP1, ACTH1, ACVP1, AC2 Pen DD, UU3
AW 137	AC	500,000 W	10,000 L	—	8 + 8 + 4 CC	50 T	AC/TH1, AC/VP2, AC/HLDD, AC/2 Pen, UU4
367	B	—	—	—	8 + 8 CC	·1 T	S215, HL2, HL2, Pen 220
135	U	500,000 W	100,000 L	—	8 + 8 + 8 CC	25 T	TP2620, VP1321, Pen DD4020
SMC Port.	B	26·5 L	—	—	—	10 T	215SG, HL210, HL210, Pen 220
335	B	500,000	10,000 L	—	4 CC	(4) ·1 T	VP215, FC2, VP215, HL2100, QP21
389	B	1,000,000 W	50,000 L	—	16 CC	50 T	TP23, VP22, DD/207, Pen 24
37	AC	500,000 W	100,000 L	—	8 + 8 CC	25 T	AC/VP2, AC/TH1, AC/VP2, V914, AC/2 Pen, UU4, TV4 (T.I.)
373	B	100,000 DP	100,000 L	—	8 + 8 CC	50 T	VP210 (7), TP23 (7), VP210 (7), HL21/DD (5), QP230 (7)
382	AC	500,000 L	—	—	28 + 8 CC, 8 M	50 T	AC/TH1, ACVP2, HL41DD, AC5 Pen, AC5P1, ACVP2, V914, V914, UU4
381	AC	500,000 W	—	—	8 + 8 + 16 CC	50 T	AC/TH1, AC/VP2, HL/41/DD, AC5/Pen, UU5
808	AC	500,000 W	—	—	8 + 8 CC	50 T	AC/TH1, VP4, HL41DD, AC5 Pen, UU6
380	AC	500,000 W	100,000 L	—	8 + 8 CC	25 T	AC/TH1, AC/VP2, V914, AC/2 Pen, UU4

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
MARCONIPHONE							
62 Trans. 6 v. ..	B	250,000 W	—	—	4 T	50 T	W21, W21, X21, HD22, KT2, KT2
69 Port	B	—	—	—	2 T	—	S21, S21, VS2, HL2, PT2
272 & 274	AC	25,000 L	—	20,000 LVA	2, 4, S, CC (4) 1 T	—	MS4B, VMS4, MH4, MPT4, U12
262, 286, 288 ..	AC	25,000 20,000	—	—	2, 6, 2, CC	·1, 2 T	MS4B, VMS4, MH4, MPT4, U12
296	AC	15,000 L	—	—	8, 8 M	·1 T	MX40, VMS4B, MHD4, PX4, U12
276, 290, 291 ..	AC	100,000 L	—	—	8, 8, M	50 T	MH4, VMS4B, VMS4B, MS4B, MH4, PX4, U12
366 RG	AC	250,000 L	—	—	16 + 8 CC	(2) 4, 8, T	VMP4G, X41, VMPG4, VHD4, N41, U12
346 AW	AC	250,000 L	—	—	4, 16, 8 & 8, CC	(5) ·1 T	VMP4G, X41, VMPVG, MHD4, N41, U12
356	U	500,000 L	—	—	4, 12 + 12 CC	(3) ·1 T	X31, W31, D41, N31, U30
382	U	500,000 L	—	—	4, 12 + 12 CC	(3) ·1 T	X31, W31, D41, N31, U30
556	AC	500,000 L	—	48 HM	8 + 4 CC	25 T	X41, VMP4G, D41, MH4, MPT4, U12
222	B	500,000 L	—	—	2 CC	—	X21, VS24, HD22, QP21
557	AC	2,000,000 L	—	—	(2) 4, 8 + 4 CC	25 T	W42, X42, W42, DH42, N42, U12
