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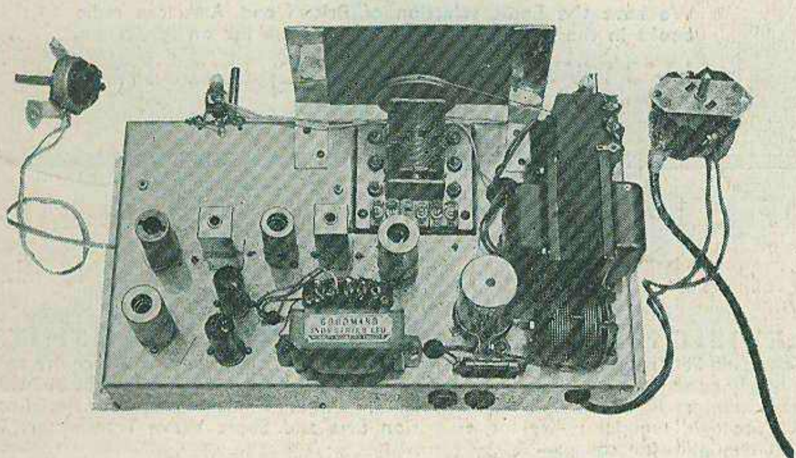
The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

The MAGNA-VIEW



Quality Radio Unit

ALSO
IN THIS ISSUE . . .

A VALVE MULTIMETER
TOM THUMB—A MANTELPIECE RECEIVER
Hum Reduction · Audio Pre-Amplifiers
Mains operated Photoelectric Relays · Radio Miscellany
Radio Control Equipment · Daylight on Meters · Query Corner
Volume Control by Triodes etc., etc.

1/6

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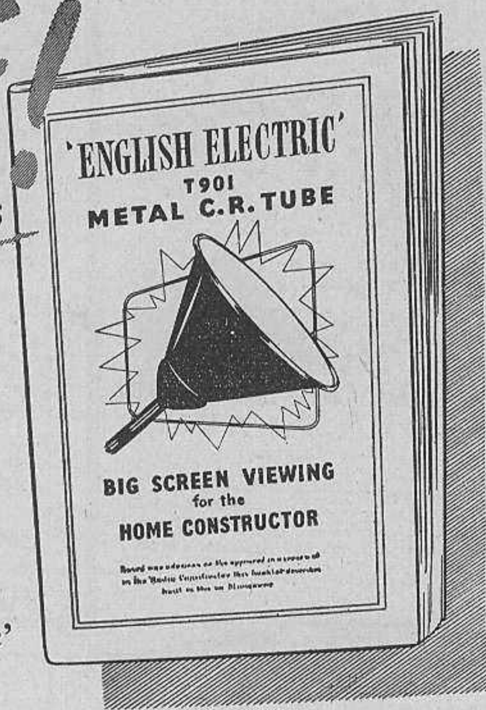

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Edited by C. W. C. OVERLAND, G2ATV

CONTENTS

NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but relevant information should be included. All Mss must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57 Maida Vale, Paddington, London, W.9. Telephone CUN. 6518.

A Companion Journal to THE RADIO AMATEUR

Suggested Circuits for the Experimenter

The circuits presented in this series have been designed by G. A. FRENCH *specially for the enthusiast who needs only a circuit and the essential relevant data*

No. 28 Volume Control by Triodes

The problem of controlling AF volume in an amplifier by means of a separately developed DC voltage is usually solved by applying the DC voltage to a suitable grid of a variable-mu valve included in the amplifier chain. This method has the disadvantage of introducing distortion unless the variable-mu valve works at a low amplitude level.

In this month's Suggested Circuit we show an alternative system which, if used carefully, should introduce hardly any distortion at all; and which can be employed at any reasonable amplitude level.

The basic circuit of the system is illustrated in Fig. 1. In this diagram the AF voltage appearing at the anode of V1 (an amplifier valve) is applied, via R2 and the capacitor C1, to the grid of the following stage. A second valve, V2, has a variable source of negative grid bias (controlled by R3), and is connected between R2 and chassis. R2 and the anode resistance of V2 form a potentiometer, the capacitor C1 being connected to its "tap." The ratio between the two elements of the potentiometer can then be varied by altering the anode resistance of V2. Thus, when R3 is set to give a cut-off voltage, the anode resistance of V2 is infinity, and the AF passed to the following stage is not attenuated. If, on the other hand, R3 is adjusted to give zero

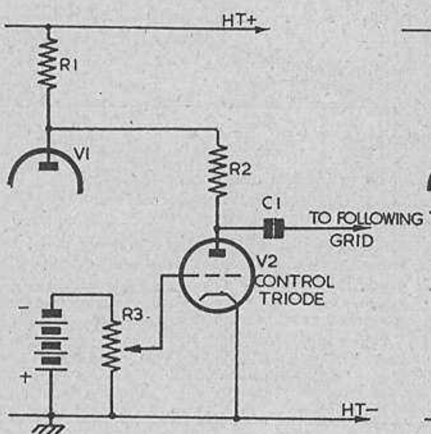

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FIG. 1

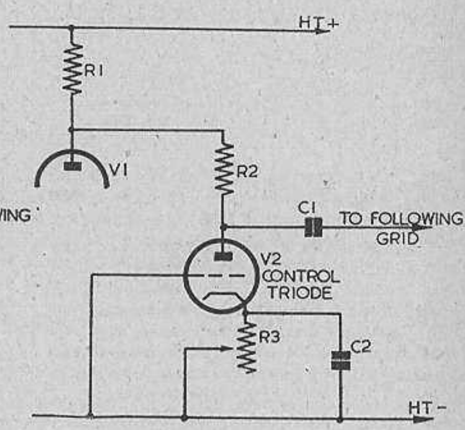


FIG. 2

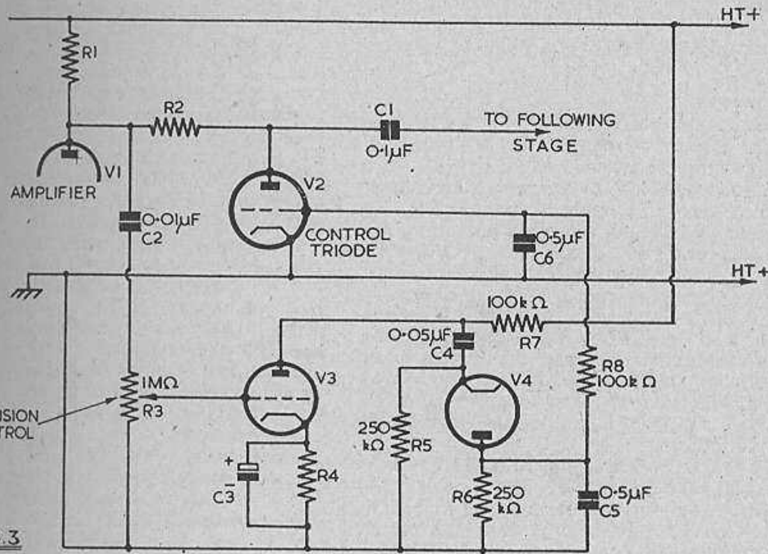


FIG. 3

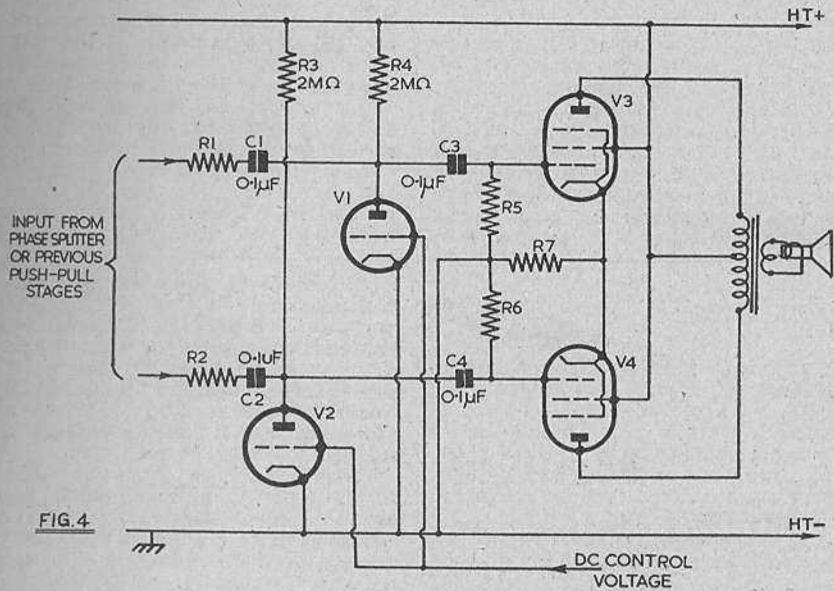


FIG. 4

RC133

grid bias, the anode resistance of V2 is at its lowest, and heavy attenuation takes place. The degree of AF attenuation given by the circuit can, therefore, be controlled by adjusting R3.

Limitations

There are several limitations to the usefulness of the circuit. Firstly, it is impossible to obtain complete attenuation of the AF, since the anode resistance of V2 cannot be brought down to zero. Secondly, the value of R2 has to be made large for adequate operation, and also to prevent the circuit from reducing the effective anode load of V1. (For this latter reason R2 should have a value at least twice that of R1). This high value for R2 necessitates, in its turn, a low input capacitance for the following stage, since the higher audio frequencies might otherwise be attenuated. Due to Miller effect it may therefore be necessary to use a pentode, and not a triode, in the following stage.

A point to notice is that full attenuation is given when the grid of V2 is most positive, and not, as in the variable-mu system, when it is most negative. Because of this, the circuit cannot be used in conventional corrected AVC systems, etc., without additional components.

Remote Volume Control

As it stands, the circuit of Fig. 1 may be used for a practical remote volume control; R3 being fitted at the remote point. An alternative and simpler method is shown in Fig. 2. Here, the control of volume is effected by a variable cathode resistor R3, which may also be installed at a remote point. The usefulness of this circuit is, however, restricted by the fact that complete attenuation cannot be obtained.

Expansion and Compression

Because the volume control circuit may be used at any reasonable AF level and because it introduces negligible distortion, it is extremely useful for compression, expansion and similar systems. (For such applications the inability to provide complete attenuation is not of great importance). An instance is illustrated by Fig. 3, where the circuit is used for expansion. Fig. 3 is somewhat similar to the expansion circuit given by Suggested Circuits some months ago, with the exception that the original 6L7 control valve is now replaced by the triode, and that the diode is reversed. Additionally, no bias supply is now needed. If, however, it is found that too heavy an attenuation is given at low volume levels, the resistors R5 and R6 may be returned to a variable source of negative bias (relative to chassis) instead of to chassis itself. Suggested values are given to those components in Fig. 3 which are not experimental or do not depend upon valve characteristics. Both V2 and V3 may be 6J5's, or similar types.

Another circuit is given in Fig. 4, in which two control triodes, V1 and V2, are used to control two push-pull valves, V3 and V4. (V3 and V4 are shown here as output valves). The particular point of interest of this circuit lies in the fact that, even if AF is present on the DC voltage controlling the triode grids, (with the result that it is then applied to the grids of V3 and V4), it is cancelled out in the output transformer. This has the immediate advantage of allowing expansion or compression to be obtained without the time delay given by the usual heavy AF filtering in the DC control line. The valves V1–V2 and the resistors R1–R2 and R3–R4, will need to be matched.

from our Mailbag

8-10 Watt Amplifier

Dear Sir,

It was with considerable interest I read the article on an 8-10 watt amplifier by K. R. Piper in your February issue.

However, I can't help feeling — without wishing in any way to question the author's knowledge — that there must be a snag in the combined phase-split, push-pull output stage, for if not why has it not been used before in hi-fi amplifiers? I know everything has to start with somebody's idea but so much research has been done on amplifiers in recent years and so many excellent designs published that I should have thought this present arrangement would have been used before — or has it and I've missed it? It seems one of those things that are too good to be true!

Perhaps Mr. Piper or another reader can supply a clue through the medium of your excellent journal which I'm sure would be of general interest. What is the performance, for example, from the distortion and frequency response viewpoints of the arrangement compared with the normal system with separate phase-splitter of one of the various types, and does it really take no more driving power than a single ended output stage?—

J. B. K. GOUGH (Carshalton Beeches, Sy.)

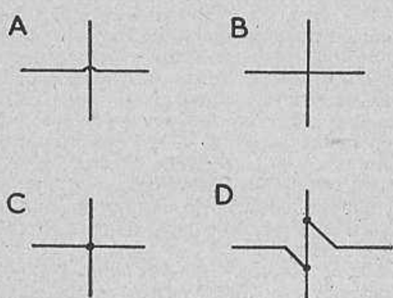
In Your Workshop

In which J. R. D. *discusses Problems and Points of Interest connected with the Workshop side of our Hobby based on Letters from Readers and his own experience.*

In all phases of life controversies continue to crop up from time to time. They catch a certain amount of interest and then fade away from the public eye, to be resuscitated at a later date. The radio fraternity has its share of controversies, and one of the oldest of these concerns the methods used in circuit diagrams for interpreting wires which cross but are not connected together. I noticed that this particular bone of contention was given an airing again quite recently.

Circuit Crossings

In the argument, one school of thought prefers the use of the bridge type of crossing, whilst the other favours the straight-line crossing. Both types are shown in Figs. 1 (*a*) and (*b*). The 4-way junction shown in Fig. 1 (*c*), quite permissible in circuits using bridge crossings, has to be re-drawn as in Fig. 1(*d*) when it is employed in circuits which use straight-line crossings. If the re-drawn version were not used, it might prove difficult to tell whether a certain wire crossed another or was connected to it.



RC134

Fig. 1 (*a*) *and* (*b*)*: Bridge and straight-line crossings respectively; both are commonly used in circuit diagrams*

Fig. 1 (*c*)*: A 4-way junction permissible in circuits using bridge crossings*

Fig. 1 (*d*)*: The junction of* (*c*) *has to be drawn as shown here if the associated circuit uses straight-line crossings*

RC135

Fig. 2*: A diagram which may assist in remembering Ohm's Law. Its use is explained in the text*

In my own opinion, the bridge type of crossing is definitely superior to the straight-line crossing, because the fact that no connection is made is so manifestly obvious. In addition, speaking from a personal point of view, I find also that the bridge crossing is especially helpful if I have to scribble quick circuits whilst working an experimental equipment or whilst tracing the circuit of an unknown piece of gear. At such times, I merely need such a circuit for momentary use or for later reference, and its layout is, within reason, unimportant so long as it is accurate. In the confusion of lines which occasionally results from this procedure, the convenience of the bridge crossing shows itself immediately.

Mnemonics again

The mnemonics still keep coming in ! Two new ones are mentioned in a letter from reader B. H. Ross of Mufalira, Northern Rhodesia. In his letter Mr. Ross shows a figure, (reproduced here in Fig. 2), which may help in remembering Ohm's Law. In the diagram one places one's finger over the value required; whereupon the remaining two values equal it.

A further reader, G. B. Brown of Swansea, points out a useful mnemonic for Fleming's Left and Right-hand rules. He writes, " The left-hand rule concerns motors and the right-hand rule generators. In the well-known initials ' M.G.', the letter M (for motors) is on the left, and the letter G (for generators) is on the right. And there you are ! "

Mr. Ross also suggests the following for the colour code:

" Blackie	Black	0
Brown	Brown	1
Read	Red	2
Over	Orange	3
Young	Yellow	4
Green's	Green	5
Book;	Blue	6
Violet	Violet	7
Grey	Grey	8
Waited	White	9 "

Another reminder, sent by a reader who wishes to remain anonymous, goes:

" Oil on Copper, not on Brass,
Oil on Wrought but not on Cast."

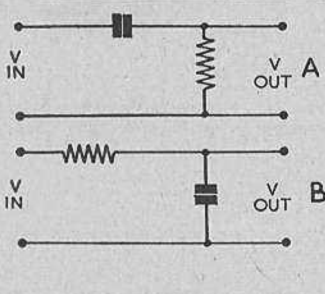


Fig. 3 (a) and (b): Differentiating and integrating circuits. These are referred to in the paragraphs on mnemonics

Here is a simple mnemonic which I have found useful myself. Until one gets used to them, one is sometimes liable to get a little confused between differentiating and integrating circuits. In the differentiating circuit, (Fig. 3 (*a*)), the capacitor comes before the resistor, whilst in the integrating circuit, (Fig. 3 (*b*)), the resistor comes before the capacitor. To recall which is which one may remember that C comes before R in the alphabet; as does D (for differentiating) before I (for integrating) .

Since I originally mentioned radio mnemonics in these columns some eighteen months ago, I have from time to time asked friends and acquaintances whether they find these aids to memory useful. About thirty per cent have admitted using mnemonics to remember facts or formulae which are new to them or which they use infrequently. Usually, however, their subsequent experience has been something the same as my own. They have found that, after having committed something to memory by means of a mnemonic, they can usually recall what is required accurately and immediately at a later date without the aid of the mnemonic at all. Indeed, some find that they have forgotten the mnemonic which helped them to remember the fact in the first place !

However, this is deep psychological stuff and I had better perhaps press on to my next subject. I must say before finishing, though, that I shall always be glad to hear of any further mnemonics which may prove to be of interest to readers.

Extension Loudspeakers

The problem of providing extension loudspeaker leads over a considerable distance can sometimes be a little difficult to solve.

The usual method of feeding an extension speaker consists of connecting it to the output transformer secondary in the receiver. If, however, too much resistance is introduced by the interconnecting leads there are liable to be losses and even distortion. When the leads have to cover a long distance, therefore, it follows that fairly heavy wire will be needed if this type of connection is to be used; with a corresponding increase in cost.

The older-fashioned method of using a second transformer at the extension speaker and connecting its primary between chassis and the output valve anode (via an isolating capacitor), can result in loss of top due to capacitance in the leads. There may also be a lack of bass unless the HT isolating capacitor is large.

A solution to these problems can often be found by running the extension speaker at 600 ohms impedance. Speaker transformers giving a step-down from 600 ohms to voice-coil impedance are encountered now and again on the surplus market and they may often be obtained quite cheaply since they are of no use for normal purposes. Such transformers are suitable for connection at the extension speaker.

Output transformers with additional 600 ohm windings (for the receiver end) are a little more difficult to find. They are often used in communications receivers, as well as in one or two items of surplus AF gear. Alternatively, it may be possible to obtain an output at approximately 600 ohms from a multi-tap transformer.

The longer the extension leads, the greater becomes the advantage given by the 600 ohm connection. Light twisted flex should prove quite satisfactory for almost all reasonable distances. In many cases ordinary bell wire could be used.

Before concluding, it must be pointed out that this method of connection may not necessarily be beneficial when used with high fidelity amplifying equipment, since, amongst other things, an additional transformer is fitted between the output stage and the speaker.

Radio Control Equipment

PART 2

By **RAYMOND F. STOCK**

Signals

Every simple, single-channel radio control receiver terminates in a sensitive relay similar to the one described, possibly followed by a secondary relay. In any case, the type of signal that can be handled is limited to either make-and-break of a single circuit or a simple change-over between two circuits. However complicated the control movements required in a model, they must all be initiated by these simple pulses.

