"TRADER" SERVICE SHEET 590

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

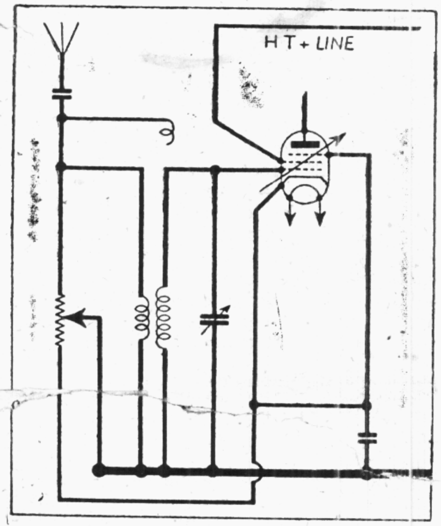

Fig. 8.—A popular form of dual-action volume control in TRF receivers. The aerial circuit is damped as the GB is raised.

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-mu 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 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 0.0005μF, 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 capacitative, is to twist the lead connecting the tuning condenser to the tuning coil round the connecting lead from the aerial to the coupling coil.

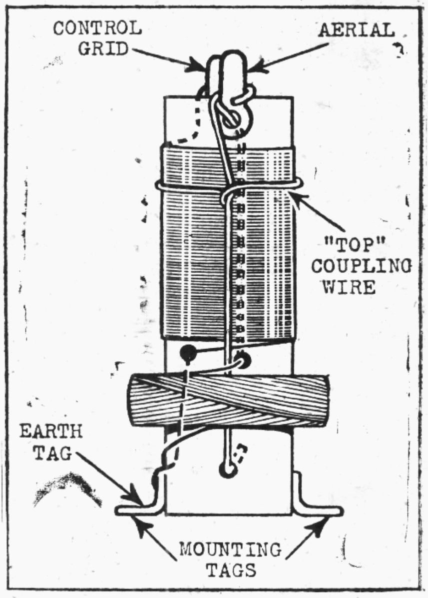

Fig. 9.—Sketch showing the construction and connections of a single band aerial coil. The same type is used on TRF and superhet receivers.

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-mu RF pentode in the case of the TRF type, or a frequency changer if the receiver is a superhet. In the TRF, a variable-mu 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-mu 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 like the aerial transformer shown in Figs. 8 and 9.

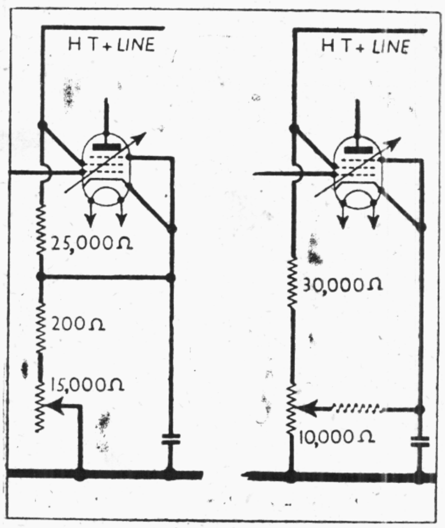

Fig. 10.—Other forms of volume control often found in TRF midgets. The values given in the diagrams may be taken as typical.

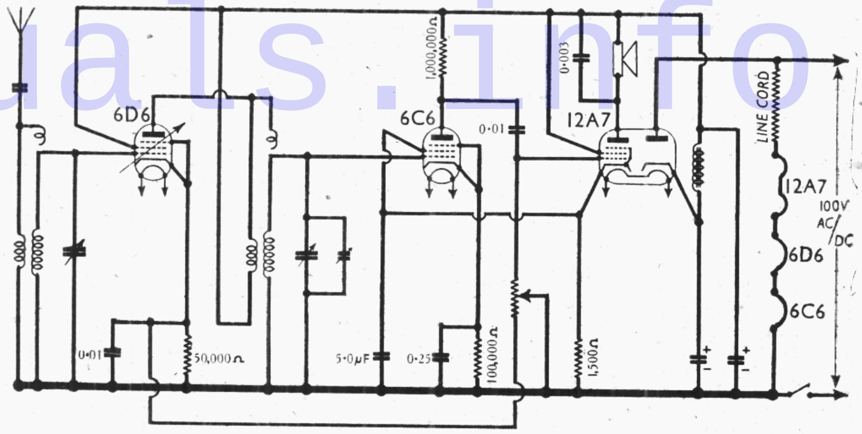

Fig. 11.—Complete circuit diagram of the Kadette "Jewel" midget receiver. An unusual volume control arrangement is used, and the speaker is of the moving iron or "cone" type. Anode bend detection is used.