537 & 534	AC	500,000 L	—	—	(3) 4, 10, 16 CC	(2) 25 T	W42, X42, W42, D41, H42, N42, U14
561 & 546	—	1,000,000 L	1,000,000 L 50,000 L	—	(2) 32 (1) 16 M 8 + 8 CC	25 T	W63, X64, Z63, W63, W63, D63, Z63, KT63, KT63, U50
538	AC	2,000,000 L	1,000,000 L 2,000,000 L	—	16, 12, 8 (2) 2, CC	(2) 25 T	W63, X64, Z63, W63, D63, Z63, KT66, U50
219	AC	500,000 L	—	48 HM	8 + 4 CC	25 T	MX40, VMP4, D41, MH4, MPT4, U12
209	AC	500,000 L	—	—	8 + 4 CC	25 T	MX40, VMPG, D41, MH4, MPT4, U12
279 Port.	AC	—	—	—	8 + 4 CC (2)	25 10T	VMS4B, MS4B, VMS4B, MHD4, MPT4
347 & 363, 366 & 367 ..	AC	250,000 L	—	—	4 + 4, 16 + 8, CC	·1 T	VMP4G, X41, VMP4G, MHD4, KT41, U12

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
MARCONIPHONE							
851	AC	2,000,000 W	—	—	8 + 4, 4 + 4 + 4 CC	25 T	W63, X63, W63, DH63, KT63, U50
224 & 236	U	200,000 W	—	—	12 + 12 + 4 CC	(2) 50 T	X30, WD30, N30
858, 871, 853	AC	2,000,000 W	—	—	4 + 4 + 4, 8 + 4 + 4 CC	25 T	KTW63, X65, KTW63, DH63, KT63, U50, Y63
859	U	2,000,000 W	2,000,000 L	—	8 + 16, 32 CC	50 T	X63, KTW63, DH63, KT32, U31
857 & 861	AC	2,000,000 W	2,000,000 L	—	8 + 16, 4 + 4 CC	50 T	X63, KTW63, DH63, KT63, U5
855, 868, 869, 870 ..	AC	2,000,000 W	2,000,000 L	—	8+16, 4+4+4 CC	50 T	X63, KTW63, DH63, KT63, U50
874	AC	2,000,000 L	2,000,000 L	—	16 + 8, 4 CC	50 T	X65, KTW63, D63, KT63, U50, Y63 (T.D.)
315	B	125,000 L	—	—	4 CC	—	W21, HL2, KT2
McCARTHY							
S6AW	AC	500,000 W	10,000 L	—	8 + 8 M	(2) 25	TH4, VP4B, 2D4A, 354V, Pen A 4, IW4
MURPHY							
A8	AC	—	—	—	4, 8, 8 MC 2 T	—	VMS4, AC/HL, AC/SIVM, AC/SIVM, AC/DD, VMS4, AC/Pen
A4	—	10,000 L	50,000 L	—	4, 8 MC	(3) ·1 T	AC/Pen, AC/SG, AC/HL, AC/Pen
MULLARD							
MB3	B	10,000 W	—	—	2 T	—	VP2, SP2, PM22A
MAS4	AC	500,000 L	—	—	(2) 32 M	(2) 25 T	FC4, VP4B, TDD4, PenA4, DW2
MAS8	AC	350,000 L	—	—	(3) 32 M	50 T	FC4, VP4B, TDD4, Pen DD, DW2
MUS6U	U	500,000 L	50,000	—	(2) 32 M	25 T	FC13C, VP13C, TDD13C, Pen 36C, UR1C
ORR							
AW57	—	250,000 W	50,000 L	—	8 + 8 CC	(2) 25 T	FC4, VP4B, 2D4, 354V, Pen 4VA, IW3