Apparatus which overcomes the apparent limitations of such a simple radio link offers an enormous scope for ingenuity in its design; some of the more popular systems will be described, but there are many other combinations of units which can be used, and which cannot be described for lack of space.

The simplest way of using incoming signals is to cause them to trigger off a pre-arranged sequence of operations in the model, step by step; there are many variations on this theme, but the least complex one is the magnetic escapement.

Magnetic Escapement

Fig. 5 is a plan view of a typical escapement. **A** is a 4-toothed ratchet wheel, mounted on a shaft which tends always to rotate under the influence of a wound steel spring and gear train, or a wound skein of rubber.

A is held by the claw **B**, which is pivoted at **C** and provided with an iron armature opposite the electromagnet **D**. The latter is energised from the receiver relay whenever a signal is sent, and attracts the armature and claw to

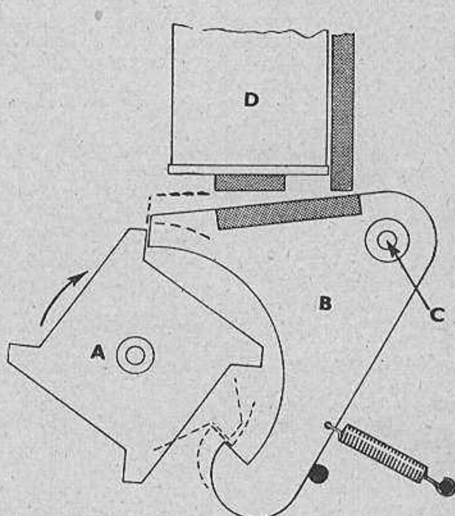


Fig. 5. Magnetic escapement.

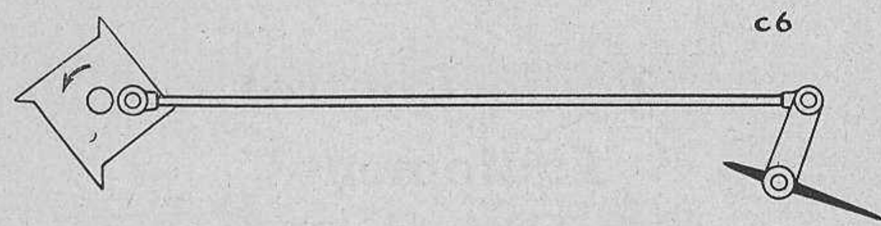


Fig. 6. A light alloy knitting needle makes a good connecting rod.

the dotted position, thus permitting the wheel to turn through 45°. When the signal ends, the claw returns to its former position, impelled by the tension spring, and the wheel rotates through 45° again, thus completing one step.

Each command pulse transmitted thus rotates the wheel through 90°; if a crank pin and long connecting rod are attached to the wheel they may operate the steering gear of an aircraft or ship model. Fig. 6 shows the idea, and the rudder is indicated in the 'Port' position. Three further impulses would provide, successively, 'Neutral,' 'Starboard' and 'Neutral' again. This is therefore a simple four-step sequence for controlling a rudder, and though apparently crude it has the virtues of simplicity and reliability. It is an ideal scheme for an introduction to radio control, and it can control quite effectively small 'diesel' powered ships and aircraft with a fair degree of precision. The fact that unwanted positions may have to be passed in order to reach a nominated control step is quite unimportant, since the high speed at which the unit can step prevents it remaining on an unwanted control for sufficiently long to influence the course of the model.

An old spring mechanism from a large toy

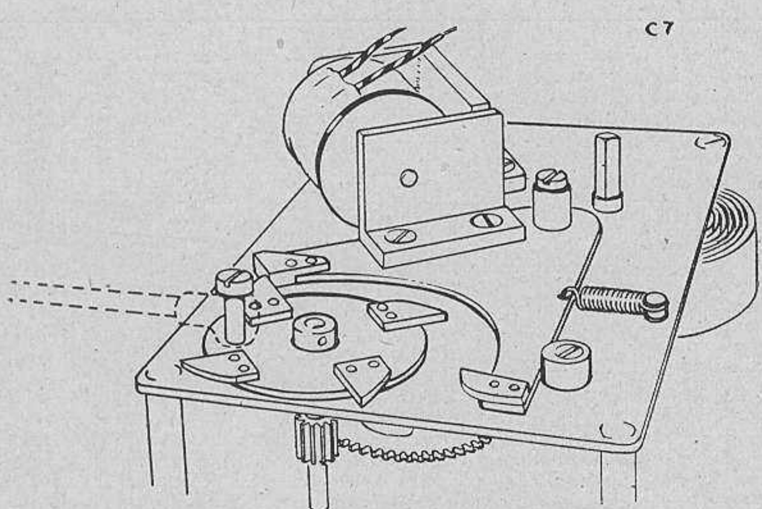


Fig. 7. Note adjustable (eccentric) backstop.

C8

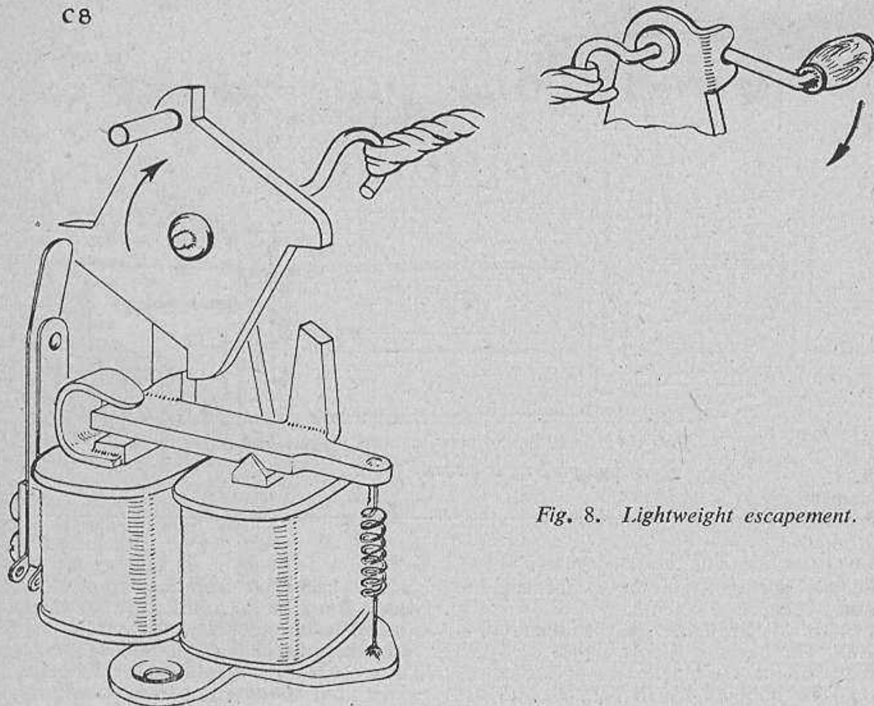


Fig. 8. Lightweight escapement.

(such as an "O" gauge locomotive), or a clock mechanism, is very suitable for conversion to an escapement.

The toothed wheel is cut and filed from sheet brass (or preferably mild steel) $\frac{1}{16}''$ thick, and it must be rigidly attached to whichever shaft in the gear train is selected for final drive.

Obviously, as high a gear ratio as possible is desirable between wheel and spring to reduce the amount of winding required, but at the same time sufficient torque must remain to operate the rudder. Possibly the shaft chosen will not project beyond the motion plates of the motor, in which case the gear can be mounted between the frames.

The claw should be of steel to resist 'burring' at the teeth, but again sheet brass or even duralumin can be used if the unit is not too powerful. A portion of a steel claw can be bent up to form the armature, or a separate iron bracket may be riveted or bolted to a non-ferrous claw.

A small brass bush or length of tube is soft soldered into a hole in the claw to act as a bearing, and may work on a 6-BA steel bolt as a pivot. Some form of adjustable back stop is necessary to limit the movement of the claw away from the electromagnet. In the opposite direction, the movement of the claw is limited by the armature coming into contact with the poles of the electromagnet; actual iron-to-iron contact of these members should be prevented by a small brass rivet through the armature, the rivet being filed nearly flush on the magnet side so that the iron parts are separated by about 0.005″ when the armature is fully home. This feature should be incorporated in all electromagnets to prevent residual magnetism causing the armature to 'stick.'

These points are all shown in Fig. 7, a drawing of an escapement mechanism originally designed for, and used in, a 32″ 'diesel' engined motor gunboat model. To conserve weight the wheel and claw are both of duralumin, the teeth being riveted on and made of steel. The rest of the spring mechanism started life as a clockwork boat motor, and

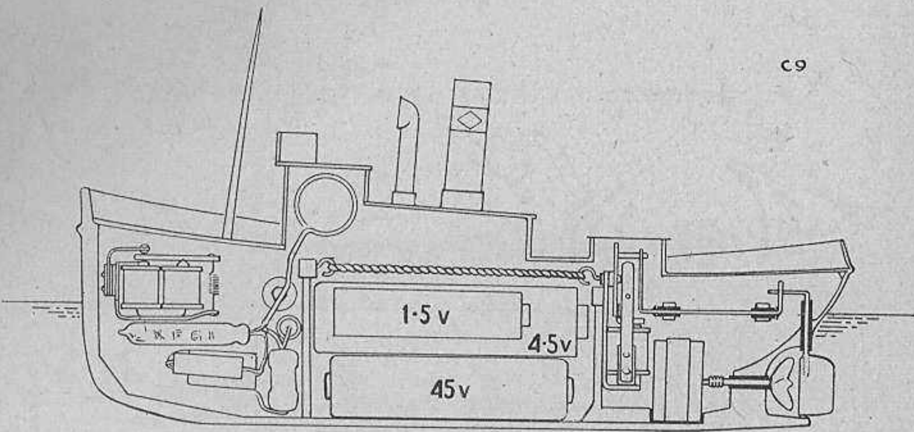


Fig. 9 This very small model was intended for use in a garden pond. Signal pick-up is directly on the tuning coil.

about 400 operations of the escapement are obtained between rewinding.

A much smaller, lighter gear is illustrated in Fig. 8. The basis of this is a pair of 37.5Ω bobbins on the U-shaped core of a Siemens relay. The bobbins are in parallel, and use about 0.25A from a 4.5V flash lamp battery.

The claw and armature, bent from one piece of 18 swg mild sheet steel, are pivoted on a knife-edge and returned by the coil spring.

The wheel is cut from a scrap of duralumin with a brass bush riveted in; a 16 swg piano wire shaft and hook is soldered into the bush and takes the ends of several rubber bands. These are wound by a handle at the other end, which after winding is parked in a notch cut in its sheet dural bearing.

A device of this type has been used in model aircraft, and similar units are probably the most common for this particular service. Another way in which the rubber driven escapement has been utilized is in a very small tug which was produced to decide just how small such a model could be made. Fig. 9 shows the arrangement of parts inside the model (or was it a toy ?) and by using a 45V HT supply in conjunction with a thyratron XFG1 valve the overall length was kept down to under 9″.

Another simple feature is indicated in Fig. 8. The two contacts at the side of the wheel are connected in the propulsion motor supply circuit, and are broken by the crankpin on one of the ' neutral ' or amidships positions. This enabled the boat to be stopped; it will be realised that this method of controlling another function can be applied to any escapement. Often it is undesirable to operate this separate circuit at every revolution of the wheel, and it will be described later how a delay device can be inserted to prevent operation except when a position is dwelt on for a given period.

[*To be continued*

TEMPORARY TELEVISION STATIONS IN NORTH EAST ENGLAND AND NORTHERN IRELAND

As already announced the BBC has undertaken to install temporary low-power television transmitters at Pontop Pike, in North-East England, and near Belfast before the Coronation. It is now proposed that these transmitters shall use the asymmetric sideband system of transmission, and not, as first announced, the double sideband system. This change will not affect receivers of the types now normally manufactured. The temporary transmitters will thus be similar in this respect to the permanent transmitters that will later replace them; these will also use the asymmetric sideband system, as originally planned.

Valves and their Power Supplies

Part 5

By F. L. Bayliss A.M.I.E.T.

1.4V Battery Valves

There are two main classes of 1.4 volt battery valves: (a) the group of which the 1C5 output pentode is a typical and popular example. This group have octal bases and are suitable for use in household battery receivers and large portables. They are more robust in design than group (b) which are miniature all-glass valves having B7G bases, and are suitable for use in small portables and personal receivers.

It is practically certain that 1.4 volt valves, of both types, have almost extinguished the popularity for so long belonging to the 2.0V class of valve, for the simple reason that LT cells are much more convenient, and cleaner, than the rather messy accumulator.

Originally, too, they could claim some advantage in battery current consumed, over the 2.0V kinds, although now, with the introduction of newer varieties of the latter valves, this advantage is no longer of account.

The Parallel Circuit

When they were introduced, the parallel filament type of circuit was perhaps the most popular. The battery power supply circuit is shown in Fig. 13. The 1.4 volt cell, a large capacity type, serves all valve filaments connected in parallel, whilst HT+, usually 90V for the octal base group and 67.5V for the B7G group (although often 90V may also be used for these, too) is obtained either from a standard type battery or a small layer type.

Grid bias is nearly always arranged to be automatic, the resistor R1, usually 800Ω to 1000Ω, dropping the HT– voltage to give some 7 volts negative bias to the output valve.

Typical superhet valve 'sets' within the two groups are, octal type:

DK32, DF33, DAC32, DL35: and, B7G type, DK91 (1R5), DF91 (1T4), DAF91 (1S5), DL91 (1S4).

The types bracketed are American equivalents.

The filament current of the first three valves in each group is 0.05A each, the output valves each being rated at 0.1A.

Before leaving the subject of parallel connections, it is perhaps interesting to make a note of the B7G valve base.

With the 1.4V miniature valves so far dealt with, the filament negative pin is always pin 1 and the positive one pin 7. When the valve has a suppressor grid, this grid is often connected to pin 5, and pins 1 and 5 connected together inside the valve. When parallel connecting, then, always strap pin 1 to chassis, and reserve pin 7 for the LT+ connection.

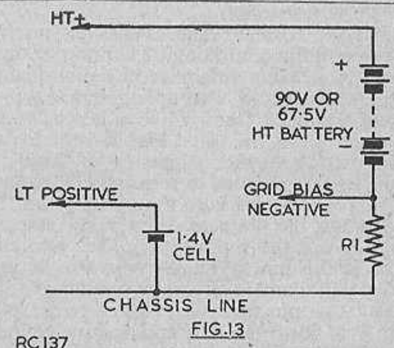


FIG.13

Please note that these remarks do *NOT* apply to valves having tapped filaments, but only to the original 1.4 volt valves of the 1S4 type.

The Series Circuit

Later types of output valves—DL33 octal, and DL92, DL94, B7G—having tapped filaments rated alternatively at 2.8V, 0.05A or 1.4V, 0.1A were introduced to enable all filaments to be wired in series.

For battery working there is little to be gained, in the writer's opinion, by series operation, although as the battery drain is now

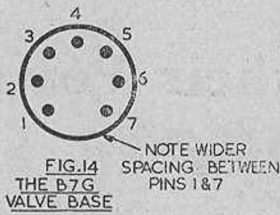


FIG. 14
THE B7G
VALVE BASE

only 0.05A smaller filament battery cells may be used—even part of the HT battery, at a pinch.

However, there are many receivers employing series connection in use, and 7.5 volt and 4.5 volt LT batteries are readily available for them.

The filament arrangement is shown in Fig. 15.

Resistors R1 and R3 are cathode (emission) current by-pass resistors, the shunting effect of which prevents the *emission* currents of valves high in the chain from adding to the *filament* current of valves lower in the chain and thus endangering these filaments. R1 bypasses the emission currents of V1 and V2, whilst R3 prevents the filament section of V4 between pins 1 and 5 receiving the emission current from that section between pins 5 and 7. If you value your valves *do not, on any account,* omit these resistors.

R2 is the correct value of bias resistor for the valves quoted, although 1 kΩ may be used without noticeable difference in signal quality.

C1 is an audio decoupling capacitor to prevent feedback from V4 to other valves in the chain: C2 is the usual bias resistor bypass capacitor. A further capacitor of 2.0μF to 4.0μF may be shunted across the HT battery.

It is worth noting here that, unlike the 1S4, the 3S4 has the filament centre tap connected to pin 5, and the suppressor grid is also connected to this pin. The 3S4 may also be used in a 1.4 volt filament circuit by treating pin 5 as the negative pin and strapping together pins 1 and 7 to form the filament positive connection. Used thus, however, the filament current is doubled—0.1A—and the valve is then suitable only for parallel connection, and not in a series circuit where the chain current must not exceed 0.05A.

Finally, if the grids of V1 and V2 are returned to chassis via the AGC resistor network, as they normally are, V1 and V2 will have a permanent positive bias on the filaments of 4.2V and 5.6 V respectively. This, of course, is tantamount to a similar negative bias on the grids and no further permanent bias is necessary. This voltage may be lowered by returning the AGC resistors to a point—say, pin 1, V3—higher in the filament chain.

Similarly, to avoid bias on the V3 diode and control grid, the usual chassis end of the components in the external circuit of these electrodes should be returned to pin 1, V3 and *not to chassis.*

1.4 V. Battery Eliminators

Perhaps one of the most frequent and constant enquiries which the writer receives in the course of his daily round is for a battery eliminator suitable for a 1.4 volt valve battery portable receiver.

Now, if it were a question of HT only, the problem would be simple and the expense small. The enquirers, however, are usually quite definite about their requirements—the eliminator must supply LT current, too !

There are very efficient LT–HT eliminators on the market, but—unless bought as ex-W.D. surplus, they cost around £5.

All the parts to make one are available, however, either at one's local store or through the advertisements in this journal, and the cash saving effected by so doing would be about half of the above cost.

A suitable circuit is shown in Fig. 16.

The HT+, LT+, Earth, and Grid Bias connections may be terminated at sockets, whilst a four-wire cable may be made up, having four wander plugs at one end and the other end connected to the appropriate points inside the receiver. If the existing battery leads are used, plug these in as follows:

HT+ plug into HT+ 90V of eliminator.
LT+ plug into LT+ of eliminator.
LT– plug into Earth (Chassis) of eliminator.
HT– plug into Grid Bias– of eliminator.

Used thus, the bias resistor R3 will shunt the existing bias resistor in the receiver, however, and if the receiver current becomes abnormally affected, the *receiver* bias resistor should be disconnected *or* R3 omitted.

Both types of metal rectifier are readily obtainable, as also are the smoothing chokes.

