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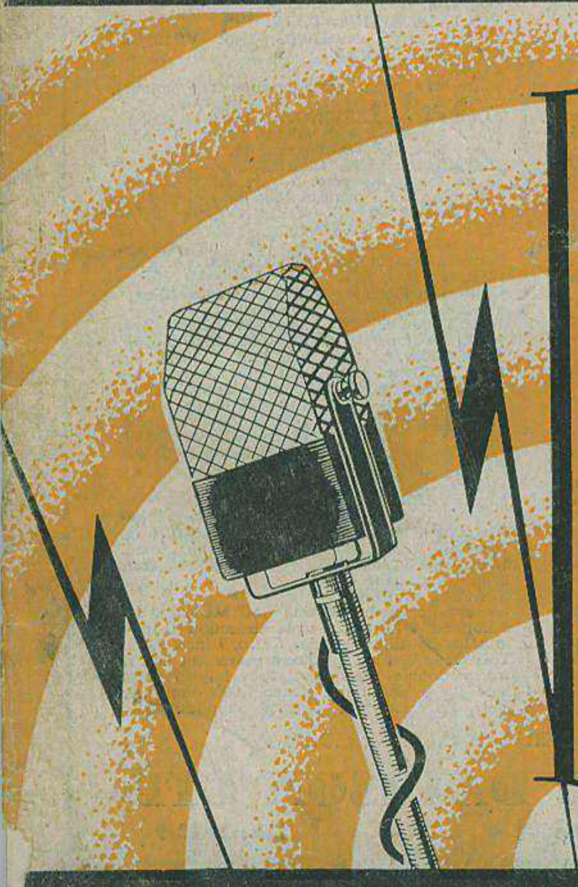
Vol. 1 No. 10
MAY
1948

RADIO CONSTRUCTOR

For Every Radio Enthusiast



Contents

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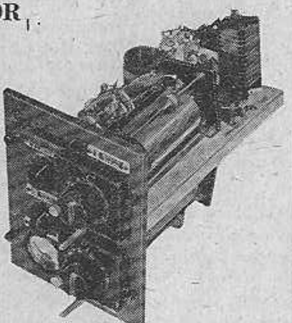

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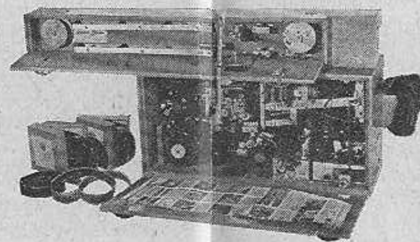

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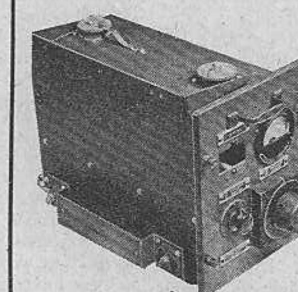

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PERIBRAID SLEEVING.
Finest quality for high voltage. 1mm., 1.5mm., 3mm., blue, yellow, or green, 4d. yard.

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33 in. long. 0.3 amp. 2-way, fitted 5 amp., 2-pin plug, and American 2-pin flat socket, 7/11.

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SPECIAL OFFER.
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Radio Constructor

Vol. 1, No. 10 **Annual Subscription 16/-** **May, 1948**

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LIONEL E. HOWES, G3AYA

Advertisement & Business Manager:
C. W. C. OVERLAND, G2ATV

Editorial

LAST month, readers will have noticed an extra name in our heading—that of Lionel Howes, G3AYA. Recently returned to civilian life from the R.A.F., Lionel has been appointed Technical Editor to *Radio Constructor*. He will assist his two co-editors from the technical angle and we feel that this addition to the staff will enable us to maintain a higher technical and literary standard. To do this, we must all work together—co-operation the keynote.

Lone Hands.