S6	AC	500,000 W	50,000 W	—	(2) 32 M	25 T	FC4, VP4B, TDD4, Pen A4, DW2

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
MULLARD							
MBS6	B	500,000 L	—	—	8 T	—	VP2B, PH2HL, VP2B, 2D2, PM22D
MUS6	U	500,000 L	50,000 L	—	(2) 32 M	25 T	FC13C, VP13C, TDD13C, P36C, UR1C
MAS15	AC	350,000 W	50,000 L	—	28, 32, 32 M	(2) 25 T	
PHILIPS							
716	B	500,000 L	—	—	8 CC	·5 T	VP2B, PM2HL, VP2B, 2D2, PM22D
838 B..	B	20 W	—	—	(3) ·1	—	PM12A, PM12A, PM2DX, PM22A, PM1HL
747	AC	500,000 L	500,000 L	—	(3) 32 M	50 T	FC4, VP4B, TDD4, Pen 4DD, 1821
634	AC	—	—	500 LST	16, 16 M	·25T	S4VB, S4VB, S4D, PM24A
588	AC	500,000 L	50,000 L	—	(2) 32 M	(2) 25 T	FC4, VP4A, 2D4, SP4, PM24M
585	U	50,000 L	—	—	(2) 32 M	(2) 25 T	FC13, VP13A, HL13, Pen 26
940A	AC	—	—	—	(2) 32 M	25 T	SP4, PM24M
587	U	500,000 L	50,000 L	—	(2) 32 M	(2) 25 T	FC13, VP13A, HL13, Pen 26
575	AC	500,000 L	—	—	(3) 32 M	16, 25 T	VP4B, FC4, VP4B, TDD4, OCO44, 1561
838	U	—	—	—	(2) 32 M	16, 25 T	VP13A, SP13, Pen 26
822	B	10,000 L	—	—	2 T	—	VP2, SP2, PM22A
577A	AC	—	50,000 L	—	(2) 32 M	25 T	VP4B, VPV4, DD, MH4, PM24A
795	AC	500,000 L	5,000,000 L	—	(2) 32 M	(2) 25 T	FC4, VP4B, TDD4, A4, 1821
V5	AC	500,000 L	—	—	32 + 32 CC	—	FC4, VP4B, TDD4, Pen A4, 1821
794	AC	500,000 L	2,500,000 L	—	(2) 32 M	(2) 50 T	FC4, VP4B, TDD4, Pen A4
714 B	B	500,000 L	50,000 L	—	8 T	—	VP2, PM1HL, VP2, TDD2A, QP22A
748	AC	500,000 L	50,000 L	—	(2) 32 M	50 T	FC4, VP4B, TDD4, 1821, Pen A4
785	AC	350,000 L	—	—	(3) 32 M	50 T	FC4, VP4B, TDD4, Pen 4DD, 1821
727 A	AC	500,000 W	50,000 L	—	(2) 32 M	25 T	FC4, VP4B, TDD4, Pen A4, 1821
940 A	A	—	—	—	(2) 32 M	25 T	SP4, PM24, 1821

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
PHILIPS							
555A, 597A / 555U, 597U	AC	500,000 DP	50,000 L	—	(2) 32 M	25 T	EK2, EF9, EBL1, AZ1, EM1
650A ..	AC	350,000 L	50,000 L	—	28, 32 M	25 T	EF8. EK2, EF9, EBL1, AZ1, EM1
470A ..	AC	500,000 W	50,000 L	—	(2) 32 M	25 T	FC4, VP4B, Pen 4DD, 1821
753A ..	AC	580,000 L	300,000 L	—	28, 32, 8 M	—	EF8. EK8, EF9, EAB1, EF6, EL3, AZ1
