

AMERICAN MIDGETS

PART ONE: POWER SUPPLIES

IN response to many requests for information dealing with the servicing of American midget receivers, it has been decided to revise and reprint in the form of *Service Sheets* a series of articles, prepared in *The Trader* laboratory, which were published in the journal about two years ago and are now out of print.

Problems connected with the servicing of American midget receivers are bound to crop up frequently, because literally thousands of these sets are in use in this country, while only in a few isolated cases has even a circuit diagram accompanied any of them upon importation.

Some dealers have done a lot of business with this type of set, and their service departments have consequently become familiar with the "shape" of midget design, so that they can handle repairs to all kinds of midgets, because, although individual designs vary widely, certain general principles are followed fairly regularly. In some ninety cases out of a hundred the conventional service manual is quite unnecessary to the service man who has familiarised himself with the trend of their design.

General Circuit Design

For those who have not had sufficient experience to acquire this familiarity it is proposed in this series to discuss the general outline of midget receiver practice, at first dealing broadly with the most common arrangements of various parts of the circuit and then working round to the less frequently encountered arrangements, finally winding up with innovations and peculiarities which may be considered comparatively rare.

In general, it may be said that the midget is an AC/DC receiver, usually designed to be operated from 100-120V

mains. In the early days of the midget invasion the sets were almost all TRF types comprising a four-valve combination of variable- μ , SG detector, pentode and rectifier; but more recently the conventional five-valve superhet circuit has become as popular.

The Heater Circuit

In either case the heaters will be arranged in a series circuit, and the almost invariable respective sequences of valves in the heater chains are as shown in fig. 1, where it will be seen that the detector valves (double-diode-triodes in the superhets) are at the chassis end in both cases.

There will usually be four valves in the TRF circuit, and five in the superhet, including the rectifier in each case, and some form of ballast resistance is therefore necessary in series with the heater circuit.

One or two scale lamps are interposed at some point in the chain in most sets, but not all. Usually it is one lamp, and in most cases it will be found at one end of the chain or the other. If we regard the end connected to chassis as the "bottom" of the circuit, and the other end as the "top," then in some cases the scale lamp, or "dial lite" as some Americans choose to call it, will be at the top, but more usually it is at the bottom, between the detector valve heater and chassis. Since any resistance between the detector heater and chassis is liable to develop hum, however, the scale lamp may in some cases be connected between the upper side of the detector heater and the heater of the preceding valve in the chain. It may or may not be shunted by a resistance.

It may be assumed that the ballast resistance will be connected between the

rectifier heater and the top or positive side of the mains. There are several types of ballast resistance used in American sets.

The most popular type used is the well-known "line cord." This forms part of a three-core mains lead, although sometimes the resistance wire is wound round one of the other conductors, using it as a former, thus giving the appearance of a twin cable.

When attaching a mains plug to such a lead, the two normal conductors are connected to the two pins of the plug, and the resistance wire also goes to one

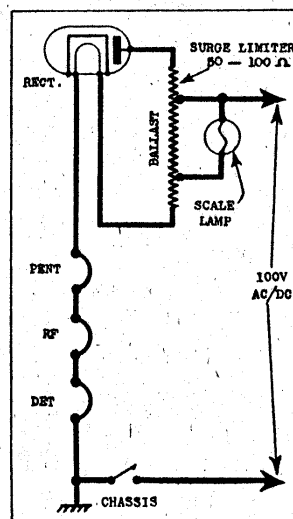


Fig. 2.—An example of the less simple arrangement, where a plug-in type of ballast tube is used. Part of the ballast resistance element is used as a surge limiter, and part as a scale lamp shunt.

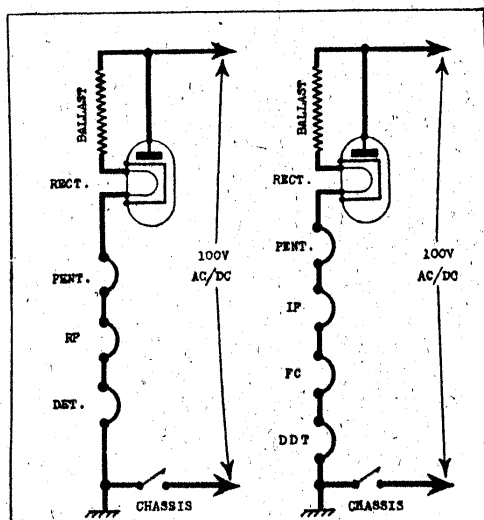


Fig. 1.—Diagrams showing the usual sequence of the valves in the heater chain of the American midget receiver.

Left: The TRF series;
Right: The superhet series.

In many cases there will also be one or more scale lamps included in the chain, as described in the text.

of them, namely, that to which the conductor from the rectifier anode is connected. If the conductors do not bear distinctive colourings, a simple continuity test will identify them.

Other Types of Ballast

The next type in order of popularity, especially in the more recent receivers, is the plug-in type, often miscalled a barretter. This consists of a spiral resistance element supported on mica discs and strung up and down after the manner of the filament of the old vacuum lamps. The whole assembly is mounted on an octal valve base and enclosed in either a glass or metal envelope, but it has not usually the current regulating property of the English type of barretter.

These resistance tubes are made in many types, from the simple untapped element using only two of the base pins,

to comparatively complicated networks using up to six of the pins.

The more complex types provide topplings for special scale lamp connections, but essentially they all simply replace the line cord previously mentioned. They are, therefore, connected at their ends between the anode and heater respectively of the rectifier. If the rectifier anode circuit is provided with a surge-limiting resistance, the connection of the ballast resistance will be on the mains side of the surge limiter.