List of Components for Fig. 16

R1	10 kΩ, 2 watt
R2	20Ω to 50Ω W/W Pot.
R3	1kΩ, 0.5 Watt
C1	16.0μF, Electrolytic, 350 V.W.
C2, C3	8.0μF+8.0μF, Electrolytic, 450 V.W.
C4, C5, C6	25.0μF, 12 volts W.
Choke 1	20 Henrys, 20–30 mA.
Choke 2	250 mA LT Type
MR1	250 volts, 20–30 mA Metal Rectifier
MR2	6.0 volts, 0.5A, LT Metal Rectifier
S1, S2	2-Pole, Q.M.B. Toggle Switch
LT Transformer	230–250 volts Primary, 6.3 volts, 1.0A Secondary,

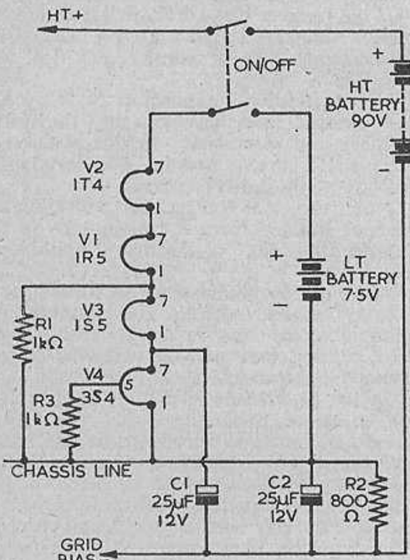


FIG.15

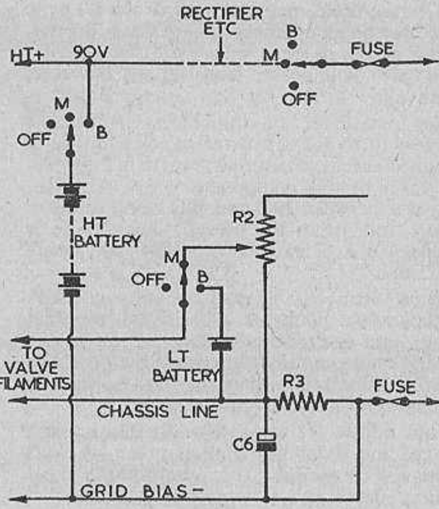


FIG.17

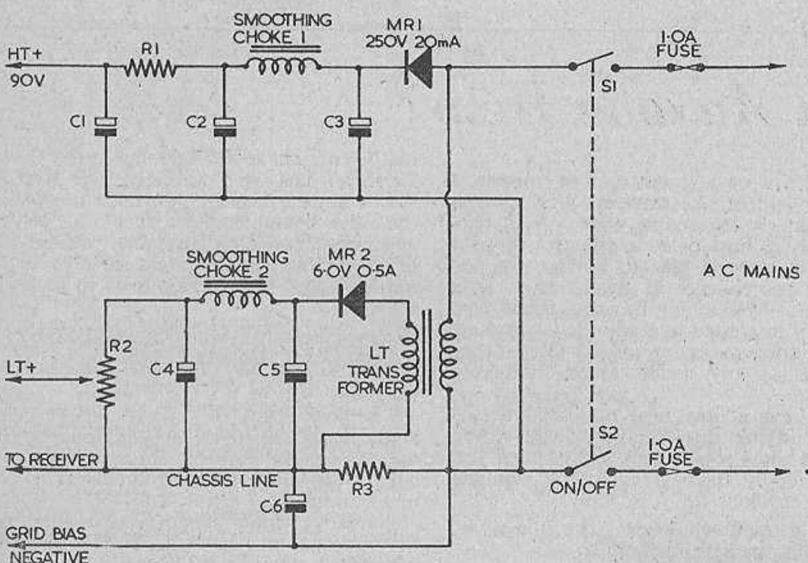


FIG.16

LT–HT BATTERY ELIMINATOR

RC139

Choke 2 is a special LT choke having a negligible DC resistance and a large current carrying capacity; the cost is around 5/–.

With the usual metal rectifier of the LT type there may be as much as a 50 per cent drop in voltage across it, when working. The use of a standard 6 volt heater transformer, however, would allow amply for this voltage drop.

The remainder of the excess voltage is disposed of by R2, a low resistance wirewound potentiometer connected across the LT supply. The value of this component is not critical—any value between 20Ω and 50Ω being suitable. It may, too, be of the preset 'slider' type, a quite small and inexpensive kind also easily obtainable.

When setting R2 to give 1.4 volts at 0.25A to the valve filaments (the usual superhet rating), an external resistance of 5.6 ohms should first be connected between the potentiometer slider and the eliminator chassis—leaving the receiver valves out of circuit.

Now adjust R2 until a voltmeter reading between the slider and chassis gives 1.4 volts exactly. Disconnect the temporary 5.6Ω resistor, make the potentiometer permanent to this setting, and connect the eliminator to the receiver for the final working.

A 5.6Ω resistor may easily be made by winding a 10½ yards length of 36 swg enamelled wire on to a bobbin.

If the receiver has a 7.5 volt LT rating, it is merely necessary to use a 12 volt heater transformer and a 12 volt rectifier instead of those specified.

Note carefully the position of R3, i.e. in the chassis line between the transformer primary and secondary. In this position the receiver LT current does not flow through this resistor—only the HT current.

Note, too, that the receiver and eliminator are not isolated from the mains, so—a 1.0A fuse in each 'leg' of the mains would be an asset.

Although propounded as an eliminator for existing battery receivers, the circuit is quite suitable to be used in a new mains/battery receiver, and the modified switching arrangements are shown in Fig. 17.

Switch S1, S2 of Fig. 16 has been omitted, and in its stead a 3-pole, 3-way rotary switch fitted for combined on/off, mains and battery switching. Other parts of the circuit remain as in Fig. 16.

Finally, perhaps it is worth noting that this circuit may also be used for 2 volt receivers, providing R2 is correctly adjusted to give 2.0 volts. R1, however, may be changed to 6.8 kΩ, 2 watts.

Can Anyone Help?

Dear Sir,

When I was on a recent visit to London, I bought an old service receiver, S/LC No. 4, at an extremely reasonable price. As it contains a whole host of components I thought it would be a good idea to build a receiver using the components in this receiver as a foundation. Mentioning this to a friend who is also very interested in Radio he advised me to write to some magazine and ask them if they had published any details about modifying this receiver.

If you have at any time published details about modifying this receiver please would you let me know about them, and whether you can still supply them, I enclose a stamped addressed envelope for your reply.—

Yours truly, A. C. CUTLER, The Bungalow, Woodfalls, nr. Salisbury, Wilts.

(Can any reader help ? — Ed.)

Dear Sir,

...Secondly, you were kind enough to suggest hat space might be available in your "Mailbag" column to include my query on the Govt. Surplus Ex.-R.A.F. Receiver Unit type 71. I am particularly interested in obtaining the valve line-up and circuit of this set, also any conversion data available. Perhaps one of my fellow readers might be able to help me with data or suggestions as to a possible source ?—

Yours faithfully (Mr.) G. SWEENEY, 23 Cedar Road, Dartford, Kent.

Dear Sir,

I wonder if any of your readers can either lend me, or sell to me at a reasonable price, the instruction manual, information on, or circuit for the Hammarlund HQ120 communications receiver.

Similarly, should any of your readers need the information, I have one each of the HRO and AR77 manuals available.

Yours faithfully,
J. R. GRIFFIN, 117 Fairbridge Road, Upper Holloway, N. 19.
(*Telephone* ARC 6031 after 6 p.m.).

A Valve Multimeter

By John S. Reynolds

This useful instrument, which was built mostly from "junk," is now giving excellent service and is, in the author's opinion, more useful to the amateur than an expensive precision multimeter. It combines in one circuit a DC Volt-Ohm-Milliammeter and Megger. It has five voltage ranges covering 1V–10,000V, with a load impedance of 10 megohms on all ranges, (this high impedance allows one to probe into circuits where conventional meters cause too heavy loading); and five current ranges covering 1mA–10A. The resistance test covers 1Ω–100MΩ in four approximately linear ranges, while the megger test can give a rough indication up to 100,000MΩ at a pressure of 250V. In spite of this formidable specification, this meter is easy to construct, and should not cost more than £5 if every part has to be bought (which is unlikely).

The Circuit

As will be seen from the diagram, the circuit consists basically of a Wheatstone Bridge network, in which two of the arms are replaced by triode valves. If the grids of these valves are at the same potential, the 0–1mA meter, which is virtually connected between the anodes, records no deflection. If one grid is disturbed, the balance is upset and the meter will register a deflection proportional to the voltage change on the grid. In actual fact, the valves and resistors will not be identical, and so balance is obtained by adjusting the 5 kΩ potentiometer. The shunt across the meter is the sensitivity control, and this is adjusted until a change of 1 volt on the grid of one valve gives just full-scale deflection. The reversing switch in the meter circuit is for convenience. It will be noted that there is a common resistor in the cathode circuit: this is to force the valves to operate on the straight portion of their characteristic. The other point deserving mention is the condenser between the two grids, and the high resistance to earth for the balance valve. This is merely a device for smoothing the hum picked up by the numerous leads in the switching circuits. The condenser, incidentally, must be a first-class component (preferably mica) of high leakage resistance.

We have, thus, a basic valve-voltmeter of full-scale-deflection 1 volt and an infinite input impedance. The remainder of the circuit is to enable this basic meter to measure voltage, current, and resistance.

Voltage Measurements

The input is switched across a voltage divider network of total resistance 10 MΩ. As will be seen, successive steps in this attenuator give 10 times multiplication; and as the input impedance of the valve is infinite, the external loading is 10 MΩ on all ranges. Some remarks may be necessary about how these values are obtained. The total resistance in the chain is 10,000,000 Ω: then, if an attenuation of 1 to 10,000 is required, obviously the bottom resistor must be 1,000 Ω; but if 1: 1,000 is required, the resistance below the tapping must be 10,000 Ω—an increase of 9,000 Ω. This value is best obtained with a 10,000 Ω resistor in parallel with one of 100,000 Ω. This argument holds for each resistor in the chain, though of course the values are 10 times greater between successive tappings. The top resistor is specified as 9 MΩ at 4 watts, and this was made from four resistors of 2.2 MΩ at 1 watt in series. Theoretically these will overheat, but the amateur is not likely to load a 10,000V power-pack for long periods at 1 mA !

Current Measurements

The current is switched through one of five shunts, which develops a PD of 1V between its ends. This voltage drop is, admittedly, rather high for high-current measurements, but is no great disadvantage in radio. The shunts of 1 Ω and of 0.1 Ω are best made by trial-and-error, the meter being checked against some standard meter.

Resistance Measurements

This is a very convenient circuit working on an unusual principle: the resistance scale on the meter is reasonably linear, and the meter reads high for a high resistance and *vice versa*. Its use is possibly only because the input impedance of the valve voltmeter is infinite.

A DC voltage of 1V is obtained from the LT supply through a metal rectifier. If this is applied direct to the grid, it produces a full scale deflection, and if it is applied through a resistor, R, there is no voltage drop (infinite input impedance) and the meter still reads maximum. If the input impedance is now paralleled by another resistor R, the voltage will fall to 0.5V.

In the general case, if the grid is supplied through a resistance R, and the unknown resistance applied across the valve is r, then the voltage at the grid falls to $r \div (R+r)$. If r is $R \times 10$, then the voltage is 0.91, and if it is $R \div 10$, then the voltage is 0.09: both these are easily detected on a 2½" scale reading to 1V. This formula holds for all values of R, and so the dial can be calibrated between $0.1 \times R$ and $10 \times R$, and the value of R can be fixed by the range switch. Using the resistors of 10 Ω, 1,000 Ω, 100 k Ω and 10 M Ω, a range of 1 Ω to 100 MΩ is secured. The calibration details are given later in the article.

The Megger Test

A DC voltage of 250V is obtained from a variable potentiometer across the HT line. (The 500 kΩ resistor in series is merely a safety device). The insulation to be tested is connected between this supply (terminal I) and the positive prod, and the meter switched to " volts." If the meter reads 250V, then there is a low (negligible) insulation, and if it reads 25V, then there is an insulation of 100 MΩ. (The voltage was reduced to one tenth, so the external insulation is ten times the 10 MΩ load in the meter). A slight indication can be given up to 100,000 MΩ by this method. No calibration details are given for this test, as they are easily worked out as above if desired. It is easy to measure the resistance of wooden base-boards, etc., and it is quite eerie to find what a lot of current can be passed over the handle of that " insulated " screwdriver with which we so gaily probe our apparatus !

Constructional Notes

It is not intended to give full details of construction, as the meter should give no trouble in this respect, but a few hints on suitable components may be useful.

To start at the easiest end, the power-pack can be almost anything. A conventional circuit is shown, but a vibrator supply for portable work could be used, provided a voltage of 350 or more is obtainable. The author's supply is 600V (unnecessarily high), and is obtained from an old transformer run on the 200V primary tapping so that the 4V heater supply can run the 6.3V valves: the smoothing condenser is 1.2 μF at 1,500V from some surplus unit lying around. (Motto: " Economy—and still more economy ! ") Thus the HT supply cost precisely nothing. The metal rectifier for the 1V supply is one section of a low-voltage rectifier, which should be rated at 500 mA or more, and the potentiometer for adjusting the voltage is a shaft-type humdinger. R1 should be adjusted in value to make the lowest resistance range read as accurately as possible, when compared with standard values.

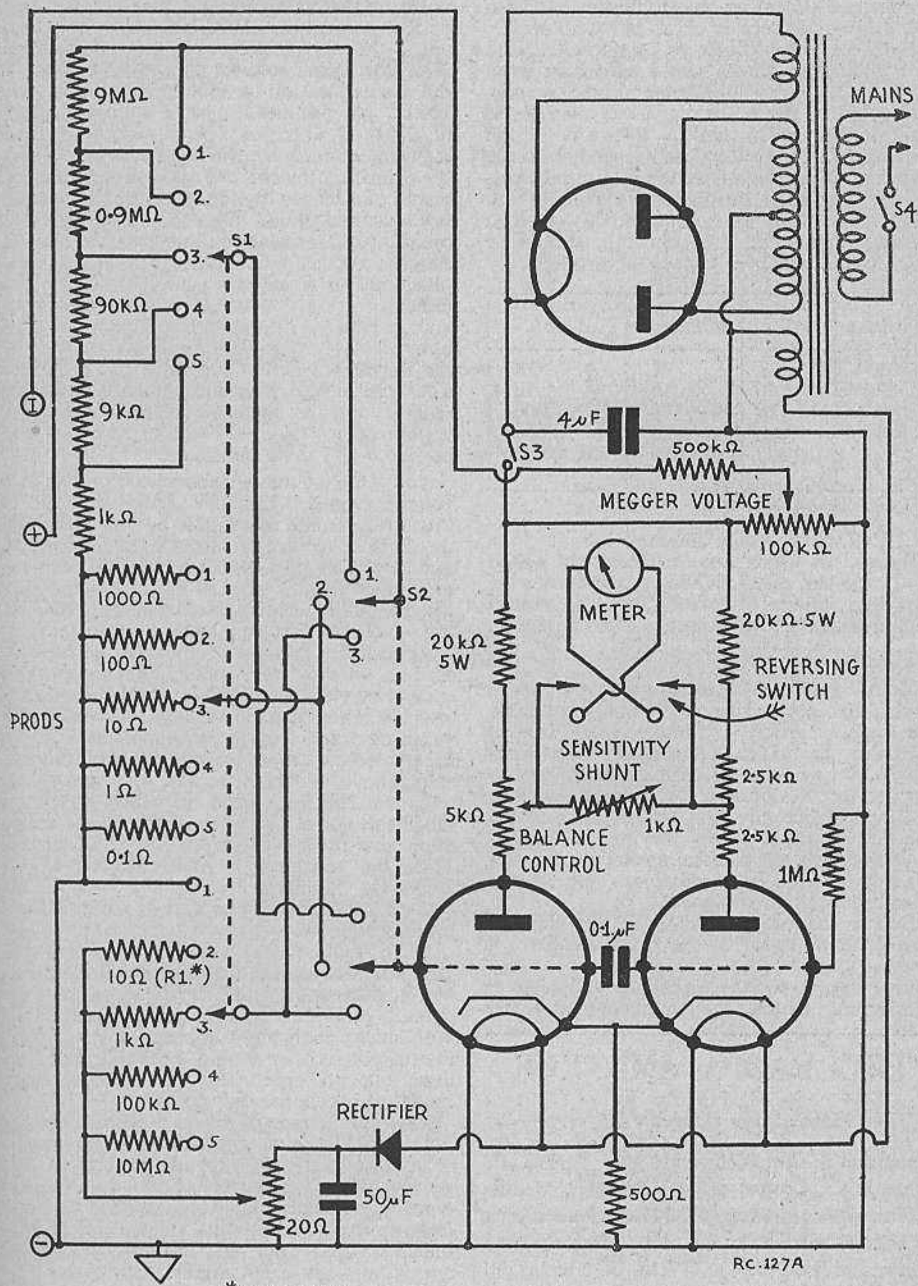
Perhaps it would not be out of place now to mention the milliameter, which seems to occupy a very inconspicuous position in the circuit. (It was not until the final check that the author noticed he had not built it into his apparatus !) This should be of the 0–1 mA type, with a large clear dial, although it need not have a particularly accurate movement. The cover should be removed and the dial unfastened, on which a space should be prepared to accommodate the resistance scale. It will probably be necessary to cover some print to do this, possibly by glueing over it a sheet of high grade paper. A much better method is to paint the required area with concentrated tennis-shoe white, which, when dry and hard, takes ball-pen ink beautifully. The scale to be added is from 10 to 0.1, and, supposing the existing linear scale is from 0 to 100, the positions for the resistance figures are as shown in Table 1:

Resistance Scale	*Existing Scale*	*Resistance Scale*	*Existing Scale*
10	91	1	50
9	90	0.9	47.5
8	89	0.8	44.5
7	87.5	0.7	41
6	85.5	0.6	37.5
5	83.5	0.5	33
4	80	0.4	28.5
3	75	0.3	23
2	66.5	0.2	16.5
1	50	0.1	9

Table 1. Calibration of Resistance Scale

Having removed any excess whiting, which might get into the movement, the meter is re-assembled.

The balance-valves used can be any well balanced triodes, or, better, a double triode such as the 6SN7. At present in use is a pair of 7193's, priced 1/6 each, whose two top-caps (one for grid, the other for anode) allow a


9MΩ
0·9MΩ
90kΩ
9kΩ
1kΩ
S1
1000Ω
100Ω
10Ω
1Ω
0·1Ω
PRODS
10Ω (R1.*)
1kΩ
100kΩ
10MΩ
S2
MAINS
S4
4μF
S3
500kΩ
MEGGER VOLTAGE
100kΩ
METER
20kΩ 5W
20kΩ.5W
REVERSING SWITCH
SENSITIVITY SHUNT
5kΩ
BALANCE CONTROL
1kΩ
2·5kΩ
2·5kΩ
1MΩ
0·1μF
RECTIFIER
50μF
20Ω
500Ω
RC.127A

*SEE TEXT

symmetrical layout to be employed, and also avoid low-resistance in cheap valve holders.

S_2 is the Volts-Milliamps-Ohms switch, and S_1 is the range switch, whose ranges are given in Table 2. Both should preferably be ceramic, and could be those 3-bank, 5-way switches as used in the RF24 Units. Resistors in the switching circuits should be suspended on the switches, as paxolin insulation in group-boards is not perfectly satisfactory. Wires which carry high voltage (maximum 10,000V) or high current (maximum 10A) or both, should be traced, and material chosen accordingly.