660A ..	AC	666,000 W	50,000 L	—	(2) 32 M. 28 M	25 T	EF8, EK2, EF9, EBL1, AZ1
PHILCO							
263 ..	U	250,000 L	—	—	8 + 8, 16 M	—	6A7, 78E. 75, 18E
295 ..	B	250,000 L	25,000 L	—	8, 4, 2 CC	—	1A4E, 1C6. 1A4E, 2102, 2103
237 ..	B	5,000 L	—	—	·5, ·1, ·5 T	—	15, 32, 32, 30, 19
260 / 261 ..	AC	350,000 L	—	—	8, 8 M	—	6A7E, 78E, 75E, 42E
269 ..	AC	330,000 L	—	—	8 + 8 M	—	6A7. 78E, Pen, DD61, 80
290 ..	U	1,000,000 W	—	—	16 + 16 CC, 8 T	25 T	78E, 6A7, 78E, 75, 18E, 25RE
255 ..	B	1,000,000 W	—	—	8 M	—	1C6, 1A4E, 2102, 2103
282 ..	AC	3,500,000	100,000	—	8 + 8, 16, 12 CC	—	6A7, 78E, 75, 42E, 80
D521 ..	AC	500,000 L	—	—	8 + 8 CC	35 T	6A7, 78E, 85, 42, 80
P538 ..	B	2,000,000 L	100,000 W	—	(2) 2 T, 4 T	—	1C6, VP21, 2102, 30, 2103
P337 ..	B	100,000 DP	—	—	1 T	35 T	SP21, HL2, OP22
A539 ..	AC	500,000 W	—	—	8 + 8 CC, 16 CC	60, 35 T	6A7, 78E, 75, 42E, 80
D531W, D521B, D521W ..	AC	500,000 W	—	—	8 + 8 CC	35 T	6A7E. 78E, 85, 42E, 80
D732BG / D732CG ..	AC	100,000 L	—	—	16 + 8 CC	35 T	6A7E, 78E, 85, 85, 42E, 42E, 5X4G
U429 ..	U	500,000 W	—	—	8 + 8 CC	25 T	6A7, 6F7E, 18E, 25RE
PILOT							
B43 ..	B	750,000 W	—	—	8 CC	10 T	TP23, VP22, L22DD, Pen 24
650 ..	AC	1,000,000 L	100,000 L	—	8 + 8 M	(2) 10 T	6D6, 6A7, 6D6, 75, 42, 80
U355 ..	AC	750,000 L	100,000 L	—	8 + 8 M	·25 T	6A7, 6D6, 75, 42, 80
U225 ..	U	750,000 L	100,000 L	—	12 + 16 + 4, 4 CC	(2) 10 T	6D6, 6A7, 6D6. 75, 43, 25Z5
B344 ..	B	1,000,000 W	100,000 L	—	M 8 CC	10 T	1C7G, 1D5G. 1H6. 1E7G
U357 ..	U	750,000 W	100,000 L	—	8, 12 + 16 CC	(2) 10 T	6A8G, 6U7G, 6Q7G, 25A6G, 25Z6G

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
PILOT							
U106 ..	AC	750,000 L	750,000 W	—	(2) 8 M, (2) 4 M, 20 CC	10 T	6U7G. 6L7G. 6J7G, 6U7G, 6A8G, 6Q7G. 6N6G, SU46
537 U ..	U	750,000 W	100,000 L	—	16 + 10 + 4 M	(2) 10 T	6A8G, 6U7G, 6Q7G, 25A6G, 25Z6G
T 63 ..	AC	1,000,000 L	—	—	16 + 8 M	(2) 10 T	X65, 6U7G, 6Q7G, 6F6G, 5Z4G, 6U5
PT 36..	AC	1,000,000 L	100,000 W	—	16 + 8 M	(2) 10 T	X65, 6U7G, 6Q7G, 6F6G, 5Z4G, 6G5, T.G.