Surge Limiter Type

A departure from this generalisation, and one which might be very confusing, is found in one type of ballast tube in which one limb of the resistance element is used as a surge-limiting resistance, in series with the mains lead to the rectifier anode. Here the top mains lead would be taken to a tapping on the resistance element, where the surge limiter and ballast sections met, instead of to one end of the element. This arrangement is shown in fig. 2.

A third but less frequently encountered ballast resistance is the "Candohm" type. Most dealers will have met this type in American sets generally, but some may not recognise it by this name. It consists of a wire-wound element on some heat-resisting, insulating former in a flat metal case, and is insulated from the casing by more insulating material. The casing is about $\frac{1}{4}$ in. wide and varies from, say, 2 in. to 6 in. in length, with flat connecting tags projecting at intervals along its length.

The functions of these resistances are similar to those of the plug-in tubes, but sometimes one section of the element is isolated from the rest and used in some part of the receiver circuit, perhaps as the output valve GB resistance.

Cases have been met where the ordinary moulded carbon resistance was used as a ballast, but such cases are rare.

While on the subject of ballast resistances in general, it must be emphasised, more particularly where the line cord type is employed, that the value of the resistance is arrived at on the assumption that the mains voltage is round about 100V, and the drop required is the difference between 100V and the voltage developed across the total heater chain at the rated heater current, usually 0.3 amp. The actual mains voltage rating now adopted by the RMA of America as standard is 117V.

Where the receiver is required to operate from mains voltages in the neighbourhood of 200 V, a second line cord is usually employed (see fig. 3 (a)). It consists of a twin lead, in which one of the conductors is a resistance of the line cord type.

The differences between the two types of line cord, apart from their value, are that one is a three-core while the other is a two-core cable, and that while the resistance element of one carries only the heater current, the other is required to drop approximately 100 V at the total receiver current. It is evident, from queries received in *The Trader* laboratory, that many dealers confuse these two line cords.

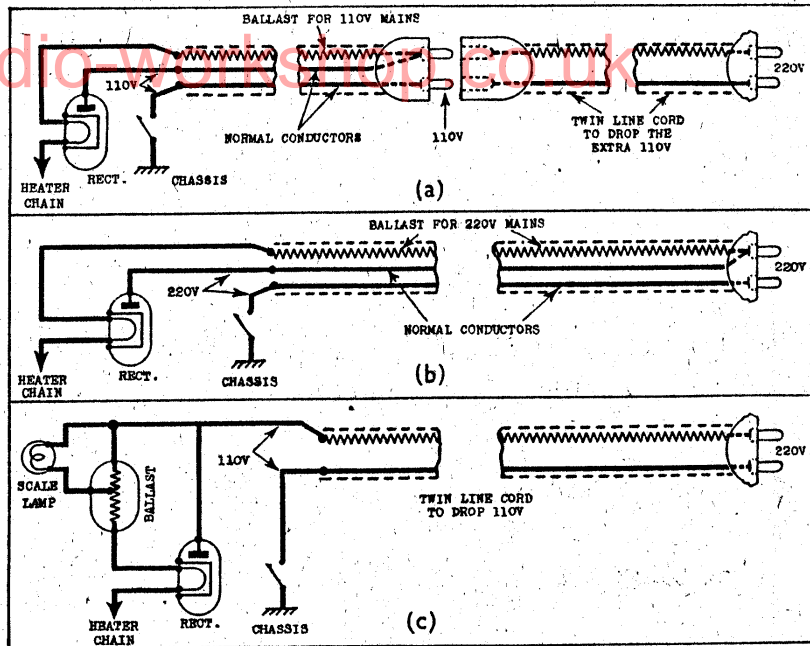


Fig. 3.—Three arrangements of line cords: (a) on the left the normal line cord for a 110V mains receiver. On the right is shown the additional plug-in line cord to operate from 220V mains; (b) line cord permanently attached to a receiver designed to operate directly from 220 V mains only. In (c) the cord is permanently attached for operation from 220V mains, but the receiver chassis is designed for 110V mains and includes a separate ballast tube in the heater circuit.

Value of the Line Cord

Another query that is frequently received is that concerning the value of the line cord. It is a simple matter to arrive at a suitable value by the elementary application of Ohms law. If the cord is one of the ballast type, the heater voltages must first be totalled up, including the scale lamp or lamps if included in series with the chain. If in a TRF receiver three voltages are 6+6+25+25, as is frequently the case, and the scale lamp requires 6 V., the total is then 68 V.

An average value must be taken for the mains voltage, which is usually 100-120 V, and it may be placed at 110 V. For the same reason that no main voltage adjustment is provided, namely, that the American valve heaters have a fairly wide tolerance, an average value is quite safe.

We require then 110 minus 68=42 V drop in the line cord, at 0.3 A. From Ohms law, $R = \frac{42}{0.3} = 140$ ohms, which is the value required. The nearest value commercially available may be used.

The correct method of checking the heater circuit, if a fault is suspected in it, is to insert an ammeter in the heater chain and measure the current, which should be the same as the current rating of the valves. If the test is made on AC mains, an AC ammeter will, of course, be required. An AC voltmeter is useful for locating high or low resistance faults in the chain, where the current is incorrect and the ballast resistance is known to be correct.

If the line cord required is the second

type, to operate a 100 V receiver from 200-240 V mains, the voltage drop may be taken as 220 minus 110, that is, 110 V, but this time the total current demanded from the rectifier (sometimes including speaker field) must be added to the filament current.

Assuming that there is no parallel speaker field, the total anode current must be computed; we will take it as 50 mA, a fairly reasonable value.

We now require a drop of 110 V at $0.3 \text{ A} + 50 \text{ mA} = 0.35 \text{ A}$. From Ohm's law, $R = \frac{110}{0.35} = 314$ ohms to the nearest whole number. Again the nearest commercial cord will do.