Another type of co-operation is that which may be exercised by the amateur radio constructor. We refer to the local club. Taking into account the enormous numbers interested in radio work, it is obvious that only a few attend their local club meetings. There are many obvious reasons which cannot be helped for the "stay-aways," but we also know that the feeling of having insufficient knowledge of the subject keeps many away. This feeling should be ignored. The rank and file of the local club are not *all* experts! Should the test be made, furthermore, it would be discovered that many absentees would outshine the club-goers.

In any case, knowledge is *not* the criterion. The dominant factor is, or should be, keenness. A veritable Marconi who neglects the club affairs is less valuable an asset than the 15-year-old who has yet to build a stable one-valver, but who puts all his energy into the club.

Practical Work.

Another possible deterrent is the feeling that meetings may be just a lot of talking—no doubt informative and interesting, but with no practical side offered. It is fair to say that it is only the very stubborn cases who take this view, but it is important that clubs without practical facilities should lose no time in making them available. Fortunately, many clubs are now running constructional sections and several ISWL Chapters offer a "members' repair service," whereby offending receivers are serviced at the club.

An Extension.

Co-operation is the vital ingredient of amateur radio, but it does not have to be confined to the immediate boundaries of the hobby. For example, the Dagenham branch of the ISWL is co-operating, to mutual advantage, with the South-West Essex Model Aircraft Society, since both are interested in the radio control of models. So, it will be seen that all along the line co-operation is the key. It starts with the individual enthusiast, so how about dropping a line to your local club secretary to start the ball rolling?

W.N.S.

NOTICES

THE EDITORS invite original contributions on construction of radio subjects. All materia used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsman 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.

COMPONENT REVIEW. 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. 6579.

An Introduction to the Theory of Thermionic Valves

By Kenneth R. Goodley

Part 2—The Triode

IN the first article in this series it was explained that a Diode consisted of an evacuated glass "envelope" containing an anode and a filament. If a spiral of fine wire is inserted between these two electrodes, the valve then becomes what is known as a Triode.

This spiral of wire is known as the CONTROL GRID (or more commonly "grid," for short), and is situated in the path of the electrons flowing from the filament to the anode. From this it can easily be seen that any voltage applied to the Grid will have the effect of accellerating or retarding the flow.

An examination of the effects of various voltages being applied to the grid shows that when a low positive voltage (that is positive with respect to the filament) is applied, the electrons will be accellerated by the proximity of a positive voltage and more current will flow across the valve to the anode, thus increasing the current in the circuit.

If, on the other hand, we continue to raise the positive grid voltage, the stage will be reached in time where no further increase in anode current will result, regardless of how much the voltage is raised. This is known as SATURATION POINT and the effect is due to the fact that the grid, although not solid like the anode, is absorbing part of the electron flow and to all intents and purposes is acting as an auxiliary anode.

What happens if the grid voltage is reduced to zero and then made negative with respect to the filament? When the grid voltage is reduced in 1 volt steps from -2 to -5 or −6 v. (approximately) it is found that each reduction results in an equivalent reduction in anode current. Past this point, making the grid voltage more negative causes a reduction to zero of the anode current (Ia). This is the point at which the negative voltage on the grid is sufficient to reduce the effect of the positive anode potential to such an extent that the electrons are no longer attracted from the filament and therefore no current flows. This is known as the CUT-OFF POINT.

Before going further I would mention that there are a number of constants which are of importance in circuit design and in the accurate choice of valves for specific purposes.

The first of these is known as the MUTUAL CONDUCTANCE (or "SLOPE") of the valve—usually indicated by gm.

This is calculated by finding the change of anode current (Ia) resulting from a given change in grid voltage (Vg), the anode Voltage (Va) remaining constant.

Formula:

$$gm \left(\frac{\Delta\ Ia}{\Delta\ Vg} \right) mA/volts.$$

Note: The sign Δ (delta) indicates "a small change in . . ."

It should be realised that these calculations are taken on the ***straight*** section of the characteristic and that we are not concerned with actual values of voltage and current, but merely with small changes. The Mutual Conductance is usually measured with Va=100 and Vg=0 and is obtained under static conditions.