Position	*Volts*	*Milliamps*	*Ohms*
1	1	1	Off
2	10	10	10
3	100	100	1,000
4	1,000	1,000	100,000
5	10,000	10,000	10,000,000

Table 2. *Switch* 2 *Positions*

The whole meter should be built on a metal chassis which is *not* earthed, and placed in a wooden case. When measurements of very high voltages are made, the negative prod should always be the nearer to earth potential.

Setting Up

With the meter shunt resistor set to minimum, (and a fire extinguisher at the ready !) put on the mains. After a minute has elapsed, switch on the HT and increase the shunt carefully. (Set switches to read 10,000V, but do not connect the prods). A deflection will be obtained in one direction or the other, which can be reduced to nil by varying the 5,000 Ω potentiometer. If all components are in order the shunt can be set to maximum value, and a balanced position obtained.

Switch the voltage switch to any but the lowest range, re-adjust the balance control if necessary, and proceed to measure a voltage source across which a reliable voltmeter is connected. Rotate the shunt potentiometer until the meters agree, and then seal or lock it; this control should not again be touched, unless the valves age or the power supply is changed. Next connect the positive prod to the insulation test terminal, and adjust the 100 kΩ potentiometer until a voltage reading of 250V is obtained. Now switch to read Resistance on any but the 10 MΩ range. Short the prods, set the balance control, separate the prods, and set the humdinger to obtain exactly full scale deflection. This should be the same on all resistance ranges, though on the highest range it may be a little off. This is due to a phenomenon which has caused the only real difficulty encountered: a valve *generates* a voltage between its grid and cathode which may be as high as 0.2V. This is only apparent when the impedance across the valve is very high. Thus the highest resistance range is not very reliable, and the balance control (*not* the low voltage control) should be adjusted to put the needle at full scale deflection.

The same trouble is experienced on the low voltage ranges. The 10V range may be a little off zero, and this should be corrected with the balance control. The 1V range will be quite a way off, but no attempt should be made to correct this as almost invariably the test will be made across a resistance of 1 MΩ or less which will bring the meter back to zero.

Apart from this point, the voltage scale is used as on any other meter, and the current scale is conventional. The use of the megger test has been explained, and the only test requiring practice is the resistance test. Having carried out the simple adjustments enumerated above, connect across the prods an unknown resistor. Find on which resistance range the pointer is on the home made scale. Suppose it reads 0.7 when on scale 4 (Table 2). Then the resistance is $(0.7 \times 100,000)$ Ω, or 70,000 Ω. Similarly 3 on scale 2 is 30 Ω. A little practice enables one to read the resistance off immediately.

If it is required to read AC, experiment can be made with crystal diodes or metal rectifiers. Valve diodes are not satisfactory, as they actually generate a voltage which is appreciable with such a high input impedance. A bridge instrument-rectifier would probably suit the case, but no experiment has to date been made, and these are only ideas.

Thus this sermon of instructions is complete, but I would like to emphasize that this meter is not such a fussy brute as it sounds. The golden rule is always "check the balance control," remembering that changes in working temperature and in mains voltage disturb the balance. To reduce temperature drift, always apply the mains a few minutes before the HT.

That is all, and—good metering !

Mains Operated Photoelectric Relays

By R. C. Walker B.SC. (LOND.), A.M.I.MECH.E., A.M.I.E.E.

The advantages of a photoelectric relay circuit which operates from supply mains of lighting voltage is almost self-evident. Some of the simple forms of valve relay circuit of this type can function quite satisfactorily without the need of any rectifier, so that the arrangement is then reduced to the simplest type possible, the various voltages required being obtained from the secondary windings of a transformer. The windings needed are those commonly found in most power sections of radio receiving sets, so that no trouble should be experienced on the score of availability.

There are two simple basic relay circuits and one or two minor modifications which have merits of their own. In both cases, since AC is applied to both valve and cell anodes, the circuit can operate during alternate half cycles of the supply voltage, and the photocell polarity must be correctly phased with respect to the valve anode voltage. In Fig. 1, the circuit is operative when the cathode of the photocell is negative and the anode of the valve positive with respect to the valve cathode. This condition is obviously secured by connecting these points to opposite ends of a transformer winding. In the half cycles when the valve anode is negative, the circuit is not operative, but this need be of no disadvantage since a condenser across the relay coil will

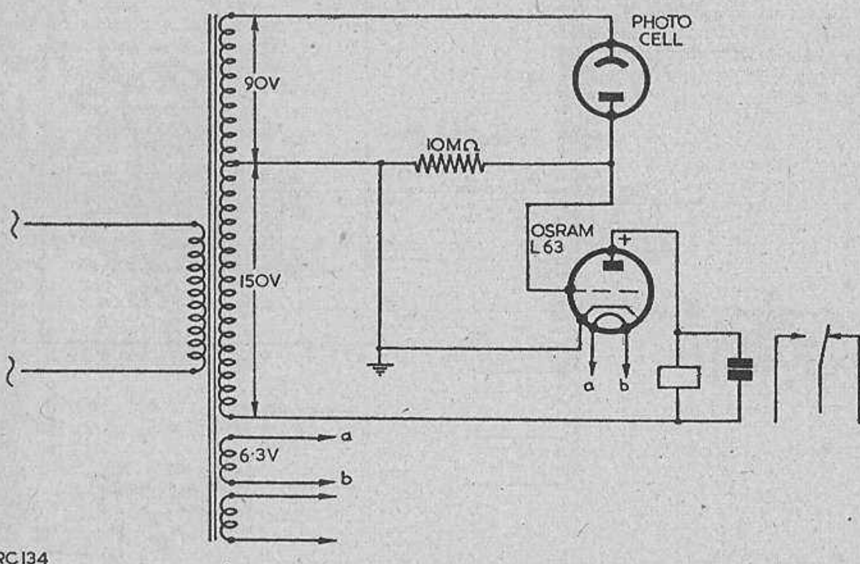


Fig. 1

succesfully carry it over this half period and will eliminate all tendency to chatter or release. With a 2,000 ohms relay coil, the condenser should be about 3–4 μF. Larger values can be used but will slightly retard the operation and release of the relay, a feature which may sometimes be advantageous. In the circuit of Fig. 1, with the photocell illuminated, the valve grid is negatively charged by the photoelectric current at the instants when the polarity is that shown and the anode current is then cut off. When the photocell is obscured, the valve anode potential. This circuit thus operates in the reverse condition to that of the circuit of Fig. 1, i.e. the valve anode current is established when the photocell is illuminated and the relay is released when the light is cut off. This circuit is rather more critical in setting than that of Fig. 1 and a grid bias adjustment is provided for this purpose. If a spare low voltage winding exists on the transformer, this can be connected in series with the main secondary winding to secure the grid bias for the valve.

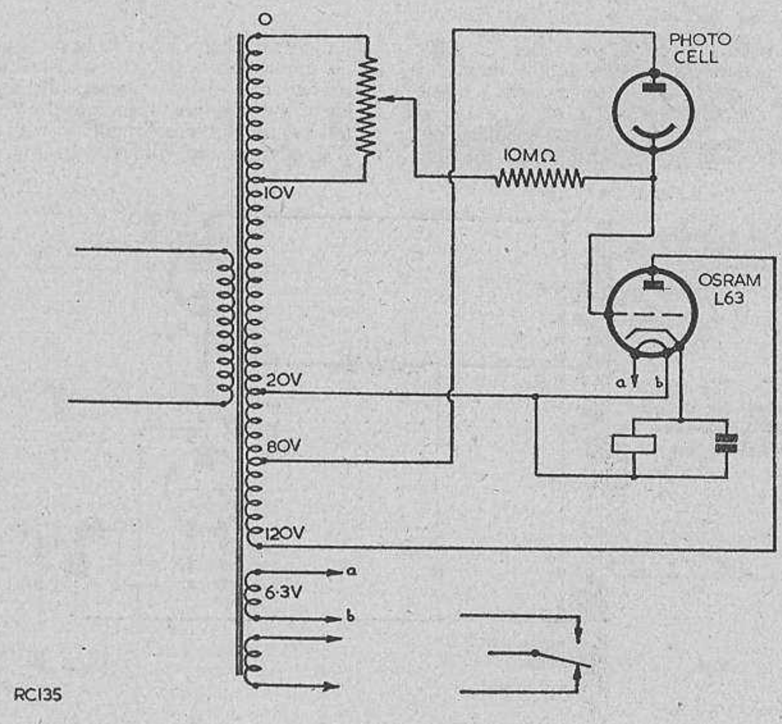


Fig. 2.

grid of the valve is at cathode potential and current passes through the relay coil during alternate half cycles. The mean anode current as measured with a DC milliammeter is then about 5 mA, and with a telephone relay having an operating current of 3 mA, positive action is secured.

In the circuit of Fig. 2 the cathode of the photocell is connected to the valve grid so that the photocell anode must be in phase with the

This circuit has the advantage that where safety in the event of failure is required, the external circuit is closed if for any reason the valve cathode emission fails during the quiescent state. The relay can also be connected in the valve anode circuit as in Fig. 1. In Fig. 2, it is shown in the cathode lead, which modification is applicable to either circuit. This makes little difference as far as the functioning of the circuit is concerned, but may often be considered an advantage since the potential of the relay coil to earth is then considerably reduced.

In most cases, the potential applied to the valve anode is considerably in excess of that which it is permissible to apply to the photocell, if the latter is a gasfilled type. Consequently, as shown in Fig. 2, a lower voltage tapping is used to feed the photocell, and since the anodes of the valve and photocell are not then exactly in phase, which is the condition for optimum performance, this circuit is rather less sensitive than that of Fig. 1.

If the transformer used does not happen to have tappings at the point indicated, which in any case are not critical to a few volts, resistors may be placed across the winding to act as a potentiometer from which the required voltages may be easily secured.

The only precaution, then, is to see that the total resistance is high enough not to overload the winding.

Both the circuits described have the merits of extreme simplicity and reliability in continuous operation, and are perfectly satisfactory except in the rare cases where very slow light changes on the photocell are involved. Then it becomes necessary to make a slight modification to the relay movement to secure a snap closure.

For all common industrial applications, such as counting, these circuits leave nothing to be desired.

Another feature which is most useful and not nearly as well known as it ought to be, is the utility of such circuits as contact operated relays.

In all low voltage low current circuits, the power available is obviously very small and provides little scope for a switching device which has to close or open a pair of contacts. Consequently, relays intended to operate under such conditions frequently give trouble through poor contact pressure and contamination of the metal surfaces. In addition, it is almost impossible to provide a snap action switching movement without introducing some accessory device, and when operating in the reverse direction, the contacts tend to stick or "freeze" together.

A slight modification of the circuit of Fig. 1 secures a valve contact operated relay which overcomes all these troubles. Providing there is a spare 12 volts secondary winding on the transformer, the photocell can be removed and the valve grid connected to one terminal of this winding. When switched on, the relay in the anode of the valve will pull in, but will release as soon as the other end of the 12 volt winding is connected to earth. It is, of course, necessary that the phase of this winding shall be correct, i.e. that the terminals are connected the right way round, which is easily found by trial.

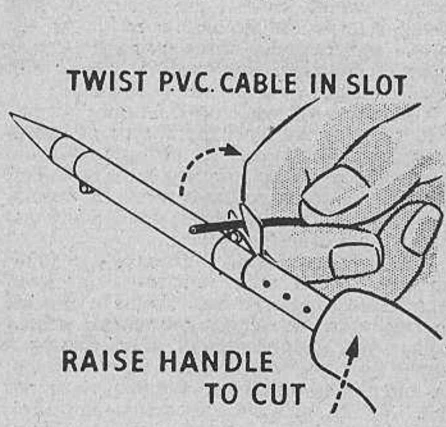
The advantages of this arrangement as a switching device are that the contact resistance can be quite high (a megohm or more), one of the contacts is at earth potential, and the contacts carry no current but merely serve to convey potential changes to the grid of the valve.

NEW INNOVATION FOR WOLF IRONS

Wolf Electric Tools, Ltd., announce that Wolf Solderguns type numbers 31 and 41 and Soldering Irons numbers 32 and 42, will in future be fitted with a patent wire stripper for stripping plastic covered wires prior to soldering. The stripper is conveniently fitted to the barrel of the tool and in a position for correct working temperature, i.e., with its forward edge 2.11/16″ from the front end of the soldergun barrel.

It can be used on all sizes of plastic insulated wires—single or stranded—without damage to the internal wire or stranded conductors. This innovation will be of great assistance to the operator and as shown in the illustration, the stripping can be done with ease and simplicity and particularly on repetition work, will save much time and reduce fatigue.

The attachment is not suitable for stripping rubber insulation.



Daylight on Meters

By T. H. Robinson B.SC.

Some meters read A.C., some D.C., others both. A.C. types may show R.M.S. values, or average. Sometimes frequency limits the range, which may or may not be dependent on waveform—and so on.

Owing to the flood of ex-Government meters, many amateurs have quite a box full of different types without appreciating their capabilities or limitations. On different occasions the writer has seen a moving iron ammeter trying to measure current in a television line time-base, and an R.F. hot-wire meter in circuit on an accumulator charging board.

In these and comparable circumstances the readings will be false, and in this article it is intended to throw a little daylight on some of the common classes of meter, with a brief description of their characteristics.

Moving Coil Meter

Here, a current-carrying coil is pivoted in the field of a permanent magnet. As current flows, a needle attached to the coil former swings across the scale. A hair spring returns the needle to zero. As the torque and resistance of the spring are similar types of function, the scale is linear, with equal divisions over the whole length.

This meter will work on D.C. only.

It is by far the most useful type of instrument in general use, being accurate and consuming very little power—a most important point in measuring voltages where the regulation is not good, i.e. where small additional loads would drop the voltage.

The basic movement is essentially a milliammeter, which with resistances in series becomes a voltmeter, or with shunts in parallel, an ammeter. A good movement should register full scale deflection when passing a current of not more than one milliamp, i.e. offering a resistance of 1,000 ohms per volt. As an ammeter, it should not drop more than about one tenth of a volt at f.s.d.

An advantage of the moving coil type is the automatic damping of the needle, due to eddy currents in the former on which the coil is wound. This saves the expense of air vanes or other devices.

As negative and positive currents will deflect the coil in opposite sense, a centre zero scale can be arranged, and this is the type of instrument used to show charge/discharge in accumulator charging circuits.

By varying the shape of the magnetic gap, the scale can be made non-linear. For example, to minimise the effect of overloads, the graduations can be closed up at high readings.

With resistances and shunts, the ranges can be multiplied indefinitely. For use as a voltmeter, the series resistances can be calculated from Ohm's Law if the f.s.d. current of the movement is known. When in use as an ammeter, the resistance in ohms of the parallel shunt is given by the resistance of the meter movement divided by one less than the number of times the range is to be multiplied.

Moving Coil with Rectifier

There is no true A.C. meter comparable in efficiency with the D.C. moving coil meter, and for this reason it is common practice to use this D.C. instrument in conjunction with a rectifier, to measure A.C.

Under such conditions, the scale is nearly uniform, but is slightly cramped at low readings. The readings depend on waveform, and are only accurate for the frequency specified.

The average value, not the R.M.S. value of the waveform is measured, but the scale is usually marked in R.M.S. readings, having been multiplied by the Form Factor, which in the case of a sine wave is 1.11.

Frequency limits depend on the rectifier. With a copper oxide rectifier, frequencies up to the lower radio range may be registered;

with a germanium rectifier, up to about 10 c/s, and over 10,000 c/s with a silicon rectifier.

Moving Iron

Here, a soft iron blob is pivoted in the field of a coil carrying the current. The meter is insensitive, and takes a lot of power.

It will measure either D.C. or A.C., and in the latter case registers true R.M.S. values. It is only useful for the lower frequencies, however, owing to losses, and is seldom used for A.C. at other than mains frequency.

The scale is contracted near zero, and the divisions gradually decreased up the scale.

Though there are many finely constructed moving iron meters on the market, a warning may here be given against the cheap A.C./D.C. types (certainly not ex-Government) that occasionally appear. These are crudely made objects with heavy hair springs, and require a lot of power to move the needles, which incidentally are usually devoid of damping arrangements. The writer had such an instrument some years ago, which consumed so much energy from the source of supply that, by the time the oscillating needle had come to rest, the filed coil was nearly red hot.

Thermal Meters

There are two common types. 1. The HOT-WIRE METER, where the expansion of a thin wire due to heat generated by the test current allows a light spring to swing the needle, and 2. The THERMO-COUPLE METER, which is usually a moving coil meter worked by current generated by a thermo-couple under the influence of heat produced by the test current.

Both meters may be used on either D.C. or A.C. They register true R.M.S. values of A.C.

They are generally used as R.F. ammeters, and will record ultra-high frequencies. Owing to losses and skin effect, however, the scale must be calibrated for the required frequency. They are therefore normally single range meters.

The disadvantages are delay before the needle moves, rather high cost, and the fact that even a momentary overload may wreck them.

Dynamometer

These are similar to the moving coil type, but a second coil takes the place of the permanent magnet. They may thus be used on A.C. as well as D.C., as the current in the field coil reverses with that in the deflection coil.

The scale is non-uniform, and these meters are generally in use as high grade A.C. voltmeters and watt-meters.

Induction

Here, several coils carrying currents of different phase produce a rotating field which turns a rotor. The meters are for A.C. use only, and are calibrated for one frequency.

Electrostatic

In these meters, electrostatic attraction between flat vanes causes the needle to move. A.C. or D.C. can be measured, and the great advantage of this type is that the current consumed by the meter is virtually nil. This is the meter commonly used to measure television E.H.T. voltages, where even a small current drain might seriously lower the supply voltage.

The Oscilloscope

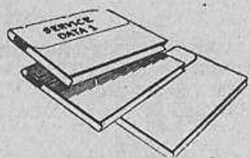
Though not exclusively a meter, the oscilloscope has two great advantages when used as such. It is quite unaffected by frequency and imposes no load on the source of voltage. If an A.C. voltage is applied to the YY plates, a vertical line will appear on the screen, and if a graduated glass calibrated against known voltages is placed in front, voltages can be read off against length of line. The actual peak to peak A.C. voltage is measured, which is $2\sqrt{2}$ the R.M.S. value.

If D.C. is applied to the plates, a spot will result, off-centre to the centre line of the screen by a distance proportional to the voltage.

Current can also be measured, by finding the voltage drop across a relatively small resistance of known value.

In our next issue . . .

"A versatile oscilloscope for the Amateurs' Laboratory."



SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makers are included: Aerodyne, Alba, Bush, Cossor, Ekco, Every-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price **£1** for the complete folder.

Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry", etc., which have been imported into this country. Names include Sparton, Emmerson, Admiral, Crossley, R.C.A., Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is **£1**. *Post free.*

R.F.-E.H.T. FOR VCR.97

Users will know that EHT mains transformers can sometimes be unreliable and unsatisfactory, therefore we feel sure that this new addition to our range of kits will be welcome. The kit comprises 2 valves, smoothing condensers, filament transformer and all necessary parts. Price **20/–**, plus 1/6 *post*. Constructional and operational data free with kit, or separately price **2/6**.