200 Volt Models

Cases will be met occasionally where the receiver is sold as a 200 V model. In such cases one of three methods will usually be employed: (a) two line cords joined by a two-pin plug and socket, as described above, in which the two cords can be separated to operate the receiver from 100 V mains; (b) the ballast resistance can be a single three-core line cord dropping the difference between the heater and the mains voltage as previously described for the 100 V model, but dropping a total of 220 V less the 68 V quoted in our hypothetical example, so that 220 V is applied between rectifier and chassis instead of 110 V as would be the case in (a); (c) the receiver is fitted with either a resistance tube or a resistance of the Candohm type, so that without a line cord it would operate directly from 110 V

mains, and a permanently connected or twin-plug connected twin line cord to drop the extra 110 V is employed externally to the receiver. Fig. 3 shows diagrammatically the three arrangements described. It will be observed in the case of (b) that the HT circuit is supplied from a high voltage source, so that HT voltages in the neighbourhood of 200 V are likely to be found.

A fairly recently introduced method of connecting the scale lamp, in addition to the methods referred to earlier and shown in the diagrams in figs. 2 and 3 (c), is to connect the lamp in parallel with the upper section of the heater of a type 35Z5, 40Z5/45Z5, or 45Z5 rectifier, whose heater is tapped and brought out to a pin on the base. The arrangement is shown in Fig. 4, where it will be observed that the anode is fed from the heater tap.

The base connections of the three valves mentioned are the same in each case, and are given in *Service Sheet 522*.

Owing to the ballast action of the scale lamp on the heater, these valves are called "ballast type" rectifiers, and where they

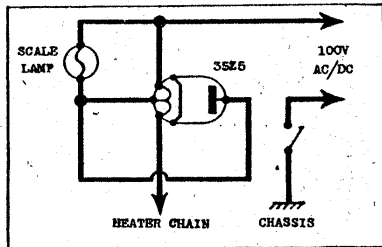


Fig. 4.—Circuit diagram of the connections to the "ballast type" rectifier, with a scale lamp shunted across part of the heater. The anode current flows through the upper section of the heater and its scale lamp.

are used it will sometimes be found that the ballast resistance is dispensed with entirely. This is because what may be termed the 0.3 A convention has been forsaken, and a new series of valves which, like the three rectifiers mentioned, have 0.15 A heaters working at higher voltages than usual has been introduced; when their heater voltages total approximately 100 V, no ballast resistance is required, and more efficient operation is thus achieved.

THE HT CIRCUIT

In most midget receivers the HT circuit is very simple; it usually consists of a thermionic rectifying valve, a smoothing choke, which may be the speaker field, in association with the usual pair of dry electrolytic condensers, from which combination runs the HT positive line. There are, as a rule, no complications in the negative side of the circuit, which consists of the chassis itself, except that the on/off switch is interposed between the chassis and one side of the mains.

Such refinements as air-cored chokes to suppress RF interference from entering the receiver circuit from the mains are dispensed with on the score of economy and compactness, two items which exercise a major influence on the design of

midget receivers, but an RF by-pass condenser is almost invariably connected between the rectifier anode and chassis.

When an energised speaker is used, its field winding may or may not be employed as a smoothing choke. From the point of view of economy it may at first sight appear to be obvious that it should be so employed, but this is not necessarily true.

As has already been mentioned, midget receivers are basically 117 V receivers, and since this voltage is low for reasonably good quality loud speaker work, volts are at a premium.

On the other hand, the HT current demand by the set itself is not usually heavy enough to load the rectifier fully—and a rectifier with a larger output can be fitted if necessary anyway—so that it is quite reasonable on the score of efficiency to connect the speaker field across the HT circuit, where it increases the total HT current, but causes only a small loss of volts by increasing the load on the rectifier.

This arrangement of parallel-fed speaker field will often be found in midgets, and in some cases a separate smoothing choke may be used as well. In many cases, however, the usual position of the smoothing choke is taken by a resistance, as shown in Fig. 5. In some cases in very cheap models there is not even a resistance, so that the entire HT line smoothing is accomplished by a single reservoir condenser connected between the rectifier cathode and chassis.

Where a resistance is used in place of the smoothing inductance, it will usually be found that unsmoothed HT is fed directly from the rectifier cathode to the output valve, at least in its anode circuit, as indicated in Fig. 5. This is because the output valve anode current is large compared with that of all the other valves, and its own screen, put together, and if it were passed through the smoothing resistance the voltage drop across the resistance would be increased and might even be trebled in some cases, thereby considerably reducing the available voltage.

There is every justification for this arrangement, because it provides the maximum number of watts at the point

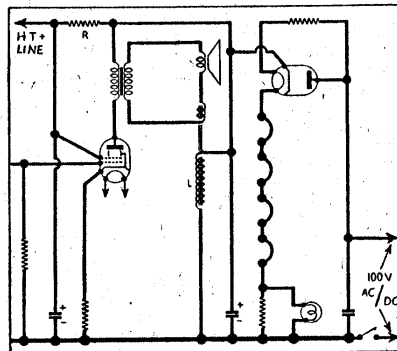


Fig. 5.—An example of the use of resistance smoothing and shunt-fed or parallel-connected speaker field. R is the smoothing resistance, and L the speaker field. A scale lamp, shunted by a resistance, is seen at the bottom of the heater chain.

where actual power is required, and the gain, which would magnify the hum voltage, is negligible. What hum there is, is

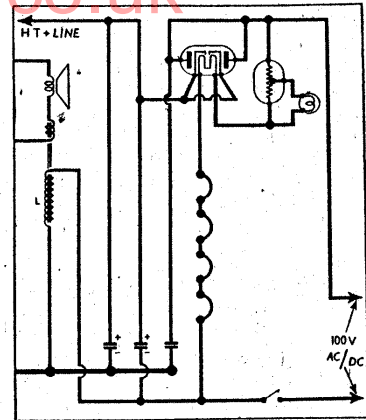


Fig. 6.—Part of the circuit of some Detrola receivers, where the speaker field is series-fed and employed as a smoothing choke in the negative side of the HT supply.

swamped by the signal, which is at its maximum here.