The second constant is the AC RESISTANCE or IMPEDANCE, which may be defined as the resistance offered by a valve to a change in current. This can be found in two ways. First, from the Anode Characteristics (Fig. 4 inset) taking a change of, say 10 volts, in Va, ascertain from the curve the effect on the Ia. Then divide the voltage change by the current change, *i.e.*,

$$Ra = \frac{\Delta\ Va}{\Delta\ Ia}\ \text{ohms}\ \textit{(at constant Grid Voltage)}$$

The second method of determining the Ra is by means of the Mutual Characteristic (shown in Fig. 4 and explained below). Taking any given point of Vg on the straight portion of the characteristic (say at Vg = 0) note the current reading for any two values of Va, calculate the voltage and current variation and then work on the formula given above.

Next we have the AMPLIFICATION FACTOR (or "μ") of the valve. As has already been shown, a given change in Anode Current can be obtained by:—

1. a change in Va (maintaining Vg at a constant level);

or 2. a change in Vg (keeping Va constant).

The ratio between the change in Anode Voltage to the change in Grid Voltage necessary to produce a given alteration in Anode Current is known as the Amplification Factor, *i.e.*

$$\mu = \frac{\Delta\ Va}{\Delta\ Vg}$$

The relationship between the three constants is
$\mu = gm \times Ra$

Having dealt with the constants, some consideration must now be given to the "characteristics" of the triode.

The Va/Ia curve or ANODE CHARACTERISTIC is much the same as for the diode valve. It is shown in the inset to Fig. 4, and gives a good indication of the effect on Ia of a change of Grid Voltage. This effect is also noticeable in Fig. 4—the Mutual Characteristic—which also shows the results obtained during experiments of varying the Anode Voltage.

By comparing the two graphs it can be seen that a variation of 1 volt on the Grid (indicated in the small diagram by the thick line) raises the Ia by 2 mA, while at Vg=0 on the main graph, the same increase (similarly indicated) is only achieved by increasing the Va by 20 volts.

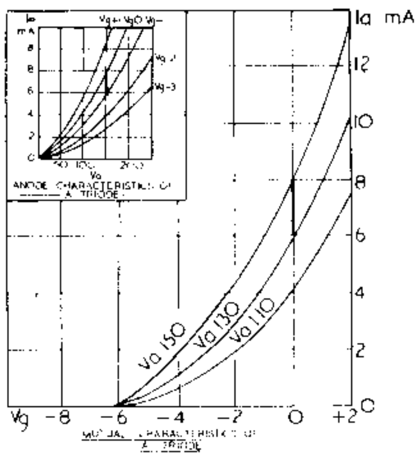


Fig. 4.

One other characteristic, though of little importance, is the Grid Current Grid Potential relationship. The grid, as has been explained, is primarily a controlling and not a collecting electrode. Grid current is normally undesirable, but when the grid is nearing or above zero potential, it does collect some electrons. The value of this current is extremely small—usually a few micro-amps.

There are three main types of triode in common use, *viz*:

(1) DETECTOR AND RADIO FREQUENCY AMPLIFIER.

(2) AUDIO FREQUENCY AMPLIFIERS.

(3) POWER AMPLIFIERS.

Typical values are :—

- Det./RF Amp.: gm 7-1.5; Ra 20,000-50,000; μ 15-50.
- AF Amp.: gm 9-1.8; Ra 4,000-20,000; μ 10-30.
- Power Amp.: gm 2-4; Ra 1,000-4,000; μ 2-10.

Thus, it can be seen from the above table that the constants derived from the characteristics prove of great value in determining the suitability or otherwise of a valve for a particular function.

FORMATION OF THE MIDLAND CENTRE OF THE TELEVISION SOCIETY.

As television broadcasting will be extended to the Midlands in the near future, it is essential for all interested in this new science to have a common platform for study, discussion and practical construction. The Television Society, which was founded in 1927, have, therefore, formed a Midland Centre with H.Q. in Birmingham.