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P.V.C. insulated 23 s.w.g. copper wire in **100**ft. coils, **2/9** *each*. Colours available: Black, Brown, Red, Orange, Pink, Yellow, White, Transparent. 4 coils for **10/–**.

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¼ watt, **4**d *each*
½ watt, **5**d *each*
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SMALL CONDENSERS

Moulded mica, silver mica, ceramic, paper tubular, all values up to .01 mfd. normal 350 v. working, **6**d *each*, **5/6** *doz.*

.01 mfd., **6**d *each*
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VOLUME CONTROL KIT

An assortment of potentiometers compiled after taking a census of values required for the most popular circuits. All first-grade components. 12 potentiometers including 2 with single pole switch and 2 with double pole switch. Price **29/6**.

29 Gns.—AUTO RADIOGRAM

Console Type Cabinet. With full grained walnut finish, will take standars type auto change gram unit. Price, **£11/10/–**. H.P. Terms, **£3/17/–** deposit, and 12 monthly payments of **16/9**, plus 15/– *carriage*.

Radio Chassis to suit. **£8/19/6.** H.P. Terms, **£3** deposit and 10 monthly payments of **13/–**, plus 7/6 *carriage*.

Auto Change Units. Collaro for long playing and standard records with suitable pick-up head, **£11/11/–**, plus 3/6 *carriage and insurance*.

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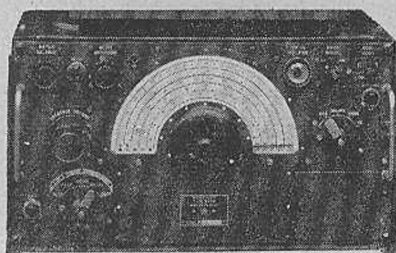
R1155—YOURS FOR £2/14/- DEPOSIT



This set, as most will know, is considered to be one of the finest communications receivers available to-day. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F., so obviously a robust receiver which will give years of service. Slightly used but completely overhauled and guaranteed in perfect working order. PRICE **£7/19/6** or will be sent against a deposit of **£2/14/–**, balance of 12 monthly payments of **11/6**. If you cannot call to collect please include an additional 10/– to cover cost of transit and carriage. This partly returnable to you if and when you return the transit case.

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With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price **£5/10/–** complete with 5*in* speaker ready to work, *carriage* 3/6.

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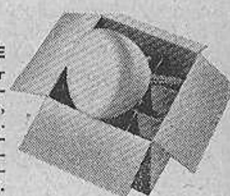

By famous maker, as used in many popular Television receivers (list on request). Specification Blue/White screen 9Kv. ion trap triode, heater 6.3 v. at .55 amp., 50 deg. deflection. New, with written guarantee offered at approximately half price, **£12/10/–** each, plus 10/– *carriage and insurance*. H.P. terms **£4/4/–** deposit and 12 monthly payments of **18/3**. Limited quantity so order immediately.

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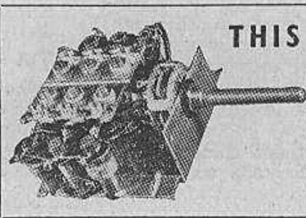
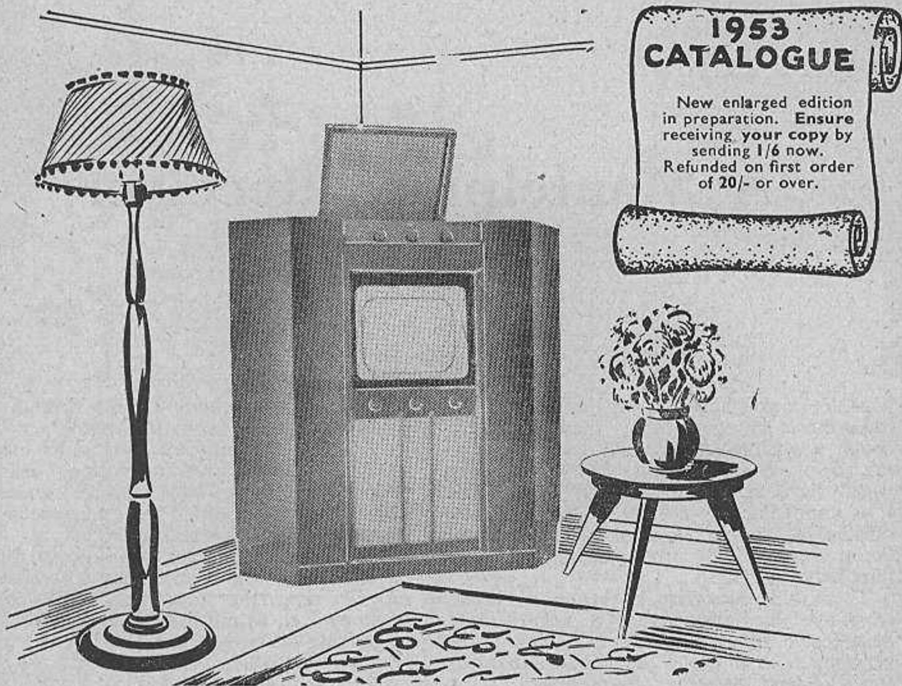


Manufactured by quite a famous company, this 3 wave Coil Pack incorporates a gram position and Long, Medium and Short wave band, designed for 465 kc/s I.F. Brand new and fully **guaranteed**, complete with circuit only **19/6**. Limited quantity, so act quickly.



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At this time of writing this page, the final details of design have not been completed but are sufficiently advanced to enable us to give approximate prices

THE T.V. CHASSIS. This incorporates a 15in. Cossor tube and has all the latest features of interference suppression, fly-back, E.H.T., etc., etc. Total cost of this, complete with tube, should not exceed **£35.**

THE RADIO UNIT. A 3-station pre-set superhet with special attention to quality is, we think, the best for the "Console." Such a set is being designed and will not cost more than **£8.10.0.**

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THE CABINET. This handsome corner fitting piece (47in. wide, 31in. deep to the corner, and 50in. high) has actually been made. We are having it redesigned so that it can be supplied flat for you to screw together. It will be polished, but we feel certain that if you scratch it a little whilst assembling you can get it touched up or repolished by a local man. We have not an actual costing, but are told that it should not be more than **£18.**

OUR PLAN. As soon as we are ready to send out the parts we will ask you to forward **£12.10.0,** upon receipt of which we will send you parts for the Televisor section. From then on you send us **30/-** every week and we will send you other sections in the following order: Radio and Audio Chassis, Cabinet, and finally Record Changer unit.

WHAT TO DO FIRST. Constructors' envelopes will be ready early in March, so first send **7/6** for one of these. Upon receipt you can study it, and we feel sure that you will want to make the "Console," but the data will be on 7 days' approval and if you wish you can return it within this period, and providing it is received in clean condition **7/-** will be refunded to you.

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Tom Thumb

A Mantelpiece Receiver

By E. Kaleveld PAØXE

Many of you have felt the desire of having radio-music in other rooms than the living-room, where the set is usually situated. This may be overcome by using extension-speakers, which have several disadvantages, however. It is impossible, by normal means, to switch off the set, should an unwanted programme 'crop up,' while programme-changing is impossible as well.

These difficulties were, at the writer's home, overcome by constructing a very simple, inexpensive receiver which, in addition, did very much to improve the relations between the XYL and the writer's ham-radio.

The set itself is very simple. It employs a Dutch Philips valve ECH21, of which Mullard makes a British equivalent, while the American 6F7 or 6AD7G can be substituted without further changes than the valve-base.

The ECH21 is a triode-heptode valve with common cathode, designed for use as a mixer-valve, but in this particular application the triode part is used as a regenerative detector, while the heptode section, strapped as a pentode, is used as the final amplifier. Fig. 1 gives you an idea of the circuit used. The rectifier is kept very small, the total current drain at a voltage of 250 being 9 mA. So a very small metal-rectifier is sufficient. For the same reason, the normal smoothing-choke can be dispensed with, and substituted by a 1 watt resistor.

The transformer can be made quite easily. The writer made his from an old smoothing-choke which happened to be at hand. As there was room for an extra winding, a random number of turns was wound over the choke-coil after taking out the core.

The number of turns was about 80, using 38 swg. As the heater-consumption of the ECH21 is about 300 mA, and 38 swg can deliver about 500 mA, that even allows for a small pilot-bulb.

80 turns gave about 8 volts "no load," so 14 turns were taken off, giving 6.6 volts "no load." or exactly 6.3 volts under load.

The detector-circuit is conventional, reaction taking place via the mica variable condenser. The tuning-condenser is a mica condenser as well, for room is scarce.

The coil is wound on an iron-core former of small physical dimensions. Because of the iron-core, the number of turns is not really critical, as much deviation can be had by moving the core in and out, but as a guide here is some data:

Core diameter: 3/8″ No. of turns: 80.

Reaction coil- 20 turns at 1/8″ from the earth end, scramble-wound with 32 swg (or thereabouts) enamelled wire. Coverage 200 to 600 metres, or 1500 to 500 kc/s. The antenna coupling coil calls for some comments, as it depends upon the length of the antenna. Should an excessively long antenna be used, then the number of turns may be down to 5 or 10, wound over the grid coil, but in case your antenna is shorter, the number of turns may be up to 35 to 50. You have to choose here between signal-strength and selectivity, and the happy medium here must be found by cut and try. This is not very hard, however. By the way, talking about the antenna, the little receiver may be connected to the same antenna as the main receiver, without any ill-effects; at least in my case this was so.

In case you are not satisfied with the quality of the set as it is in its original form (it suits your writer, though), you might add the tone filter system shown in Fig. 2. This modification is advised when you use a midget-speaker, which usually has a high pitch of its own. The improved quality, though, is gained at the expense of some loss of volume.

About the results; Here in Rotterdam, Holland, we can receive our two national programmes, plus the English Home-Service,

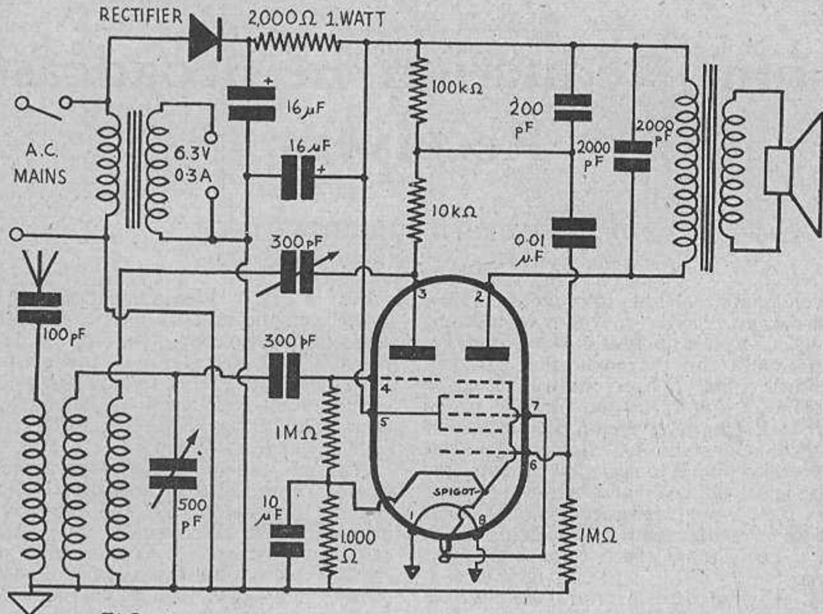


FIG 1.

at very good volume. In the evening about 8 or 9 stations can be heard separately and at good volume. The antenna, in our case, is a wire of about 50 feet, shared by the " big " receiver, of about 15 feet in height, and between houses, so it is not at all in the clear. From the component point of view the set can be built quite easily, as most parts will be found lying in the junk-box.

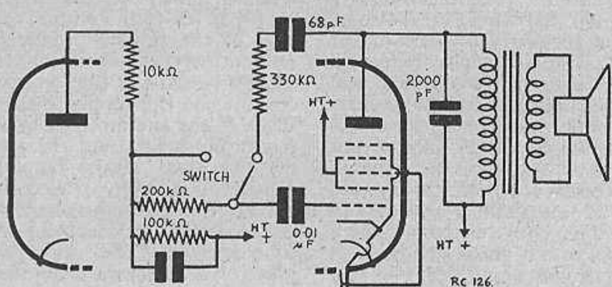


FIG 2.

Hum Reduction in Broadcast Receivers

By W. E. Thompson A.M.I.P.R.E.

The elimination of hum in radio apparatus, be it broadcast receiver or record reproducer, is a subject which is often dealt with merely by rule of thumb and the application of some well-known circuits. Everyone will recognise the circuit of Fig. 1 as the familiar mains rectifier and smoothing circuit, the purpose of which is to reduce the A.C. ripple component of the rectified output to negligible proportions. It is also widely known that a full-wave rectifier with its 100 c/s ripple is easier to smooth than a half-wave rectifier with a ripple of 50 c/s, the filter being more effective the higher the frequency.

As it may be necessary and desirable to obtain a very smooth HT supply for a particular purpose, the components in the smoothing filter may have to be large, both as regards size and values. Multi-section filters, such as the two-stage network shown in Fig. 2, enable better smoothing to be obtained, while at the same time reducing values and sizes of components. There are, however, more components.

One method of achieving better smoothing with small components is to provide a hum-bucking coil in the speaker, as in Fig. 3. By this means, hum is reduced by cancelling out the ripple in the field coil by injecting a suitable value of ripple through the bucking coil; the relative ripple voltages are then in anti-phase. At the same time the field is used as a choke, so a component is saved. This, then, removes to a large extent hum that would otherwise be reproduced by the speaker by virtue of the energizing field varying at ripple frequency. The system is very common; it is cheap and effective, especially for small energized speakers which do not, as a rule, possess very good bass note response. Quite a lot of hum is not heard because often the speaker is incapable of reproducing much below about 200 c/s anyway!

Another way of attenuating hum is to "tune" the smoothing choke by connecting a capacitor in parallel with it, the actual value of capacitance being found empirically so that the choke then has a resonance at 100 c/s, or whatever frequency is chosen. This circuit, shown in Fig. 4, does not find general favour since it may degrade the filter characteristic at some other frequency. Raising the Q of the circuit at, say, 100 c/s may well reduce it at the third harmonic, 300 c/s, so although the fundamental hum frequency is attenuated, an unwanted speaker resonance at 300 c/s might suddenly appear.

A simple and effective, though perhaps not so well known, filter arrangement is shown in Fig. 5. It is particularly applicable to resistance-smoothed HT supplies, and can offer certain advantages. It is noticeable at once that a P.M. speaker is used; this obviously is cheaper and lighter than an energized speaker of the same cone size. In addition, a comparatively heavy and expensive smoothing choke is replaced by a resistor—again there is a reduction of space taken up by a component and the cash saving is worth considering. Against this, the smoothing and reservoir capacitors need to be of higher values, though not unduly so, and modern components of this type are not at all large, nor are they necessarily very expensive. Some further advantages will be more apparent when the theory of the circuit has been discussed.

It will be seen that the output of the rectifier, appearing across the reservoir capacitor C1, is connected directly to a tapping on the primary of the output transformer, and that up to this point the only smoothing is the small amount due to C1. This comparatively raw supply is fed to the output valve via the main part of the primary winding of the output transformer; at the same time, however, a smaller winding at the top end of the primary conveys the HT supply to the smoothing filter R1, C2, the smoothed output of which feeds the earlier stages and the screen grid of the output valve. If the tapping point on the primary is suitably placed, it is possible to balance out the hum voltage appearing across the secondary, to which the speaker voice coil is connected. The upper winding of the primary is therefore a hum-bucking coil, but it is now on the transformer instead of the speaker. The transformer windings are marked

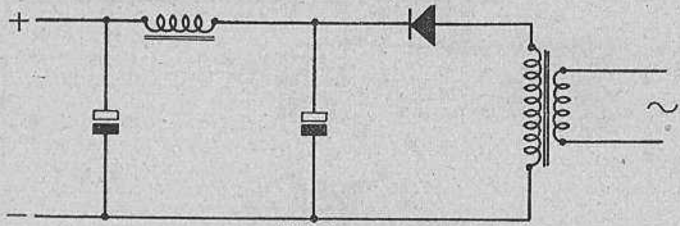


FIG. 1
RECTIFIER & SMOOTHING CIRCUIT
(SINGLE-SECTION FILTER)

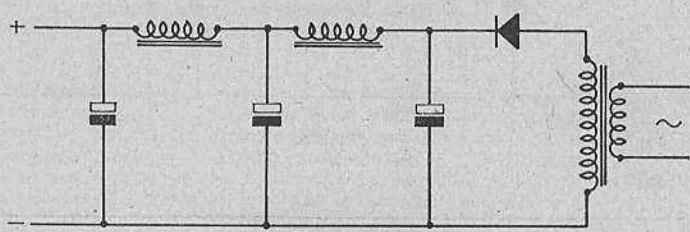


FIG. 2
RECTIFIER & SMOOTHING CIRCUIT
(TWO-STAGE FILTER)

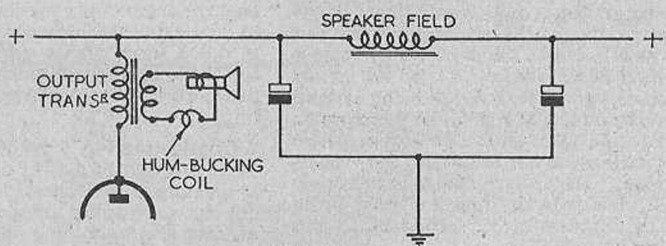


FIG. 3
HUM-BUCKING COIL ON
ENERGIZED SPEAKER

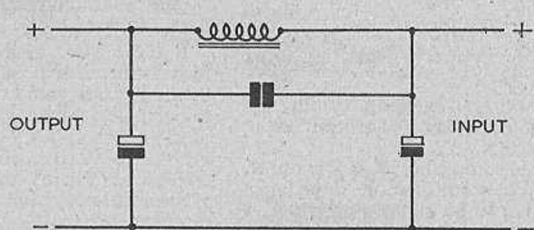


FIG. 4
TUNING A SMOOTHING
CHOKE TO REDUCE HUM

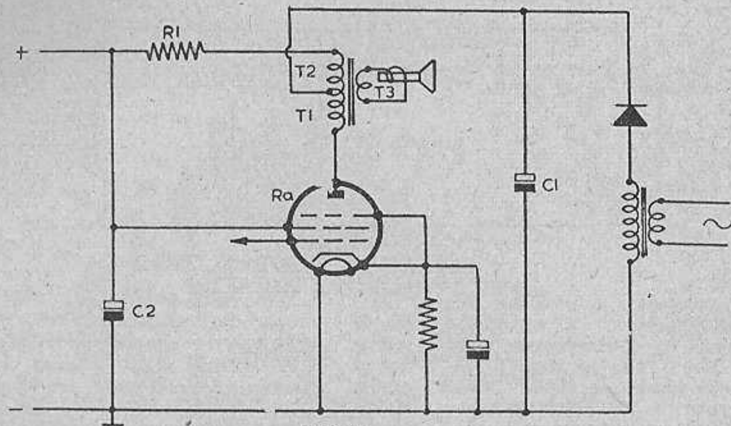


FIG. 5
HUM-NEUTRALIZATION IN
THE OUTPUT STAGE

RC90

in the diagram T1, T2 and T3, the anode impedance of the valve being denoted by Ra.