"Hum Bucking" Coil

In the valve circuits in earlier parts of the receiver, on the other hand, a slightly lower HT voltage can be tolerated, while any considerable amount of hum cannot, because the gain from such points onwards is high.

The foregoing remarks apply equally to cases where permanent magnet speakers are used, when the smoothing arrangements are independent of the speaker.

In most cases where an energised speaker is used, a neutralising or "hum bucking" coil is fitted as in the standard English commercial receiver, but sometimes a case will be met where the neutralising coil is dispensed with. It is difficult to see why it is not fitted, and we can only hazard a guess that the speaker does not require hum neutralisation because it is incapable of reproducing the hum frequency, which, it must be borne in mind, is 50 C/S with a half-wave rectifier on 50 C/S mains.

Two departures from the more general methods described are to be found occasionally in individual cases. One is where the speaker field is parallel fed, but has a low valued biasing resistance connected between its low potential end and chassis, as in the Firestone "Air Chief", where the value of the resistance is 125 ohms. The cathode of the output valve is returned to the junction of the resistance and the field, and so attains a positive potential with respect to the control grid, which is returned to chassis. The valve cathode current and the speaker field current combine to flow through the biasing resistance.

The other case is one where the speaker field is included in the negative HT lead to chassis instead of the positive lead as usual. This style is adopted in some Detrola receivers, and its circuit is shown in Fig. 6.

It will be seen that the field winding is in series with the mains lead to chassis,

"TRADER" SERVICE SHEET

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AMERICAN MIDGETS

PART TWO: CIRCUIT PROPER

WE have seen various ways in which the power is obtained for amplifying the signal in American midget receivers. Now we will consider how that microscopical volume of energy, the signal, is dealt with when it arrives and causes electrons to surge to and fro in the piece of wire that hangs out of the back of the midget.

The piece of wire is the aerial, and the earth circuit is completed mainly via the mains. Between the two, in series with them in the conventional manner, is usually a coupling coil, or two in series in many cases, with the tuning coil or coils wound close to it on the same former to obtain inductive coupling. To the top end of the tuning coil will be connected the fixed vanes of the tuning condenser (usually part of a two-gang unit) and the control grid (almost universally the top cap) of the first valve.

In many of the TRF receivers, the bottom ends of the coupling and tuning coils are connected directly to chassis, and a potentiometer is connected across

place of the conventional bias resistance in the cathode of V1. As the slider is raised, the value of resistance across the coupling coil is reduced, thus progressively increasing the damping across the aerial circuit and so reducing the input voltage, while the resistance in the cathode circuit correspondingly increases, raising the voltage drop, and therefore the bias voltage, thus reducing the gain of V1.

In this arrangement there is another advantage which may not be obvious at first sight. When a strong signal is being received, it is reduced in magnitude before it is handed on to the RF amplifier at the same time as the bias is increased, and if the resistance value is well chosen, so that the aerial damping increases with a suitable ratio of bias to suit the changing slope of the valve, cross-modulation through overloading the grid will be avoided.

The diagram in Fig. 8 shows the complete input circuit of a common type of single waveband receiver from the aerial to V1. It will be seen that a by-pass condenser is connected between the cathode and chassis, and a series condenser, to isolate the aerial from the coupling coil which is metallically connected to the mains, is included in the aerial lead.

Sometimes this condenser is omitted, and any dealer who comes across a set without one, whether in servicing or in stock, would be well advised to fit one, because otherwise, if the aerial lead happens to touch an earthed conductor, such as a gas stove, a gas bracket or almost any pipe, it is most probable that the coupling winding of the aerial unit at least, if nothing further, will burn out. The capacity of the condenser is in no way critical, and as the aerial circuit is of fairly high impedance, a small one, say $0.0005\mu\text{F}$, will do, while anything larger can be used. The working voltage, however, is important, and should exceed the mains voltage by a comfortable margin, especially for AC mains operation. It should, of course, be non-inductive.

The single turn shown above the tuning coil in Fig. 8 is a small "top" coupling, and is found in most midgets. It is not very important, but it might arouse the curiosity of the observer because it looks very much as though it has been tied round to hold the assembly together during manufacture, perhaps prior to waxing, and as a rule it can be cut off without apparently affecting the performance of the set.

Another method of obtaining "top" coupling, which is mainly capacitive, is to twist the lead connecting the tuning condenser to the tuning coil round the connecting lead from the aerial to the coupling coil.

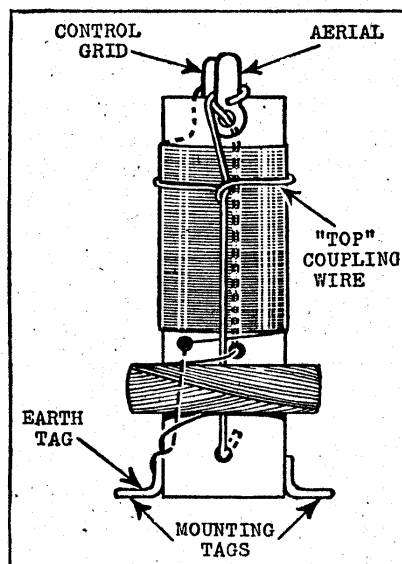


Fig. 9.—Sketch showing the construction and connections of a single band aerial coil. The same type is used on TRF and superhet receivers.