The Inaugural Meeting was held in April at the University in Birmingham and future meetings will take place on every first Wednesday of each month at 7 p.m. After the summer recess (during July and August) the new session will commence on September 15th, with meetings thereafter on each first Wednesday.

Engineers, electrical contractors and radio dealers alike will find it an advantage to become members of the Society, the programme of which caters for the scientist, the engineer and also for the television salesman and service man. A series of lectures is scheduled and all interested are invited to write the Lecture Secretary, Dr. W. Sumner, F.T.S., M.Inst.E., 169, Mary Vale Road, Bournville, Birmingham, 30.

RADIO CONTROLLED MODEL SOCIETY.

In view of the country-wide popularity and interest shown in the Radio Controlled Model Society, the London Section was formed at a meeting held in London on April 11th. The officers appointed for the area are as follows:—

Chairman: W. H. Mitchell, 48, Copse Avenue, West Wickham, Kent.

Hon. Secretary & Treasurer: Lt. G. C. Chapman, R.N., Pine Corner, Firwood Rise, Heathfield, Sussex.

The London Area will hold a meeting monthly on the second Sunday. All interested in model control should write the Secretary for further details.

The R1155

By L. F. Sinfield

Some further suggestions for modifying this popular receiver

ALTERNATIVE methods of incorporating noise limiter and S meter circuits have been tried since the methods described in last month's issue, and these are explained herewith. These latter modifications may be preferred by the prospective R1155 operator.

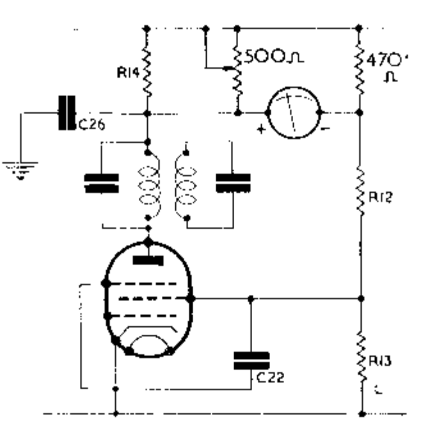


Fig. 1. Modifying the first IF stage to include an "S" meter.

First IF Stage.

The first IF stage was modified to incorporate a bridge-type S meter (see Fig. 1). Normally, the current through the screen network is approximately equal to the anode current. By adjusting the 500 Ω potentiometer (the S meter zero control), which is a pre-set and adjusted by a screwdriver slot, a balance is obtained and there is no meter deflection. This should be adjusted with the AVC on, BFO off and the aerial terminal shorted to chassis. With the receiver operating, the AVC causes a reduction in anode and screen current, though the screen network current change is small due to the normal bleeder current being high in comparison with that of the screen.

The reduction in anode current causes the voltage at the positive meter terminal to rise compared with the negative terminal point and a meter deflection results which is proportional to AVC and signal strength. The meter in the author's receiver is a 500 μA movement (actually a Government surplus one). The sensitivity of this bridge arrangement is high, but if found to be insufficiently high then by removing R14 and increasing the values of both the 500 Ω potentiometer and the 470 Ω resistor an adequate deflection will be obtained. If the deflection is normally too high, it may be reduced by either a resistor in series with the meter or a resistor in parallel.

It is advisable to have some form of switching arrangement so that the meter can be either shorted out or open circuited whilst manual RF gain is being used, and when the BFO is on. This can be carried out quite simply by a 3-pole 4-way rotary switch marked—

PHONE		CW	
AVC on.	AVC off.	AVC on.	AVC off.

and wired as shown in Fig. 2.

Switches are shown in PHONE/AVC off position. The switch can be mounted in place of the existing BFO toggle switch. To check the strength of a CW signal the switch should be in the PHONE/AVC on position.

V5 (Detector-AVC-1st LF).