By using a large capacitance for C2, its reactance compared with the value of R1 can be made small, and as the A.C. voltage across C2 will then be very small, R1, to all intents and purposes, can be regarded as being earthed to A.C. The circuit of Fig. 5 can therefore be re-drawn in the form shown in Fig. 6, where it reveals itself to be our old friend the Wheatstone Bridge. The voltage source is the ripple across C1, the balance indicator now being replaced by the transformer secondary T3 and the speaker voice coil.

Applying the fundamental theory of the bridge, we see that if it is balanced there will be no induced hum voltage across T3, and this condition is met when

$$\frac{T1}{T2} = \frac{Ra}{R1}$$

where T1 = turns on primary, neglecting turns on T2,

T2 = turns on hum-bucking winding,

Ra = anode impedance of output valve in ohms,

R1 = value of smoothing resistor in ohms.

Taking the average value of anode impedance for an output valve to be 60,000 ohms, and a value for T1 of 1,500 ohms, the turns ratio becomes

$$\frac{T1}{T2} = \frac{60{,}000}{1{,}500} = \frac{40}{1}$$

It is unlikely, of course, that the number of turns on the primary of an output transformer will be known with certainty, but as a guide one can assume that the usual type of some 45 to 55:1 ratio will have somewhere about 2,000 to 4,000 turns on its primary. To obtain a 40:1 ratio for our additional winding, it should therefore have somewhere between 50 to 100 turns.

Considering Fig. 5 again, it will be seen that the major part of the HT current flows directly to the output valve anode; it is only the remaining current which passes through the new winding and smoothing filter. As this current will generally be about 20 to 25 mA, the wire used for this hum-bucking winding need only be thin, and so will not take up much space on the transformer. 38 or 40 SWG enamelled would be quite suitable, 100 turns of which would be accommodated in a single layer less than 1 in. long.

If these extra turns are put on an existing transformer it will be necessary to ensure that the new winding and the primary are connected together the right way round. The outer end of the new winding should be connected to the inner end of the primary. It may be easy enough to identify the inner and outer of an existing primary, but it might not be so easy to determine the direction of winding. If this cannot readily be seen, it will be necessary to try the effect of reversing the connections of the new winding, and note whether the degree of hum is higher or lower. That connection giving the lower hum should be used.

Generally, even if the exact primary turns are known, it will be necessary to adjust the number of turns on the hum-bucking coil to obtain minimum hum. This is quite easily done by taking off a few turns at a time until the hum goes.

Another way of doing this is to make R1 variable. If we use a fixed value of 1,000 ohms in series with a 1,000 ohms variable resistor, this latter can be used as a hum-neutralizing control. It need only be a pre-set component, so can be mounted at some convenient place on the receiver chassis. Such a control is not without advantage, for it will enable the circuit to be balanced at subsequent times to counteract the ageing of the output valve, when the anode impedance may alter slightly and cause an unbalance hum voltage to be developed. If we assume that 25 mA will flow through R1 and this resistor is 1,000 ohms, it will dissipate 5/8 watt, so a 1 W resistor would be suitable. A 1 K-ohm variable, usually rated at 2 to 3 W, would have an ample margin of safety. It is now fairly obvious that a 1 W resistor and a few turns of thin wire on the output transformer obviate the need for a choke, which might easily present a problem of finding space for it on a small chassis. Suitable values for C1 and C2 are 32 to 48 μF, preferably the larger value for C2. Both capacitors could be obtained in a single case.

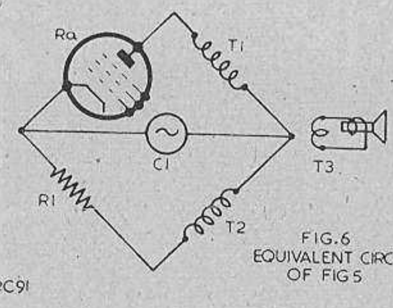


FIG. 6
EQUIVALENT CIRCUIT OF FIG 5

The author has tried the circuit in a small AC/DC four-valve superhet he made up some time ago. This used a half-wave metal rectifier with a 32 μF reservoir, smoothing being a 20 H choke and a 32 μF capacitor. The choke was replaced by a 1,500 ohm 2 W resistor which was on hand. The speaker is a 3″ P.M., and the output valve is an EL32. Seventy turns of 40 SWG enamelled on the output transformer removed hum completely, whereas with the choke it has always been possible to hear a slight ripple.

BBC and the Coronation

In view of the public interest and local arrangements now in the course of preparation, the BBC would like it to be known that its present plans envisage Coronation broadcasts on June 2 *between the hours of* 10.15 *a.m. and* 5 *p.m.*

The times, which cover both sound and television broadcasts, are based on those of the 1937 *Coronation and at this stage must be regarded as provisional.*

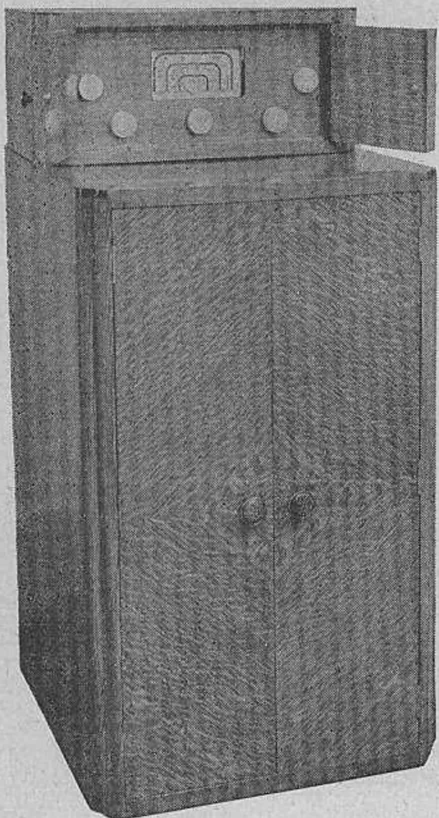
On the evening of June 2, *as has already been announced, Her Majesty the Queen will broadcast to the Commonwealth at* 9 *p.m. (B.S.T.). This will be carried by all the domestic services including television in sound only in addition to the external services.*

Telefilm recordings of the main events in the day's ceremony will also be televised during the evening. Provisional timings for this are between 8 *and* 9 *p.m., continuing again from* 9.15 *until* 10 *p.m.*

No objection will be taken by the Corporation to the rediffusion in public of the sound an television broadcasts of the Coronation ceremony and processions. The Corporation is also authorised to make the same statement on behalf of the Performing Rights Society.

The rediffusion of television programmes to paying audiences is not covered by the G.P.O. £2 receiving licence but the Postmaster-General has announced that he proposes to issue a collective licence, free of charge, to cover the rediffusion of the Corporation broadcasts to paying audiences.

For the benefit of local authorities wishing to test public exhibition sets the television transmitters will be on the air one hour before the start of programmes on June 2, that is to say about 9.0 *a.m.*



Quality Radio Unit for the "Magna-View"

The Radio Constructor's 16 inch Televisor

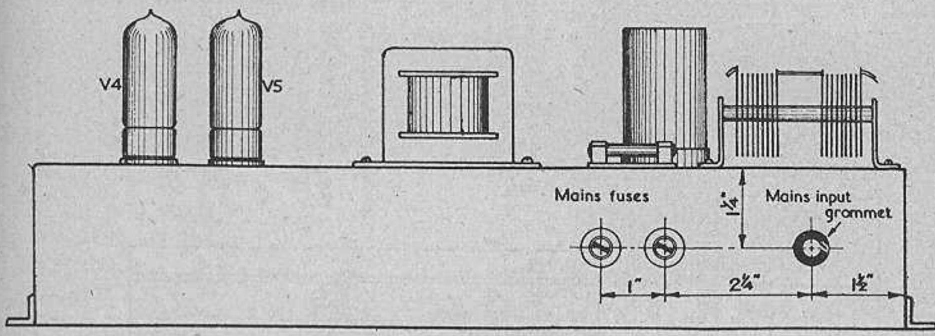
By A. S. Torrance A.M.I.P.R.E., A.M.T.S.

PART 2

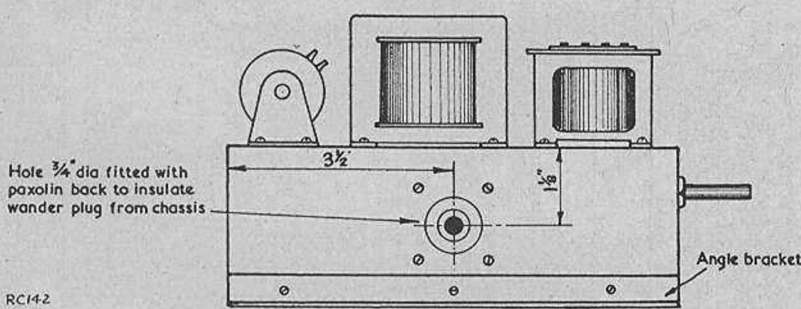
The title illustration this month graphically shows the composite version of the " Magna-View." This picture may be compared with the cover photo of the July issue; apart from being a highly efficient receiver for both TV and radio, the result is unquestionably a dignified addition to the home. As mentioned earlier, the top (Radio) cabinet conforms exactly to the style of the TV predecessor, but it may also be obtained in other dimensions by any reader desirous of building this receiver as a complete instrument within itself. It is therefore recommended that readers study both the photographs and diagrams and make sure of their subsequent intentions before ordering. Quite obviously, to mount a speaker might necessitate a larger chassis and would in any case demand a larger cabinet, if the Unit were to be entirely self contained.

A chassis to specification is obtainable from Denco (Clacton-on-Sea) Ltd., and Messrs. H. Ashdown assure us that any variation in cabinet design required will be undertaken by them with pleasure.

Reference to the circuit diagram (last issue) will, in association with the illustrations that month, enable readers to form a clear idea of the layout and general pattern advised. All



BACK OF CHASSIS



CHOKE END OF CHASSIS

the components specified are readily obtainable, and assembly should present no difficulty.

Care should be exercised in mounting the tag-boards. which are, of course, insulated from chassis. For convenience, most of the items were secured with Parker-Kalon self-threading screws, but this is entirely a matter of personal preference.

Advantage was taken of the cut-out for the CP2 coil pack to provide partial screening. The dotted lines shown in the top-deck layout diagram indicate that the two halves of the metal are bent down. The cut-out is marked out on the chassis and a small hole is drilled along one side. An *Abrafile* is passed through the hole, and drawn tight in a hacksaw frame. The front and back edges of the cut-out are thus easily sawn through, together with a cut through the centre from front to back. The two halves are then bent down, automatically providing screens for the coil pack.

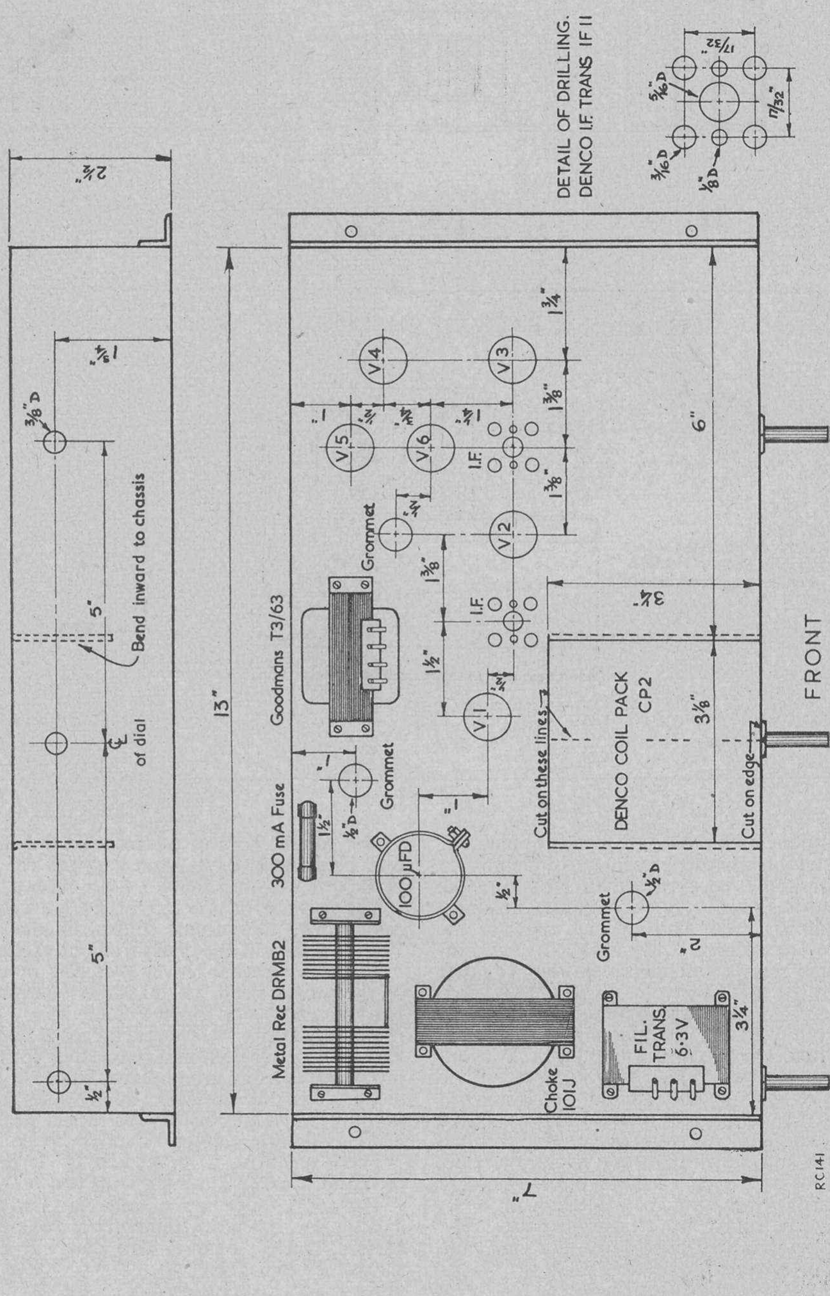
The spindle hole in the front of the chassis may be made ¾″ diam., and the pack can then be held in position by two 4-BA screws.

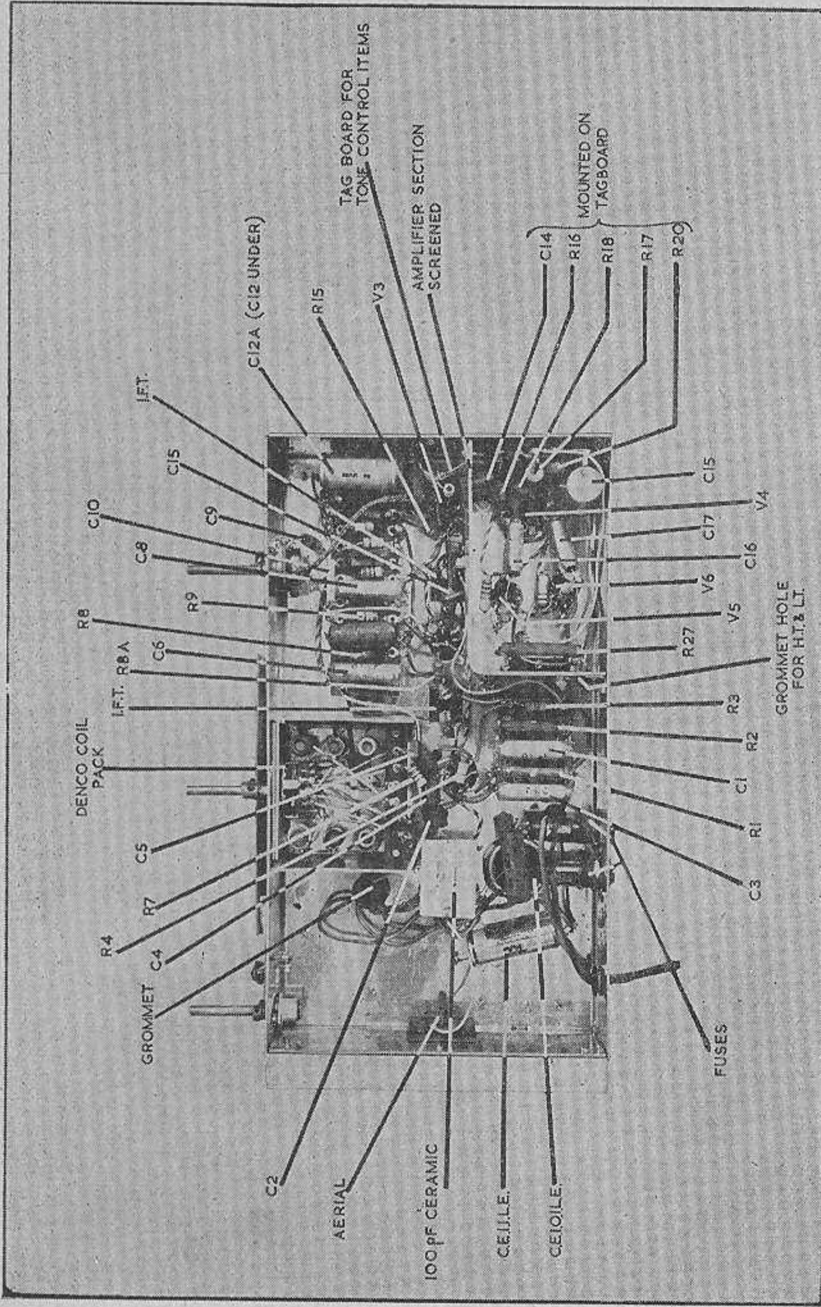
The drive is on the left of the wavechange switch, with the volume control on the right. This is shown in the chassis layout sketch.

The receiver changeover switch is mounted on the cabinet itself, as also is the tone control, one on each side of the set. The overall response of this receiver is so good that the tone control has been included mainly for those programmes using gramophone records. Surface noises from the discs are reproduced too faithfully, and the control as shown provides just enough attenuation for this purpose.