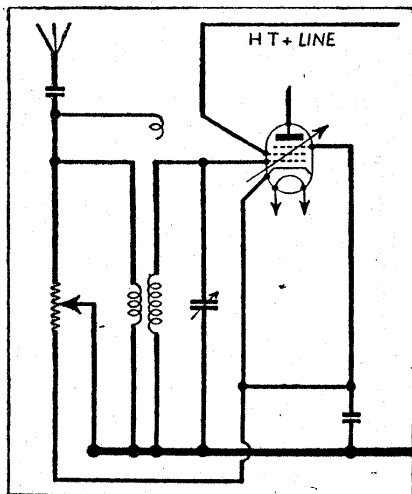


Fig. 3.—A popular form of dual-action volume control in TRF receivers. The aerial circuit is damped as the GB is raised.

the aerial circuit to operate as the volume control. One end of it is connected to the aerial, the other to the cathode of V1, which is an RF pentode with variable- μ characteristics, while the slider goes directly to chassis. The circuit is shown in Fig. 8.

This arrangement exhibits another example of the economical design of the midget. Diagrammatically, the upper portion of the control is across the aerial circuit, and the lower portion takes the

The style of assembly usually adopted is shown in the sketch in Fig. 9, where the "top" coupling wire is indicated. The brackets by which it is mounted are actually connecting tags, which are soldered to the chassis; one of them is used as the earthing tag of the assembly.

Where two wavebands are provided, the second one is usually LW, added for European use. This is done in such cases by winding on to the former a third coil, somewhat like the coupling winding in shape, and at the opposite side of it relative to the MW winding. This LW coil is then connected between the bottom of the MW coil and the chassis, with a switch across it to close for MW operation.

Sometimes, especially in more recent productions, the theme is elaborated, and a separate coupling winding is provided for each waveband. This requires an additional switch to short-circuit the LW coupling coil for MW operation.

Where departures are made from the foregoing general case, they usually affect only the method of volume control. Occasionally this will form part of a potential divider across the HT circuit, the cathode of V1 being joined to the junction of the potentiometer and a fixed resistance, which runs up to HT positive, the potentiometer slider going to chassis while its lower end is unconnected; or the cathode may be connected to the slider of the

potentiometer, whose lower end would then go to chassis.

There may also be a fixed limiting resistance, to prevent the cathode from reaching chassis potential when the volume control is turned up, reducing the GB potential. If so, in the former case it would be inserted between the potentiometer and the first fixed resistance, while the cathode would be connected to the junction of the two fixed resistances; and in the latter case it would be connected in series with the slider of the potentiometer.

These two arrangements are shown in Fig. 10, where the values marked are those which have been found in typical receivers.

The aerial circuits of the superhet midgets are simpler than those of the TRF models, since the complications introduced by the volume control are avoided. Otherwise they are similar, apart from the introduction of AVC, except in cases of special design.

Where AVC is used, the bottom of the tuning coil, or the bottom of the lower coil if two are in series, is disconnected from chassis and connected instead to the AVC line, the coil being earthed to RF via the usual fixed condenser.

Arrangements other than those described are used, but not generally, so they are not mentioned here. Sometimes the second band will be SW, but this is not general.

The TRF Receiver

The first valve in the receiver will usually be a variable- μ RF pentode in the case of the TRF type, or a frequency changer if the receiver is a superhet. In the TRF, a variable- μ pentode valve of the 6D6 or 12K7G type will usually be employed, and it will be coupled to the second valve, a detector of the 6C6 or 12J7G type. These latter are non variable- μ RF pentodes, and may operate on the grid leak or anode bend system. The coupling between the two valves is effected via an RF transformer somewhat

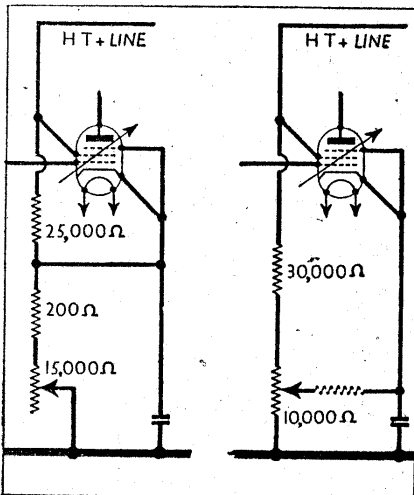


Fig. 10.—Other forms of volume control often found in TRF midgets. The values given in the diagrams may be taken as typical.

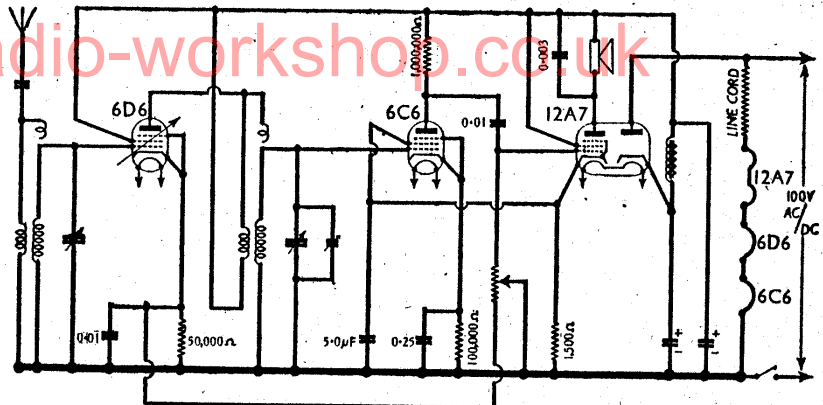


Fig. 11.—Complete circuit diagram of the Kadette "Jewel" midget receiver. An unusual volume control arrangement is used, and the speaker is of the moving iron or "cone" type. Anode bend detection is used.

like the aerial transformer shown in Figs. 8 and 9.