Little Maestro ..	U	250,000	—	—	16 + 8 CC	10 T	6A8G, 6K7G, 6Q7G, 25A6G, 25Z6G
53, C53, RG53 ..	AC	750,000 W	100,000 L	—	8 + 8 M	50 T	X65, 6U7G, 6Q7G. 6F6G, 5Z4G
BT 530 ..	AC	750,000 W	100,000 L	—	8 + 8 M	60 T	X65, 6U7G, 6Q7G, 6F6G, 5Z4G
PORTADYNE							
Class B Super B72 ..	—	5,000 L	—	—	4 T	—	PM12M, SG215VM, L2DD, PM2DX, PM2BA
PYE							
P/AC Port. ..	AC	50,000 L	—	—	4, 4. 8, 8 M, 4 T	25 T	VMS4, AC/S2, VMS4, DDT, MPT4
P/B Port. ..	B	40,000 L	—	—	—	·1 T	S215VM, S215VM, S215VM, L2, PD220
Baby QU ..	M	250 L	—	—	16 + 8	(2) 10 T	SP13C, SP13C, 36C, UR1C
T 17 ..	AC	500,000 L	10,000 L	—	8 + 8 CC	10, 50 T	A80, A50P, A23A, A70C, A11B
QAC2..	AC	500,000 L	10,000 L	—	8 + 8 CC	20 T	A80A, A50P, A20B. A70D, S11D
Baby Q ..	B	300 L	—	—	(2) 2 T	20 T	K50M, K30K, K30K, Pen 220
T/M Trans. ..	AC	2,500 L	—	—	8 + 8 CC	50 T	A50N, A30B, A70C, A11B
QAC 3S ..	AC	1,000,000 W	—	—	16 + 8 CC	20 T	A36B, A50P, A23A, A70D, S11D
QPAC ..	AC	1,000,000 W	—	—	(2) 2 CC, 16 + 8 CC	20, 50 T	50P, A36A, 50P, A2A, A70D, A11D
802 ..	AC	1,000,000 W	50,000 L	—	8, 16 + 8 CC	(2) 20 T	6A8, 6K7, 6Q7, 6F6, 5Y3
823 ..	AC	500,000 W	10,000 L	—	8 + 8 CC	20 T	FC4, A50P, Pen 4 DD, DW/4350
810 ..	B	1,100,000 L	—	—	8 CC	20 T	FC2A, VP2B, TDD2A, PM22A
834 ..	AC	1,000,000 L	—	—	8 + 8 + 8 CC	20. 50 T	TH4A, VP4B, TDD4, Pen B4, DW4
M.P. ..	AC	1,000,000 L	—	—	8 + 8 CC	20 T	ECH2. EF9, EBL1, AZ1
806, 806 RG ..	AC	1,000,000 L	—	—	8 + 8 + 8 CC	(2) 50, 20T	TH4A, VP4B. TDD4, Pen B4, DW4, TV4A

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
PYE							
812	AC	1,000,000 W	—	—	8 + 8 + 8 CC	(2) 20 T	6A8G, 6K7G, 6Q7G, EL6, 5Y3G
PP/AC	AC	1,000,000 L	—	—	16 + 16 M	50 T	TH4B, VP4B, TDD4, Pen A4, DW4
REGENTONE							
Trans.	AC	500,000 W	25,000 L	—	8 + 24 + 2 CC	50 T	202STH, 13VPA, 202DDT, 402OT, 40SUA
AC 56	AC	500,000 W	—	—	8 + 16 CC	50 T	AC/TP, HP/A115, DD4, APP4C, APV4200
SPARTON							
548	AC	500,000 L	1,000,000 W	—	32, 16 M	·5 T	6A8G, 6K7G, 6Q7G, 6F6G, 5Y3G
TRUPHONIC							
AW5A	AC	1,000,000 L	100,000 L	—	12 + 8 M, 2 T	(2) 50 T	FC4, VP4B, AC/HL/DD, AC/Pen, R2
PA5	AC	500,000 W	100,000 L	—	24, 8 CC	(2) 25 T	TH4, VP4B, TDD4, PenA4, IW3
TELSEN							
474	AC	—	—	—	2, 2, 2, 4, 4 SCC	—	SP4, SP4, AC/S2/Pen
ULTRA							
Panther	AC	10,000 W	—	—	4, 4, 8, 8 M	25 T	AC/SGVM, AC/HL, AC/SGVM, AC/SGVM, AC/HL/DD, AC/Pen
26	U	1,000,000 L	—	—	16 + 8 M	50 T	TP2620, VP1321, Pen DD4020, U4020