Much of this is as previously described, the alteration being only concerned with the noise

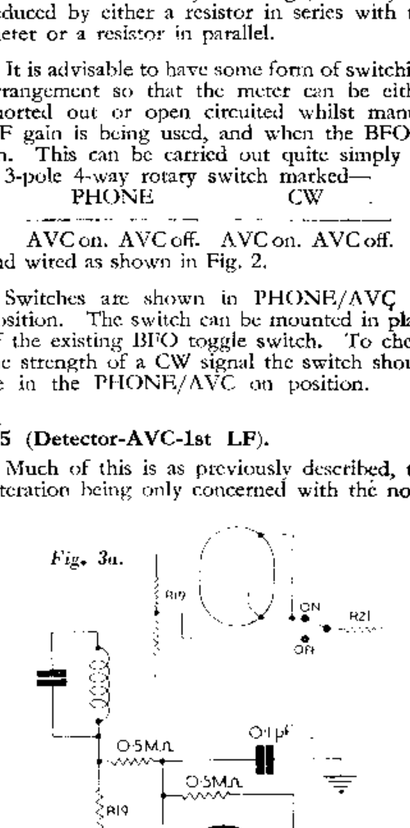


Fig. 3. The Dickert type noise limiter.

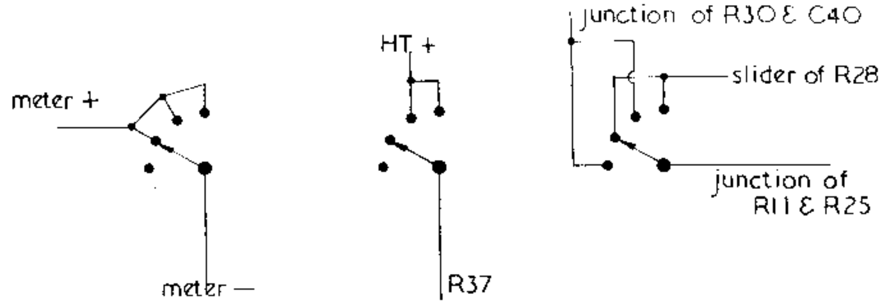


Fig. 2. Switching system for the "S" meter circuit.

limiter circuit. A Dickert type series noise limiter has been incorporated with a few deviations from standard practice (see Fig. 3). The 250,000 Ω potentiometer is the "modulation level" control. (With the slider at the R19 end, 30 per cent. modulation, and at the 120,000 Ω resistor end, 100 per cent. modulation). The control will be found to be approximately linear in calibration. The resistor network has been so arranged that only standard value components will be needed, thus the necessity for the shunt across the potentiometer. Contrary to normal practice (that of varying the diode bias in relation to the signal) this circuit varies signal relative to a fixed diode bias. The reason for this is to keep the gain as high as possible.

On heavy interference on a weak station, it is desirable to bring up the signal as the modulation level is reduced. The noise limiter action remains as normal. The network has been chosen to give best limiter results and yet to keep the diode load resistor high enough to reduce damping of the IF coil. The old BFO toggle switch (which has been replaced by a wafer type) is used to switch the limiter in and out of circuit. With the limiter "on," the 6H6 heater is switched on and at the same time the other switch section opens to remove the link from R19 to R21. If it is not desired to economise in heater current, the switch should be as in Fig. 3a, and the heater left on.

One point of importance is that the 0.1 μF capacitor must be of good quality, preferably of high working voltage and of tropical type with no leakage. Any leak via this capacitor completely upsets the biassing and prevents correct working of the circuit.

Do not expect too much from noise limiters working on the modulation percentage principle, as they are only effective on certain types of interference. The noise pulse must be of short duration compared with the time between pulses, in order that the mean bias level is not appreciably increased. Keep the wiring as short as possible in the noise limiter circuit in order to reduce pick-up and any signals which may tend to by-pass the diodes via coupling between the wiring. Screening helps also, regarding this point, but it is not necessary if the former can be accomplished.

It is hoped that these notes will be of assistance to those who are intending to modify their R1155's. The author will be pleased to answer any queries on matters raised in this article and they should be addressed to me, c/o *Radio Constructor*. Please enclose a SAE, otherwise replies cannot be undertaken.