The primary winding is, as a rule, differently arranged, and will probably be wound quite separately from the secondary, on a small bobbin fitted inside the secondary former and at right-angles to it. If the larger winding shown at the bottom of the assembly in Fig. 9 is present it will usually be the long-wave secondary in a two-band receiver.

The primary will be connected directly between the HT positive line and V1 anode, while the secondary will be effectively, but not necessarily directly, between V2 control grid and chassis. If it is connected directly, then the detector is of the anode bend type, and a resistance of fairly high value, say 100,000 ohms, will be found connected between the cathode and chassis, by-passed by a condenser, as shown in Fig. 11.

Where the grid leak system is used, the arrangements may be quite conventional, with a small condenser connecting the control grid and coil and a 1,000,000-ohm or 2,000,000-ohm grid leak between control grid and chassis or across the grid condenser.

In later types, however, the arrangement is different. The grid leak and condenser are connected between the coil and chassis, and the values are something like 2,000,000 ohms to 5,000,000 ohms and 0.05 μ F respectively. The type of detection used, of course, depends on what position on the grid-volts/anode current curve is taken by the grid, as a result of the grid current flowing through the grid leak in the case of leaky grid, and it is sometimes not quite clear from an inspection of the diagram to decide what system is used. Examples are seen in Figs. 12 and 14.

In one Detrola receiver employing two wavebands (MW and LW), the two sections of the secondary are separated by a 0.05 μ F condenser, while the top of the MW coil goes directly to the control grid and the bottom of the LW coil to chassis. The bottom of the MW coil is taken via a 2,000,000-ohm resistance to an automatic bias point in the negative side of the HT circuit, presumably for anode bend detection.

The HT feed resistances to the anode and screen of the pentode detector have high values, and the screen feed will be much higher than that for the anode. This latter, which is, of course, the load resistance, may be about 1,000,000 ohms, while values as high as 6,000,000 ohms have been found in screen feed resistances. Sometimes the screen will be taken directly to the cathode of the output valve, as in the case of the Kadette "Jewel" shown in Fig. 11.

A heptode valve operating as the frequency changer will usually be the first valve in the superhet type of receiver, which is fairly straightforward generally. All kinds of arrangements for switching, tracking and reaction coupling are found, but this is also the case with normal domestic receiver design.

In some two-band oscillator circuits, two tuning coils and two tracking condensers are all connected in series between the oscillator grid condenser and chassis, while the tuning condenser, of course, shunts the lot. The waveband switch joins the junction of the two coils to the junction of the two trackers for MW operation, short-circuiting the LW coil and tracker.

When aligning a set with this type of circuit, it is necessary to align the MW band first, and not to touch the MW tracker once that part of the alignment is completed, since on LW the two trackers are in series. In such a case, the MW tracker can be identified by virtue of the fact that one side of it is connected to chassis.

Unusual Oscillator Circuits

An unusual oscillator circuit was found in the Detrola "Pee Wee" Super 201, where the basis of the circuit was a simple LW tuning and reaction coil, with pre-set trimmer and tracker condensers. For MW operation, however, another coil was connected right across the circuit, that is, from grid condenser to chassis, via a two-position switch in the earthy end of the second coil. In the LW position of the switch, a second pre-set trimmer replaced the MW coil, so that the first (permanently connected) trimmer would need to be adjusted on the MW band, while

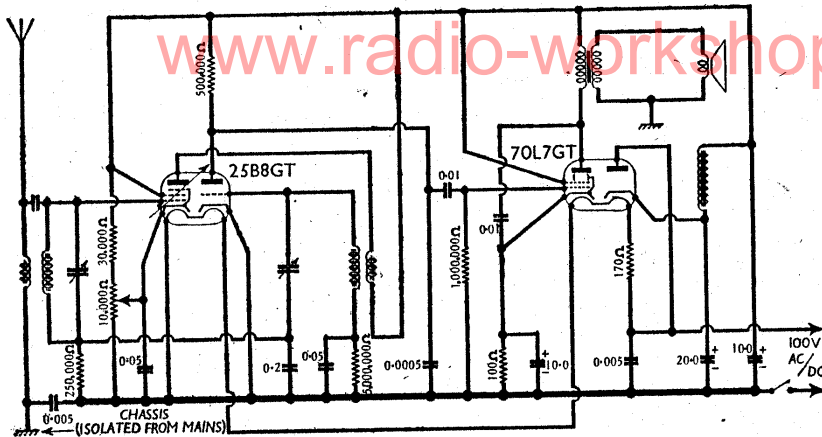


Fig. 12.—Circuit diagram of the "Mighty Mite" midget, whose valve complement consists of two multiple valves only. The aerial and detector circuits are not typical of midget practice, and iron-cored coils are used. The chassis is isolated from the HT circuit and mains.

the switched one would be adjusted on LW. Here again alignment should be commenced on the MW band.

Ordinarily, the reaction circuit is very simple, and consists of a reaction coupling coil connected directly between the oscillator anode and HT positive line. Sometimes this is varied, and the popular arrangement used in British domestic receivers, where the oscillator anode is fed from HT via a resistance, and coupled to the reaction coil by a condenser, is employed. The earthy end of the reaction coil may then be returned to chassis directly, or via a tracking condenser if tighter coupling is required.

Another unusual arrangement is that used with the 12SA7 type of valve, which has no oscillator anode electrode. A conventional oscillator tuning circuit is connected between the first grid and cathode of the valve, but the cathode returns to chassis via the oscillator reaction coil, so that the energy for oscillation is obtained from the current in the cathode circuit of the valve.