Tiger	AC	10,000 } G 50,000 }	—	500,000 W	4, 4, 8, 8 M	(2) 25 T	AC/SG, AC/SGVM, AC/SG, AC/Pen
22	AC	500,000 W	—	—	16, 8 M	50 T	AC/TP, AC/VP1, AC2 Pen/DD
48	AC	1,000,000 L	—	—	32, 8 M	50 T	AC/VP1, AC/TH1, AC/VP1, AC2/Pen/DD, UU3
103	B	500,000 L	—	—	8 T	50 T	TP22, VP210, L21DD, QP230
49	U	1,000,000 W	—	—	16 + 8 M, 2 T	50 T	VP1321, TH2320, VP1321 Pen/4020/DD, U4020

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
ULTRA							
121	AC	1,000,000 W	—	—	16, 8 M	50 T	AC/TH1, AC/VP2, AC2/PenDD, UU4
150 RG	AC	1,000,000 W	—	—	8, 16 M, 2 CC	50 T	ACTH1, ACVP2, AC2/Pen DD, UU4
123	B	1,000,000 W	—	—	8 CC	50 T	TP23, VP210, L21DD, QP230
66	AC	10,000 W	—	—	16 + 8 M	10, 50 T	AC/VP1, AC/S2/Pen, AC/S2/Pen, UU3
50	AC	1,000,000 W	—	—	32, 8 M	50 T	AC/VP1, AC/TH1, AC/VP1, AC/2 Pen DD, UU4
101	AC	1,000,000 W	—	—	8, 16 M	50 T	AC/TP, AC/VP1, AC/Pen DD, UU3
202	U	1,000,000 L	2,000,000 L	—	16, 32 M, 4 CC	25 T	TH/2320, VP1322, Pen DD4021, UA020
105	B	1,000,000 W	—	—	2 T	100 T	TP23, VP210, DD207, Pen 231
115 & 125	AC	1,000,000 W	—	—	8, 16 M	50 T	AC/TH1, AC/VP2, AC/2 PenDD, UU4
400	AC	1,000,000 W	1,000,000 L	—	16, 8 M, 4, 8 CC	50 T	AC/VP2 (7), AC/TH1 (7), AC/VP2 (7), AC5/Pen DD (7), UU4
205	AC	1,000,000 W	2,000,000 L	—	16 + 8 M, 4 CC	50 T	AC/TH1, AC/VP2, DD41, AC5/Pen, UU4
209	AC	1,000,000 W	2,000,000 L	—	16 + 8 M, 4 CC	50 T	AC/TH1, AC/VP2, V914, AC5/Pen, UU4
203 & 201	AC	1,000,000 W	2,000,000 L	—	16 + 8 M, 4 CC	50 T	AC/TH1, AC/VP2, V914, AC5/Pen, UU4
R.G.D.							
718, 723 & 739	AC	2,000,000	—	—	16, 8 M	50 T	AC/VP2, AC/TH1, AC/VP2, TDD4, AC/4 Pen, UU4, TV4A (T.I.)
VIDOR							
254	U	10,000 L	—	—	24 + 16 CC, 8 T	25 T	VP1321, SP13C, Pen 36C, 1D5
268	B	10,000 L	—	—	8 T	50 T	VP2, HL2, Pen 22D
269	U	10,000 L	—	—	24 + 16, 8 CC,	25 T	1321, SP 13C, Pen 36C, 1D5
24	B	—	—	—	8 T	—	VP2B, VP2B, PM22A
273	B	15,000 L	—	—	·25 T	·1 T	VP2, HL2, PM22
CN232	B	15,000 W	—	—	8 T	—	VP2, HL2, PM22A
79 & 283	AC	10,000 W	—	—	16 + 8 CC	50 T	AC/VP1, AC/HL, Pen A4, R2

Type		Volume Control ohms	Tone Control ohms	Various Controls ohms	Smoothing Condensers mfds.	Bias Cond'ns'rs mfds.	Valves
VIDOR							
277	AC	500,000 W	—	—	16 + 8 CC	25 T	AC/TH/1, VP4B (7), 2D4A (5), A4 (7), R2 (4).
302	AC	500,000 W	50,000 L	—	24 + 16 CC	25 T	AC/TH1, VP4B, 2D4A, Pen A4, R2
279 & 283	AC	10,000 W	—	—	4 + 8 + 16 CC	50 T	AC/VP1, AC/HL. Pen A4, R2
WAYFARER 4v.B Port	—	—	—	—	8 T	—	SG215, D210, D120, Z220

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