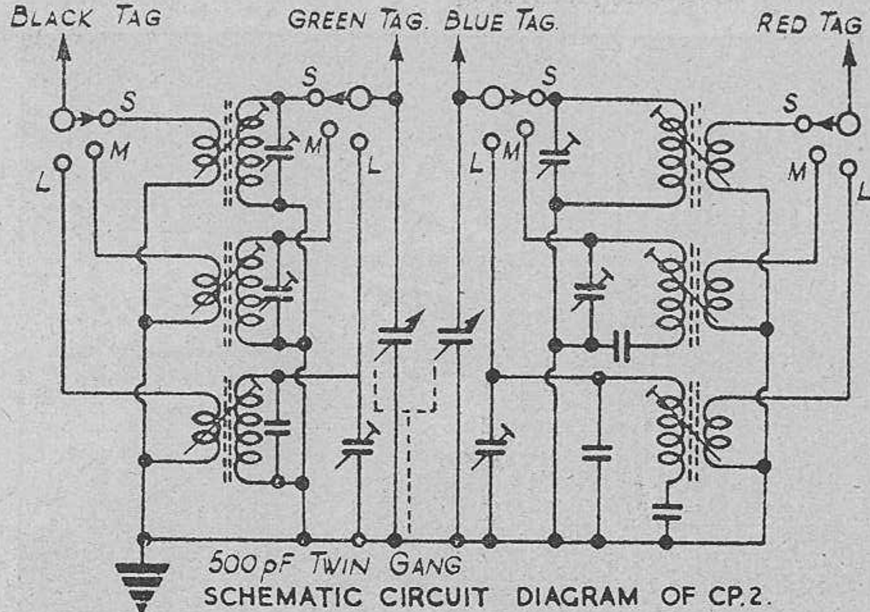
The drum drive is the Denco 2¾″ type, and the scale is easily mounted with two brackets.

The four knobs are obtainable from your local dealer, but if any difficulty is experienced Messrs. Uncles, Bliss of Croydon will gladly assist.


DETAIL OF DRILLING.
DENCO I.F. TRANS IF 11
Bend inward to chassis
of dial
Goodmans T3/63
300 mA Fuse
Metal Rec DRMB2
Grommet
Grommet
Grommet
100 µFD
Choke
101J
FIL.
TRANS
6·3V
DENCO COIL PACK
CP2
Cut on these lines
Cut on edge
FRONT
RC141



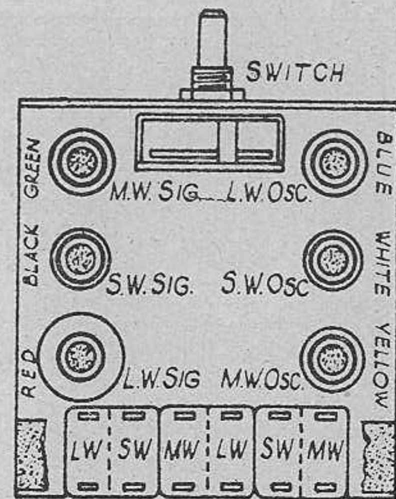
Under-chassis Layout—for top view see cover



SCHEMATIC CIRCUIT DIAGRAM OF CP.2.

I.F.: 465 Kc/s.
L.W.: 150 - 350 Kc/s.
M.W.: 530 - 1610 Kc/s.
S.W.: 6 - 18·5 Mc/s

TRACKING POINTS			
	F1	F2	F3
LW	165	250	315 Kc/s.
MW.	575	825	1450 Kc/s
S.W.	6·5		17 Mc/s.



TAG STRIP BROKEN TO SHOW TRIMMERS.

UNDERSIDE LAYOUT OF COIL PACK CP.2.

Coilpack details

Component Positioning

It is hoped that the components actually numbered on the chassis photograph will provide an adequate guide to enable the constructor to achieve a similar tidy and uncrowded appearance.

With a layout along these lines, there is less likelihood of instability and, of course, any future servicing is considerably simplified.

It will be clearly seen that a logical layout and sequence of components has been followed. Thus, the associated resistors for V1 and the coil pack may be seen on either side of V1. The IFT sequence follows in line with, again, components nicely beside their respective stages. The grid lead to the 6AT6 (detector) is screened and the metal braiding grounded to chassis at each end.

The amplifier is virtually on its own chassis; this section is enclosed by a screen of the same depth as the chassis. Grommet holes provided for the coupling condenser C14, HT and LT are made before the screen is bolted down.

The 1000 pF ceramic aerial isolating condenser appears to be rather large: it was to hand, so it was put to use.

One word to constructors who are not familiar with push-pull amplifiers. If any "howling" is experienced, this will almost certainly be due to the phasing of the output transformer. The cure is simply to reverse the anode leads.

The gain of this receiver is very high, and readers residing near a transmitter will definitely find it necessary to keep the volume control well down. A balance could be effected by the inclusion of a 50 kΩ gain control between the chassis end of R9 and chassis.

The grid stopper (R8A) is soldered right down to the base of the IFT. The lead from the latter component is cut close to the base.

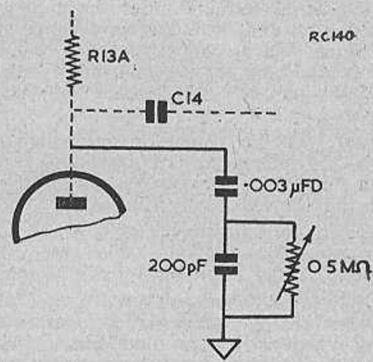
If any spurious whistles are heard near certain stations, it is advisable to try some further experiments with the aerial arrangements. The isolating condenser could be varied in value, or alternatively left out altogether and a simple separate aerial system be employed (but please remember AC/DC technique and earlier remarks concerning the chassis !) Quite obviously, where it is possible to erect a really efficient aerial system the performance of the receiver will be greatly improved.

Note (Errata)

Two resistors were omitted from the circuit diagram given last month. A 100 Ω resistor should be connected between G2 and anode of both V5 and V6. Inclusion of these greatly assists in maintaining stability. My apologies ! !

Your writer must apologise also for dropping one large brick! Valve types and their ratings have been confused, resulting in the publication last month of the wrong value for R27. For two 6AQ5's in push-pull as shown, R27 should be 150Ω 2W; the audio output is then 1.7 watts.

Alternatively, two 6BW6's could be used, with an HT supply of 285V; R27 would then be 240Ω 2W, and the audio output would be of the order of 3 watts.



OPTIONAL TONE CONTROL

Power Requirements

Approximately 100 mA at 250V HT.
Approximately 3A at 6.3V LT.

Note: The two halves of the DRM2B rectifier must be connected together as shown in the layout sketches.

Alignment Procedure

The scale provided with the CP2 coil pack must be in position, and the tuning condenser in line with the pointer.

Both the coil pack and the IF transformers are lined up at the factory, and the receiver should be thoroughly tried out before interfering with them. This trial may be carried out by reception of broadcast stations. Obviously, if the stations on identification fall upon the allotted position on the scale, the ganging and general condition of the set may be said to be "somewhere near!"

A temporary condition such as this is far better, where the constructor does not possess a signal generator or similar instrument, than attempting to find the correct laboratory setting by trial and error.

IF Alignment by Signal Generator

Connect the signal generator between signal grid (pin 2, 12AH8) and chassis. Peak each core of the IF transformers, working back from the detector (6AT6), for maximum sound from the speaker, using a modulated signal at 465 kc/s. The signal should be progressively reduced in order to avoid operating the AVC and thereby obtaining a false impression.

RF Alignment

Set the generator to 6.5 Mc/s and connect to the aerial terminal. Set the tuning dial to 6.5 Mc/s and, with the wavechange switch to Short Wave, adjust the SW oscillator coil (white) core for a signal, then peak with the SW signal coil (black) core for maximum response.

Next, set the generator and dial to 17 Mc/s and adjust the SW oscillator trimmer for a signal, and peak for maximum response with the SW signal coil trimmer.

Repeat the adjustments of cores and trimmers as above—one will affect the other—until no further improvement can be made.

Carry out the same procedure on Medium Waves at 575 kc/s and 1450 kc/s, and on the Long Waves at 165 kc/s and 315 kc/s. Always adjust the cores at the low frequency points, and the trimmers at the high frequency points of each band.

Note. If no signal generator is available, it should be possible to select known stations around the correct frequencies and so achieve considerable improvement.

The "Magna-View" Televisor

Recommended Modifications.

A considerable improvement has been effected to the Frame section of the time-base; those residing in fringe areas will feel the greatest advantage.

Frame lock is far more definite and interlace consequently easier to obtain. Refer then to the time-base circuit.

Remove C9, C11, and R17. Replace C9 with a 0.01 μF condenser connected to a 10 kΩ resistor in series, and connect the other end of the resistor direct to O.P. on the frame blocking transformer. R37 becomes 1.5 kΩ and R36 becomes 82 kΩ. This greatly increases line stability.

C27 and C28 should be the subject of personal experiment; the following series combinations have been used successfully:—(100pF–50pF), (47pF–47pF), (82pF–82pF).

There is some variation in the efficiency of the Ferroxcube in the Line output transformer, and this may be compensated by the above. Line linearity will be noticeably improved when the correct combination is employed.

LEAVING OUT THAT HEAVY SMOOTHING CHOKE

Now that there are available large capacity condensers of 60–100μF at 350 VW, it is often cheaper to use these sizes in conjunction with a smoothing resistor of, say, 500 ohms, and the ripple will be as low as when using a conventional choke with 8μF condensers.

When this type of smoothing is used for test instruments, low frequency problems are reduced by the large capacity of the condenser.

G.B.

TECHNICAL DATA SERVICE

A technical data service for the benefit of engineers engaged in the design of radio and industrial electronic apparatus has been introduced by The General Electric Co. Ltd.

This service, which covers Osram valves, G.E.C. cathode ray tubes, Germanium crystals and associated electronic devices, consists of the distribution of technical data sheets as they are published.

The initial distribution comprises a loose-leaf binder and the complete series of data sheets issued up to the current date. All subsequent data sheets are forwarded to the subscriber and the overall cost is 7/6. Additional binders can be supplied at any time, the price being 7/6 each.

The information provided meets the full needs of the designer and is published in a standardised form which allows easy and quick reference to be made. Application forms can be obtained from the Osram Valve and Electronics Dept., The General Electric Co. Ltd., Kingsway, London, W.C.2.

Radio Miscellany

Centre Tap *talks about*

Amateur Radio—Colour Television—TV Sports

It takes all sorts of people to make up a world and so, apparently, it takes a wide divergence of readers to make up a technical magazine's circulation. Thus we occasionally have suggestions that too much space should not be given over to amateur transmitting interests. Some gently suggest that such articles should be transferred *en bloc* to *The Radio Amateur*, but others are less restrained in their condemnation of "ham" radio. Not only do they regard it valueless under present day conditions, but look upon it as something more than a bit of a nuisance. The transmitting amateur can achieve nothing new, they state, and the vast majority of them waste airspace by trivialities and facetious chatter.

To hear a few amateurs "on the air," one can hardly wonder that the superficial listener should form such an impression, and it is certainly true that technical advances come from the laboratory rather than by hit-or-miss amateur experiment. Nor can it be denied that TV design, or even magnetic recording, makes more exacting demands of a constructor's knowledge and skill than the building of 150-watt transmitters.

For my own part I admit a keen and direct interest in the transmitting side of the hobby, but my objection against such charges is not simply a personal one. For a start, I cannot accept the view that official "tolerance" of amateur radio is in any way parallel to buttering the baby's heel—that it can't do much harm and it may do some good. Or that amateurs have claimed that they alone pioneered short-wave communications for so long that even the Post Office have been talked into believing it !

A National Asset

There are two reasons, at least, which from a purely official angle justify their continued sanction—and blessing. An experienced group possessing operational and technical skill is of enormous value in times of national emergency. In the last War amateurs played an important role, particularly in the early years, when a very high percentage of them were called on for instructional duties in the Services. Many of them, too, attained high commissioned rank. Secondly, the frequencies allocated for their use can officially be regarded as being "held in reserve" in the event of another War, against any Service requirement. These frequencies can be called on without disrupting any of the essential services.

Technically, amateur radio does not play such an insignificant part after all. Whilst the percentage of amateurs doing truly original experimental work may be small, their influence is considerable.

The equipment demanded by amateurs stimulates development, and helps to make possible its economic production as well as providing a useful testing ground. A testing ground, too, where progressive ideas are tried out independently and on a keenly competitive basis. Nor can it be overlooked that many radio designers are able to undertake personal experiment under an amateur licence, and the amateur movement forms a recruiting ground for the Radio Industry.

Oddly enough, one important factor has already proved its value in a casual sort of way, although it has never been put to use on an organised basis. I refer to mass observation—communication conditions, seasonal changes in propagation, etc. A world wide chain of amateurs pursuing a definite line of observation or experiment would, if properly organised, have enormous value.

In this very sketchy vindication I have carefully avoided the "appeal to sentiment" or the "democratic" justifications of amateur radio. They are admittedly of lesser importance, but are nevertheless real. I hope, however, that I have said enough to satisfy the most obstinate "anti" that ham radio has its uses. Also, that in fairness to a large number of readers transmitting topics deserve the space which may be given over to them in the pages of *The Radio Constructor*.

The Editor and I have long felt that the artificial barrier which exists in some quarters between amateurs and " others " should have never been allowed to have arisen in the first place. We hope that by sharing a common meeting place in our pages a step towards the removal of that imaginary dividing line may be taken.

Black *IS* White

As the prospects of sponsored TV and its promise of alternative programmes for many viewers grows brighter, the problem of tunable receivers is engaging more attention. True, many models now produced are tunable to the extent that they can be pre-set for several, or all, of the B.B.C. transmissions. What we have yet to see is a receiver which can be tuned, preferably by a single external knob, to a range of frequencies.

While I have sampled several of the European systems, I have not had the good fortune to visit the United States, where in many cities viewers have the choice of a half-a-dozen programmes. Two or three years ago any town became limited to not more than seven transmissions. I believe this still holds good.

The one aspect of American TV which has always fascinated me is their use of a "reversed" transmission system, and I have often wondered why we have never made use of it over here. Full modulation of the signal corresponds to black, not white as in this country. Thus unwanted signals such as ignition and other interference (in effect additional signals) appear on the screen as black streaks instead of the irritating white splotches we know so well. Under such a system visual interference becomes virtually unnoticeable.

Colour Vision

It seems that TV in colour is to be denied us for a long time to come. Basically it is not difficult. In fact, three different systems have long since been satisfactorily demonstrated. Their great drawback is that they need a wave-band two or three times as great as that of black and white. The same objection, of course, holds back the development of stereoscopic TV which is equally perfectly practicable.

It is odd how quickly viewers, who at first thought the screen size of the average home receiver absurdly small, accustom themselves to it. Yet despite what one might have normally supposed, large screen projected TV seems to be making but little progress. Many people are disappointed by the fact that the projector takes up what they regard as the best viewing position.

That so many improvements could be introduced immediately (at the risk of making many sets obsolete) makes one wonder how long it will be before they come to be regarded as normally necessary to the fuller enjoyment of the programme. That they must inevitably become part and parcel of our daily programmes, sooner or later, is beyond doubt. Just when, is still anybody's guess, or even the order in which they will arrive for that matter—colour, large screen or stereoscopic reproduction. By " arrive " I mean in the home, of course — they have all three been knocking at the door for several years now.

What a Game !

The arguments about the telecast of sporting events still continue, and again the silly suggestion is put forward that the B.B.C. should give us telefilms of events long after they have finished. I must certainly hope not ! Viewers want to see an event while it is actually happening and the result is still in doubt. Does anyone get a thrill out of seeing a horse-race in the Newsreels hours after it is all over and the whole world knows the result ?

Let us have scenes from the venue, the crowds, the bookies, the excitement and the horses at the winning post, by all means. But please, B.B.C., preserve us from the boredom of watching whole races five hours late. A football match, especially one in which the *result* is the real interest, would be equally boring. Two or three minutes of the highlights of the game is ample — not a repeat performance.

As for football, if the " Sportsmen " running the big time Clubs continue to show more interest in the clicking of the turnstiles than in the sport itself, let the B.B.C. organise a Zone competition of their own as I have already suggested. After all, they form their own Symphony Orchestras and run their own Concerts — capitalised by listeners' money. There are far more football fans than Symphony lovers. The prospect of seeing the Kirk o' Shotts Mudlarks playing the Wenvoe Wanderers in a Cup Final at Ally Pally would delight not only the football fans, but also the Elderly Ladies to whom the B.B.C. seem to direct most of their programmes.

Television Price Reduction

The General Electric Company Ltd. announces a substantial reduction in the price of the television preamplifier, BT.166, from £2 10*s* 0*d* to £1 10*s* 0*d* to take effect immediately.

Purchase tax is not payable on this item of equipment.

Query Corner

A Radio Constructor service for Readers

Two anode TV Tubes

I am using a Mullard two-anode C.R. tube in my television set, and receive a very good picture. I am not clear, however, as to the effect which the first anode voltage has on the results which are obtained with these tubes; perhaps you would enlighten me on this point?

(*D. Summer, Carlisle*)

The two-anode, or tetrode type of cathode ray tube as it is more generally known, has besides the final very high potential electrode a further anode which is maintained at a low potential. The actual voltage applied to this low potential anode has quite a marked effect upon the reproduced picture, and it is advisable to give the matter some consideration when designing a new receiver. In general, if the first anode potential is low, say in the region of 200V, the focus in the centre of the screen will be fairly good, whilst there should be very little tendency to deflection defocusing. In other words, when the potential is low the overall focus on the screen will be reasonably good, but the peak beam current will be limited and the picture may not possess all the highlight intensity which is desired. At the other end of the scale, if the first anode potential is made reasonably high the focus in the centre of the screen will be very good but there may be an increased tendency towards deflection defocusing. Also, as a result of the higher potential a greater beam current will be available and will enhance the highlight brightness, but it will at the same time increase the grid base of the tube and therefore decrease its modulation sensitivity. It will be apparent from the foregoing that the effect of the first anode potential of a cathode ray tube upon the beam current and grid base is similar to that which the screen grid of a tetrode valve has upon its anode current and grid base. The greater the voltage on the low potential electrode, the larger is the current which the tube or valve passes, but the less its sensitivity becomes.

Like so many other features in the design of a television receiver, the choice of the first anode voltage of a cathode ray tube is essentially a compromise. The compromise in this case is between centre focus and deflection defocusing on the one hand, and between sensitivity and highlight brightness on the other hand. It has been the writer's experience that the best all-round performance is obtained with tetrode tubes when the first anode voltage is in the region of 300V. The makers specify that the voltage must be within the limits 200–400V, otherwise the tube cannot be guaranteed to provide a satisfactory performance. It must be realised that when we refer to a potential on the first anode of a tube we mean

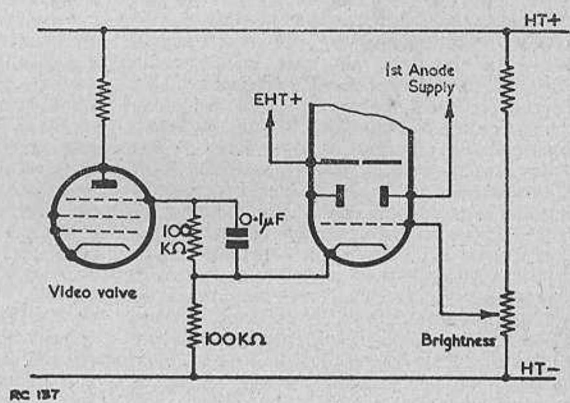


Fig. 1. Indicating the use of a potential divider across the video valve.