12SA7 Connections

If this valve is met in practice some confusion may arise in the mind of the operator, unless he bears in mind the base connections, because, although the valve is fitted with an octal base, the connections do not conform to the standard American octal arrangement. The electrodes are connected as follows: pin 1, blank; 2, heater; 3, anode; 4, screen; 5, oscillator control grid; 6, cathode; 7, heater; 8, signal control grid. There is no top cap connection, the valve being of the single-ended type.

The output from the frequency changer is amplified in the ordinary manner by an IF amplifying stage, using the usual IF transformers and a variable-mu RF pentode valve, and passed on to a double diode triode valve.

The signal diode circuit is usually simple and conventional, and the volume control operates as the diode load resistance. The two diode anodes are generally strapped together.

AVC is then obtained from the DC potential developed across the volume

control, and fed back through a decoupling circuit consisting of a resistance and a condenser to the two earlier valves.

Sometimes, when the diodes are not strapped, the second diode is fed from the high potential end of the second IF transformer secondary via a high-value resistance, and the AVC line is connected directly to the AVC diode. An example of this can be seen in our *Service Sheet* No. 479, which deals with the Pilot "Major Maestro" receiver.

The Output Stage

The rest of the circuit is usually very straightforward, and is the same in superhets or TRF receivers. Resistance-capacity coupling is used from the triode section in the superhet or the pentode detector in the TRF to a pentode output stage.

Recently, a great many new types of valves have been introduced in America, and their introduction into midget receivers is having the effect of complicating what was a very simple receiver. Most of the new sets employ beam tetrode output valves, and these are, of many types. The general arrangement of output circuits is not influenced very much, however; the complications are more pronounced in the early stages.

From the foregoing descriptions in this sheet and *Service Sheet* 589, sufficient information will have been gathered to give a good idea of the arrangements employed in all the common types of midget receivers without the need for the makers' information on the particular receiver which it is desired to service.

It is, however, impossible to give any general information that will assist in the case of special designs, many of which have found their way into this country recently, and for which only very few copies of circuit diagrams are available even in those cases where they accompanied the sets.

Later Developments

It is now proposed, therefore, to deal rather with departures from the previous generalisations, and to describe some special cases, in connection with which complete midget receiver circuit diagrams

are given in Figs. 11, 12 and 14. It must be borne in mind, however, that such innovations as are found here are not general, and may in some cases be found in only one receiver or one make of receiver.

One part of the circuit which has suffered very little change is the heater circuit, and the introduction to this series, which dealt exclusively with this aspect of the midget, may be said to apply in practically every case. The principal change that has occurred here is the general adoption of lower heater currents and higher voltages. The standard current value has changed to 0.15 A, and heater voltages have risen in many cases to 50 and 70 V.

Multiple Valves

It is unusual to find more than four valves, including the rectifier, in a TRF receiver, or five in a superhet. Sometimes cases are found in which more than this are used, and in one Emerson midget an untuned triode valve preceded the receiver proper, which was otherwise a reasonably normal TRF type. This should not cause any difficulty from the point of view of servicing, because the valve can do little more than act as a buffer, and can be short-circuited for test purposes, by connecting the aerial, via a condenser, to its anode.

One feature that was not mentioned was the use of multiple valves, in which, perhaps, an RF pentode and a triode, or an output tetrode and a rectifier, are housed in the same envelope, with their two heaters joined in series. Examples of this are seen in the diagrams of the "Mighty Mite" and the Kadette "Jewel," where the 25B8GT, 70L7GT and 12A7 valves respectively are used. This does not, however, call for any modification to our articles on heater circuits. The base connections of the 25B8GT and 70L7GT were published in our *Service Sheet* No. 522, while that for the 12A7 is given in Fig. 13.

A completely isolated aerial circuit and chassis are found in the Mighty Mite, so that the chassis could be connected directly to earth if desired, and the control spindles and other metal parts are "safe" from the mains. The chassis is used here only as a frame on which to build the receiver, and the receiver circuit does not come into direct metallic contact with it except in the aerial and speech coil circuits.

Isolated Chassis

The normal "chassis line" in the diagram of this receiver represents what may be termed the HT negative line, and not the chassis. The aerial, coupling coil and chassis are in metallic contact with one another, and if the chassis is earthed the aerial cannot become "live" to the mains even by the charging up of the aerial and earth coupling condensers, because the whole circuit is maintained from a DC point of view at earth potential.

Cases where the chassis is isolated from the HT circuit are to be found in several receivers, and if this point is borne in mind, some considerable time spent in searching for a "dis" can be saved when servicing one of these receivers.

A system of dual action volume control not previously mentioned in these articles is shown in the Kadette diagram. Here,

the stator of the volume control is connected between the RF valve cathode, which already has a fixed GB resistance of very high value, and the output pentode control grid; the slider goes to chassis.

As the control is turned up (slider moving downwards in the diagram in Fig. 11), the bias resistance becomes progressively more shunted by its section of the volume control, while the resistance in the output valve control grid circuit rises. As the control is turned down, the RF valve bias voltage rises as the shunting effect is reduced, while the output valve control grid resistance is also reduced.

In the case of the output valve, the coupling condenser and the CG resistance form a potential divider across the output of the detector valve, the signal

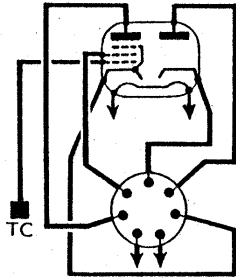


Fig. 13.—Basing of the 12A7 valve.

being taken from their junction, and when the CG resistance has a low enough value, a considerable proportion of the signal is developed across the coupling condenser, the effect increasing as the volume control is turned farther down.