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 μF 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 μF 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 preset 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

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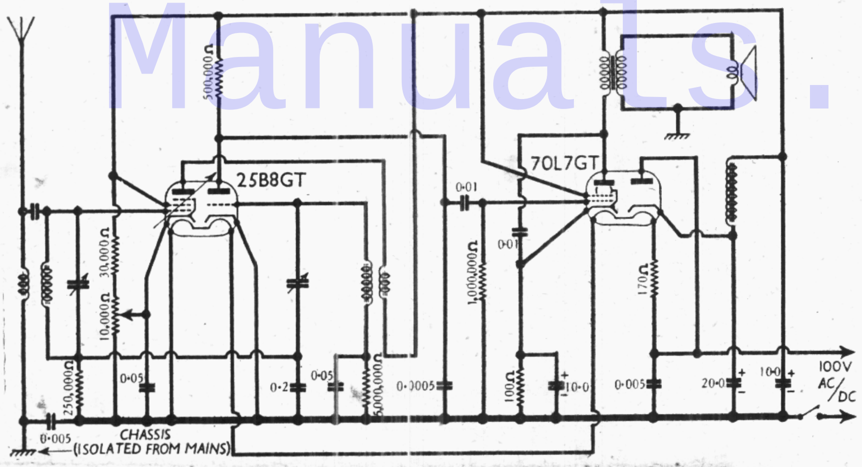


Fig. 12.—Circuit diagram of the "Mighty Mite" midget, whose valve complement consists of two multiple valves only. The aerial and detector circuits are not typical of midget practice, and iron-cored coils are used. The chassis is isolated from the HT circuit and mains.

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 .. . 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

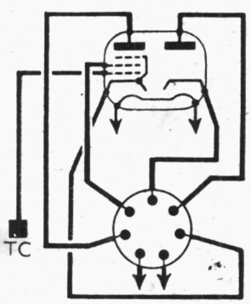


Fig. 13.—Basing of the 12A7 valve.

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 condenser 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.

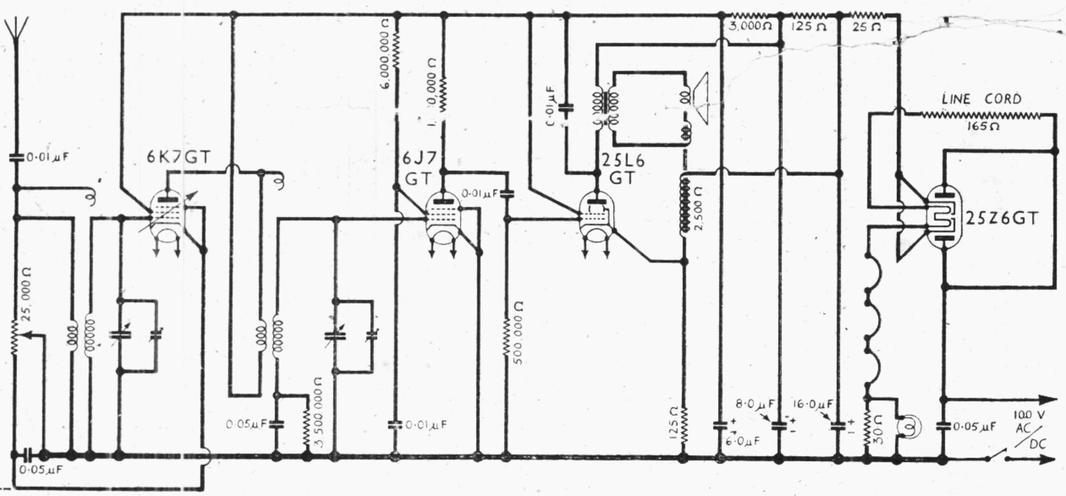
One rectifier arrangement not mentioned earlier is that where a valve of the 25Z5 class is used with its anodes strapped but with its cathodes separately connected. One cathode is then used to supply HT to the receiver in the normal manner, while the other provides an independent HT supply to the speaker 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.



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