Note. The junction of the 100 kΩ and 0.1µF should be connected to the video anode, and not to the suppressor grid as shown!

Query Corner

RULES

(1) A nominal fee of 2/6 will be made for each query.

(2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams, for the more complex receivers, transmitters and the like.

(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.

(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.

(5) Correspondence to be addressed to "Query Corner," Radio Constructor 57 Maida Vale, Paddington, London, W.9.

(6) A selection of those queries with a more general interest will be reproduced in these pages each month.

that voltage which is measured between the first anode and cathode of the tube, and not the voltage between the anode and chassis. Thus, as the cathode of the tube may well be some 150V positive with respect to chassis it is necessary to find a DC voltage of at least 350V to supply the first anode. Now this is not always easy, and in some receivers it is necessary to reduce the cathode potential of the tube so that full use can be made of the maximum available HT voltage.

The cathode voltage may be reduced by feeding the tube modulator from a potential divider across the video valve. Such a divider is shown in the circuit of Fig. 1, and consists simply of two resistors and a capacitor. The AC Component of the video signal is passed to the tube via the capacitor, whilst the DC component together with the standing or steady voltage is attenuated by the resistors. A divider of this type not only increases the voltage on the first anode of the tube but it also reduces the tendency to the defect which is usually termed " aircraft flutter " and generally enhances the stability of the picture. The values given on the circuit diagram will result in an attenuation of the DC level of 2:1, thus should the anode voltage of the video valve be 150V, the cathode voltage of the picture tube will be 75V. This represents a saving of 75V, which is of course added to the effective first anode voltage. It is not recommended that the DC level should be reduced by more than 3:1, otherwise a certain amount of realism will be lost from the picture and the flyback lines may become visible at normal settings of the brightness and contrast controls.

Finally, it may be necessary to alter values of resistors in the brightness control circuit after an attenuator has been added to a receiver. This may be necessary to enable the control to bias off the CR tube when turned to the minimum position. It is hoped that the above comments will assist constructors in that seemingly never-ending quest for the last little improvement which can be regarded as providing a perfect picture.

Long Flyback Time

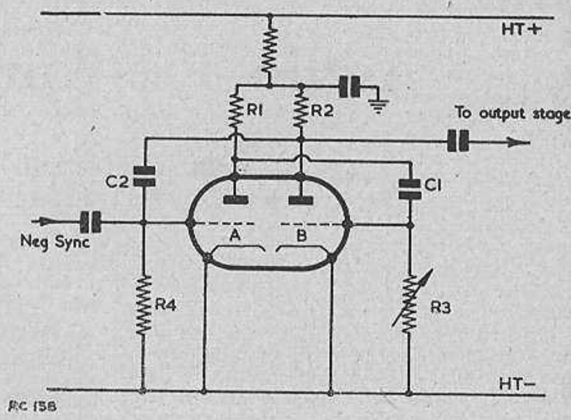
My television receiver employs a multi-vibrator in the line oscillator circuit, and whilst the results are very satisfactory, I believe that the line flyback time is rather too long as a part of the left hand side of the picture is missing. This defect, whilst not being particularly noticeable on an ordinary picture, is quite obvious when a test card is being received.

(*E. E. Colndale, Highbury*)

It is very possible that our correspondent has correctly diagnosed the cause of the trouble in his television set. A long line flyback period will certainly result in distortion on the left hand side of the picture, and because part of the picture detail is being transmitted during the time the scanning spot is returning to the left, the picture usually appears as though it has a fold down this side. With the type of line time base in which resistance-capacity damping is employed across the line coils, a fold on this part of the scan frequently indicates that the value of one of the damping components is too large. Having checked this point, ensure that the line oscillator valve is in good condition, as this is also a likely cause of the trouble.

Having checked these two possible defects, attention must now turn toward the components in the line oscillator stage, and perhaps a brief explanation of the mode of operation of the multi-vibrator will be of assistance in diagnosing faults. The basic circuit is shown in Fig. 2, and is very similar to the arrangement used in the " Magna-View." The oscillator employs a double triode, one half of which conducts during the flyback period and the other half during the forward stroke of the scan. Let us commence by assuming that Section A of the valve is conducting and that the charge on C1 is such that its lower plate is negative, thus biasing off Section B. The charge on C1 gradually leaks away via R3 until Section B begins to conduct. At this instant, section B begins to draw anode current and, due to the voltage drop in R2, the anode voltage decreases. Whilst Section B is cut off, the capacitor C2 charges up from the HT line via R2 and R4. This means that when the anode potential of B falls, the grid of A is

Fig. 2: Basic circuit of a multi-vibrator



driven negative and its anode current decreases, allowing its anode potential to increase. This in turn decreases the bias on B which conducts still more current. This effect is cumulative and very rapidly the change-over occurs, so that B is conducting and A is cut off. However, as the time constant C2/R4 is relatively short the charge on C2 leaks away quite quickly, and A once again begins to conduct and B is cut off. Thus, if the time constant of C2/R4 is short compared with that of C1/R3, Section A will conduct only during the flyback period and Section B conducts during the scanning stroke. Whilst this may seem a little involved when described in so many words, the basic mode of operation is really quite simple and once understood is easily remembered.

From this description it will be apparent that to decrease the duration of the flyback it is necessary to decrease the time constant C2/R4 by either reducing the value of R4 or C2. If, as shown in the circuit diagram, the sync pulses are fed in across R4 it will probably be found better to decrease C2, as this will not adversely affect the stability of the line hold.

The foregoing is a short survey of the most likely causes of a fold on the left hand side of a picture in a receiver which employs a multivibrator as a line oscillator.

THE R.E.P. HIGH GAIN DUAL RANGE COIL.

(Radio Experimental Products Ltd., 33 Much Park Street, Coventry).

This is just the coil for constructors wishing to build a simple and effective receiver for personal use.

The Radio Constructor has been asked many times to publish circuits employing one or two valves. We feel that this coil could very well be the basis of such designs.

The makers supply a leaflet with each coil, giving circuit diagrams and values for four battery and mains receivers.

The coil itself is very neatly made, and is wound on a low loss polystyrene former of the Aladdin type, with the medium wave winding of litz wire to minimise RF losses. The long wave and reaction windings are of silk covered enamelled wire. Connections are colour coded, and are brought out to a tag panel fitted to the top of the former.

Moderately priced at 4*s*, these coils may be recommended to those readers wishing to build an efficient, yet inexpensive, receiver.

A.S.T.

ENGRAVED CONTROL KNOBS

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Audio Pre-Amplifiers

By D .Nappin

PART 1

Pre-amplifiers are a necessity for use with any high quality gramophone or radio reproducing system. The reason for this is two-fold: firstly, due to deficiencies in the recording and reproducing apparatus certain distortions are introduced, which may be corrected for by means of the pre-amplifier; and secondly, the pre-amplifier serves to amplify the output from the pick-up or radio feeder unit to such a level as will fully drive the main amplifier.

Hence, this article sets out to describe methods of compensation for various types of distortion, and also to describe a pre-amplifier which may be used with the authors' amplifier (see May 1952, issue).

The requirements of a pre-amplifier may best be formulated by a consideration of the types of distortion liable to be present.

Basic Types of Distortion

Three types of distortion may manifest themselves in sound amplification.

Foremost amongst these is *frequency distortion*, or unequal amplification of the various frequencies in the signal, thus altering the relative level of these frequencies in the output signal as compared with the input to a unit possessing such a distortion.

Secondly, there is *phase distortion*, or alteration of the relative phase of the components of the input and output signals.

Finally, there may be present *harmonic distortion*, or non-linearity distortion, which as its alternative names imply, results in the introduction of harmonics of the frequencies present in the input, by reason of the output bearing a non-linear relation to the input effects of these distortions.

As signals liable to be dealt with most likely possess transients, i.e. rapid rises and falls in signal amplitude, the effect of the various types of distortion upon a square wave will be considered in addition to the steady state response, as the square wave possesses the characteristics of a sharp rise and fall (Fig. 1A).

(1) Frequency Distortion

For a non-transient signal the effect is merely to make the output, if produced via a loudspeaker, sound " bassy " or " toppy " in varying degrees depending on the shape of the response curve. With a square wave, reduction in the amplitude of the upper frequencies with a gradual roll-off results in rounding off the corners of the square pulse and causing the rise time to increase as in Fig. 1 (b). If a sharp high frequency cut-off be present, ringing or damped oscillation at the cut-off frequency will be produced, also with a poor rise time as in Fig. 1(c). A dip in the frequency response curve may cause ringing and a step in the rise and fall of the pulse as in Fig. 1 (d).

A similar effect is produced by a peak in the response.

Loss of low frequencies causes the top of the pulse to droop as in Fig. 1 (e), due to coupling capacitors with inadequate time constants discharging before the end of the pulse. Slope of cut-off at the low frequency end has little effect upon the droop of the pulse other than in magnitude.

(2) Phase Distortion

Little or no aural effect upon non-transient signals and programme matter is noticed where phase distortion is present, due to the ear being non-phase-conscious. This holds so long as stereophonic systems are not in use. The Author does not propose to deal with such systems in this article.

The chief effect of phase distortion upon a square wave is to introduce overshoot and pre-shoot, without ringing however, if the frequency characteristic be flat. Low frequency delay produces pre-shoot chiefly, whereas high frequency delay produces overshoot and undershoot as in Fig. 1 (f) and (g).

However, correction of phase shifts requires networks capable of changing relative phase of the frequency components of a signal without altering their relative amplitudes. This is a difficult task due to, firstly, lack of suitable networks and, secondly, the absence of any standard with which to judge the correction, hence the Author will not consider networks for use in phase correction. However, the circuitry of the pre-amplifier has been designed so as to avoid excessive phase shift within the frequency range to be handled.

(3) Non-Linearity Distortion

This form of distortion, so long as neither of the other forms of distortion are present, has no effect upon a square wave other than restricting its amplitude. However, upon sinusoidal signals the peaks are clipped causing a sine wave (Fig. 1 (h)) to distort to (j). This causes production of harmonics of the input frequencies and also the intermodulation tones of these frequencies. Thus, if frequencies of 50 c/s and 400 c/s are applied to the input of an apparatus introducing harmonic distortion, the intermodulation tones will be 350 c/s and 450 c/s.

It may be proved (Ref. 1) that the ratio of the total intermodulation products of the second order, i.e. the 350 c/s and 450 c/s tone to the second harmonic of the 400 c/s tone is 2J½ for any arbitrary amount of non-linearity.

This form of distortion causes most unpleasant harshness, and cannot be eliminated once present in a signal.

However, if the signal level handled by each stage in the amplifying installation be kept low such distortion need not be introduced into a signal, and hence will not be considered further.

Thus it will be seen that for the purposes of correction only frequency distortion will be considered. As the only forms of signal likely to be handled by a quality installation will emanate from a gramophone or radio feeder unit, the frequency distortions peculiar to these sources and corrections applicable will be considered in more detail.

Distortion occurring in radio reproduction

By International Regulations, Radio Stations or Groups of Stations are allocated, in accordance with the Copenhagen Plan, channels 9 k/cs wide. Thus, as double sideband A.M. transmission is employed the maximum sideband excursion, and hence the maximum modulating frequency, is limited to 4½ kc/s.

As the frequencies above 4½ kc/s may not be restored, a low pass filter may prove advantageous in removing interference above this frequency, such as the 9 kc/s whistle due to beating of adjacent carriers. However, a B.B.C. Official has informed the writer that on certain programmes, e.g. concerts, a frequency spectrum extending to 10 kc/s is transmitted. In this case a sharp cut-off filter is not advisable and if any cut is found desirable, i.e. to remove 9 kc/s whistle, a roll-off from 5–7 kc/s at 6 db per octave or more, but preferably less than 18 db per octave to reduce high frequency phase shift, will be necessary. A variable slope filter may prove an asset.

Further distortion may be engendered by reason of deficiencies in the radio feeder unit. A loss of higher modulation frequencies occurs due to partial removal of the sidebands carrying

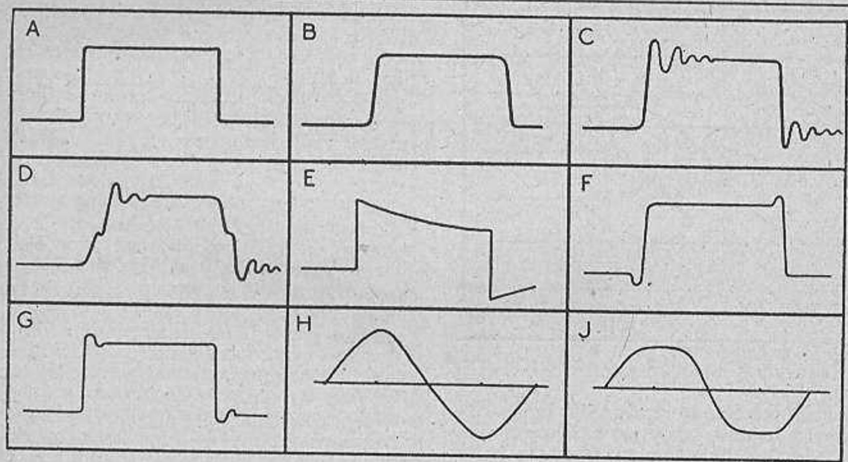

FIG 1

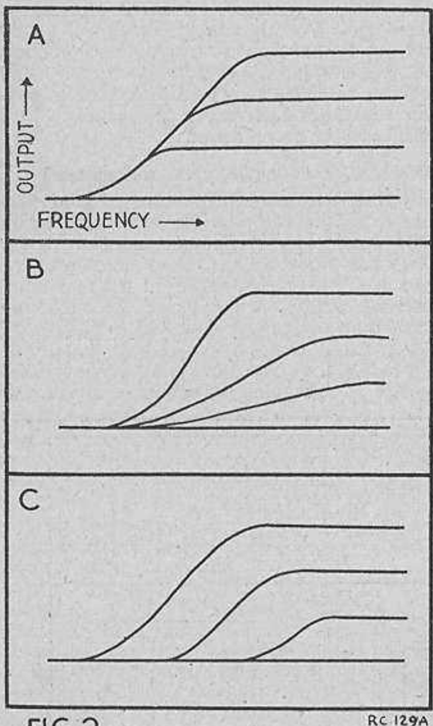

FIG. 2

these frequencies by sharply tuned RF and IF circuits.

It may be possible to remedy this by re-trimming the feeder unit; however, with appropriate design this fault should not occur. The writer intends to contribute an article dealing with radio feeder units in a future issue.

Another source of distortion occurs at high modulation percentages due to inequality of the AC and DC loads of the detector (Ref. 2). This clips peaks, thereby producing non-linearity distortion. Such distortion may be minimised by increasing the grid resistor of the following stage and tapping the coupling capacitor down the diode or other detector load resistor.

Apart from these distortions, frequency distortion due to loss in land lines, faulty equalisation and loudspeaker characteristics may occur. In addition, lack of musical balance may well be present on account of bad microphone siting. Correction for such faults must be largely empirical and often dictated by aesthetic considerations. As, however, equalization is usually performed with respect to a reference frequency of 1000 c/s, which frequency is sufficiently near 707 c/s the geometric mean of the usual frequency range for high quality equipment, i.e. 25 c/s–20 kc/s, to be considered the frequency dividing bass from treble, it is thus a suitable frequency about which to vary the response.

Boost and cut of both treble and bass are required, and these may be achieved by two means of variation, variable extent of boost or variable slope of boost, giving characteristics as in Fig. 2 (a) and Fig. 2 (b), only high frequency boost being shown, bass and HF cut characteristics being similar.

It is a debatable point which of these characteristics is the most suitable for general use. The writer, after comparative tests, has come to the conclusion that for bass compensation a variable slope control is most advantageous. A bass control to the modified " Williamson " circuit (Refs. 3 and 4) is suitable for this usage, and if desired the associated treble control may be incorporated as in Figs. 3a and 3b.

This treble circuit, according to Williamson, gives constant slope of boost and cut with a variable crossover frequency; however, as the resistor R5 forms with the left hand portion of Potentiometer R4 a potential divider, a steplike response is introduced where the maximum height of the step decreases at low levels of boost or cut giving a response as in Fig. 2C. This response is comparable with the variable slope response and is a most desirable characteristic.

It is, however, possible to combine the steep cut filter mentioned earlier with a variable slope filter employing suitable cut frequencies. This may be done by means of an amplifier employing a frequency selective feedback loop incorporating parallel—T or similar networks, and, indeed, at least two commercial pre-amplifiers employ such a circuit. The writer is not aware how this is accomplished commercially; however, it appears that a potentiometer in shunt with the bridge when arranged in a circuit such as " Williamsons " (Ref. 3) should accomplish this end and, indeed, appears to produce the desired effect although no measurements have been taken to substantiate aural impressions.

[*To be continued*

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(1) *Roddam, T., Intermodulation Distortion, Wireless World, April* 1950.
(2) *Cocking, W. T., Diode Detector Distortion, Wireless World*, May 1951.
(3) *Williamson, D. T. N., High Quality Amplifier, Wireless World, October* 1949.
(4) *Correspondence, Wireless World, December* 1949.

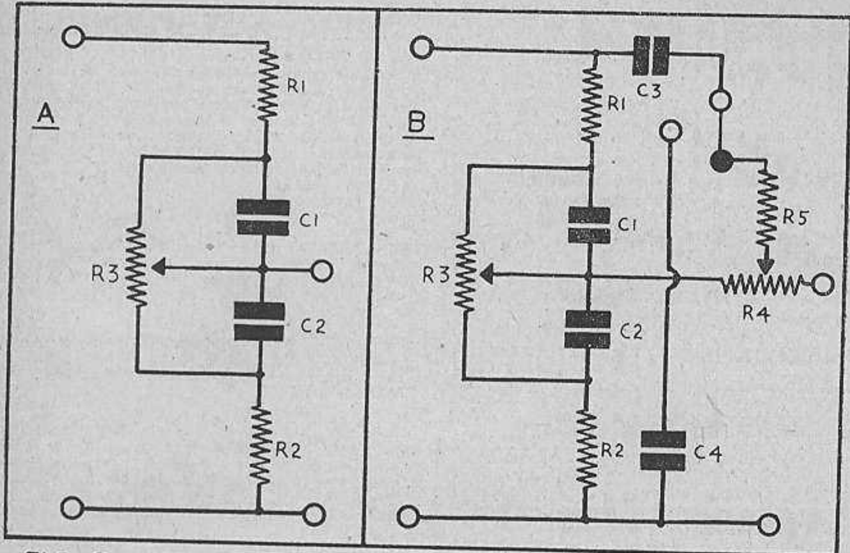

FIG. 3 RC.130A

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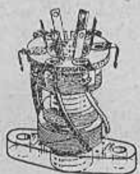

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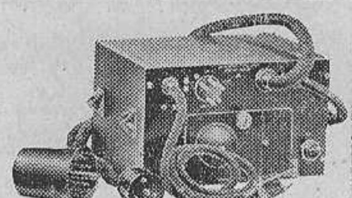

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