Since the signal applied to the output valve is only that across the CG resistance, therefore, the control governs the proportion of the available signal to be handed on to the output valve.

This type of circuit has a marked frequency discriminating characteristic also, however. The impedance of a con-

denser is inversely proportional to frequency, while a resistance is constant irrespective of frequency, so that when a considerable percentage of the signal is dropped across the coupling condenser, bass attenuation will preponderate, and the receiver will, therefore, tend to boost high notes as the volume control is turned down. This tendency may, of course, be compensated elsewhere, perhaps in the speaker, which is of the moving iron type.

The "Mighty Mite"

The Mighty Mite provides an interesting example of the use of multiple-type valves. Two multiple valves here comprise the entire valve complement of an otherwise four valve (including rectifier) circuit.

The circuit diagram is difficult to draw clearly, although it is only of a simple TRF receiver, because the two sections of each valve must be shown in one envelope.

The aerial input is handled by the RF pentode section of the 25B8GT, and volume control is of a type described earlier and shown in Fig. 10. The output from the anode circuit is then passed via an RF transformer to the triode section, which operates as detector with the high time-constant type of grid leak and condenser in the low-potential end of the tuning circuit.

Some form of coupling, probably for reaction, is introduced by returning the aerial and RF tuning condensers to HT — via a common impedance consisting of a 0.2 μF condenser. Reaction will be controlled by the volume control. The 250,000-ohm resistance across the 0.2 μF condenser provides a DC return path for the pentode CG circuit to HT negative.

Resistance-capacity coupling then carries the signal over to the output tetrode section of the 70L7GT valve. The rectifier section is connected in the conventional manner, the speaker field being used as the smoothing choke.

It appears probable that in some versions of this receiver two separate valves, a 50L6GT and a 35Z5 are used instead of the second valve. This will introduce

only a slight modification to the circuit diagram, and in the chassis it will mean simply three valve holders, suitably wired, instead of two, although it may be necessary to alter the value of the 170-ohm ballast resistance.

An example of resistance-capacity HT circuit smoothing is to be seen in the diagram of the Firestone "Air Chief," given in Fig. 14. The speaker field is shunt fed across the rectifier output, and its current, and that of the output valve cathode, combine to develop grid bias for the valve across a 125-ohm resistance. The HT supply to the output valve is smoothed, but not as well smoothed as that to its screen and the rest of the circuit.

One rectifier arrangement not mentioned earlier is that where a valve of the 25Z5 class is used with its anodes strapped but with its cathodes separately connected. One cathode is then used to supply HT to the receiver in the normal manner, while the other provides an independent HT supply to the speaker field, which is, therefore, shunt-fed. This is not really very different from the normal shunt-fed circuit, except that there are two HT circuits, but it may be misleading if encountered by an operator who is not prepared for it.

It is not proposed to describe here special types of valves, with exception of those already mentioned. Some types are, however, already covered by our Service Sheet 522.

Conclusion

It is virtually impossible at the moment to cover all types of circuit to be met in American midget receiver practice, because there are, speaking literally, dozens of them. The vast majority, however, fall into a fairly common general scheme, and if the reader has managed to absorb all the information offered in this series, some of which is written from mental recollections, some from information loaned by F.R.I., Ltd., to whom we offer our sincere thanks, and some by careful examination of chassis on which no information is available, he should, it is hoped, be capable of tackling service on this type of set without qualms and without circuit diagrams.

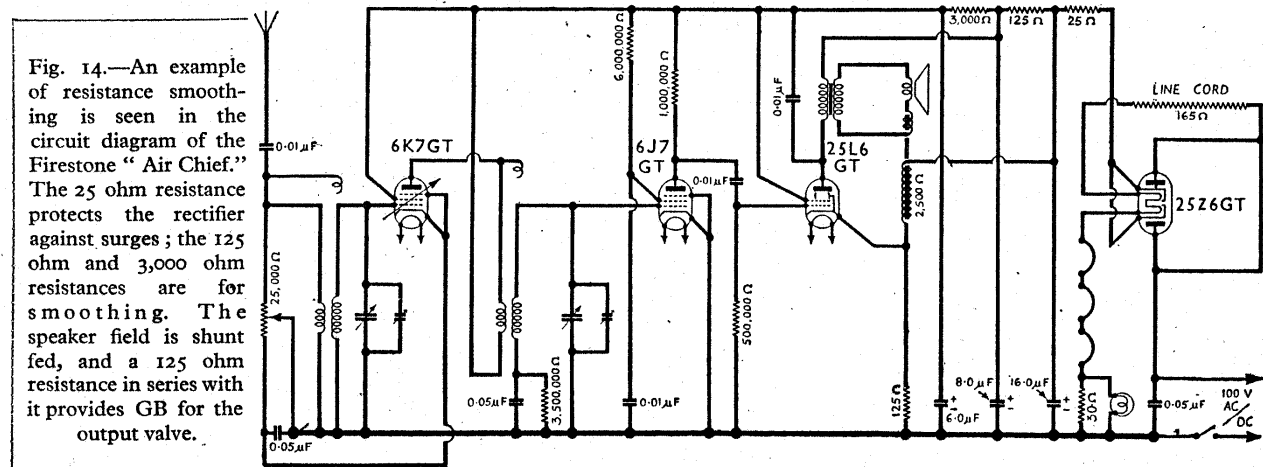


Fig. 14.—An example of resistance smoothing is seen in the circuit diagram of the Firestone "Air Chief." The 25 ohm resistance protects the rectifier against surges; the 125 ohm and 3,000 ohm resistances are for smoothing. The speaker field is shunt fed, and a 125 ohm resistance in series with it provides GB for the output valve.