Values of components referred to by the *Wireless World* circuit diagram and mentioned in the text of this article are:—

R11	100,000 Ω	R30	56,000 Ω
R12	27,000 Ω	C22	0.1 μF
R13	22,000 Ω	C26	0.1 μF
R14	2,200 Ω	C33	100 μμF
R19	56,000 Ω	C40	200 μμF
R21	22,000 Ω		
R25	150,000 Ω		
R28	50,000 Ω		

OUR NEXT ISSUE CONTAINS . . .

further instalments in our regular series of "Radio Simplified," "Thermionic Valves" and the ever-popular "Query Corner." The first article in an informative two-part discussion on "Short Wave Coils," by G3XT, will also appear. In addition, full constructional articles on a Six-Valve Radiogram Chassis and a Simple Receiver for Television Sound are scheduled for publication.

Output Coupling and Output Transformers

By [illegible]

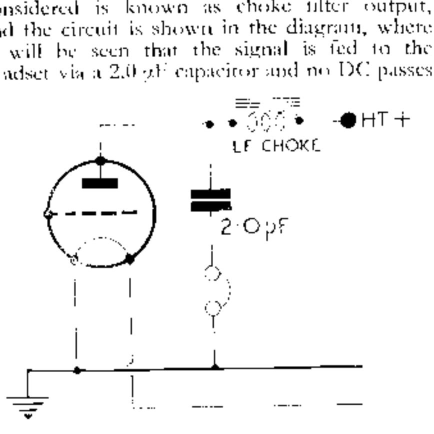
WITH all forms of low impedance headphone or loudspeakers, a matching transformer must be used, although it is not necessarily essential with high resistance headphones, or speakers of the balanced armature type. From the purely circuitry standpoint all that it is necessary is to join a pair of high resistance phones in series with the anode connection of the valve, and this indeed is often done in the case of simple receivers.

However, there are two important objections to this as a general practice, and they both become progressively more important as we move away from the simple receiver with small wattage output valves. Firstly, when the phones are wired directly in the anode circuit they have to carry the high tension current drawn by the valve and as they are wound with a very fine gauge wire there is a risk of an early burn-out if the current exceeds the few milliamps required by only the most economical valves. Secondly, there is the risk of shock which may be quite considerable, and violent especially for the man with a bald pate!

High resistance phones do not require matching to most output valves and are often coupled via a 1 to 1 ratio transformer. The HT current is thus carried on the primary of the transformer which is designed to comfortably handle it and the headphones are completely isolated from the DC.

Choke Filter Output.

Another effective and widely used method of overcoming the two drawbacks already considered is known as choke filter output, and the circuit is shown in the diagram, where it will be seen that the signal is fed to the headset via a 2.0 μF capacitor and no DC passes through the windings. This form of coupling also has the advantage of avoiding headphone capacity effects.



Standard form of choke output.

Matching Transformers.

Moving coil speakers and low resistance headphones require to be matched to the impedance of the output valve and this is done by a step-down ratio transformer. Accurate matching is essential both in the interests of maximum performance, sensitivity, and quality of reproduction.

As a general rule it can be taken that the transformer with the largest core will give the greatest efficiency but other factors, such as the method of arranging the windings and the core material also have to be taken into consideration. The additional expense of a high-class output transformer, preferably with tapped primary and secondary for matching up any type of valve to a wide range of speaker or phone impedances, is a good investment with a dividend in the form of greatly improved efficiency.

To ascertain a required ratio, and thus obtain correct matching, the following simple calculation is used.

The number of turns ratio equals the square root of the optimum load resistance of the loud speaker speech coil (or headphones).

Thus, assuming the valve load, always quoted by the manufacturers, to be 5,000 Ω and the speaker to be 2 Ω (these, by the way, are representative figures) we find :—

$$\frac{\sqrt{5{,}000}}{2} \text{ or } \sqrt{2{,}500}, \text{ which equals } 50$$

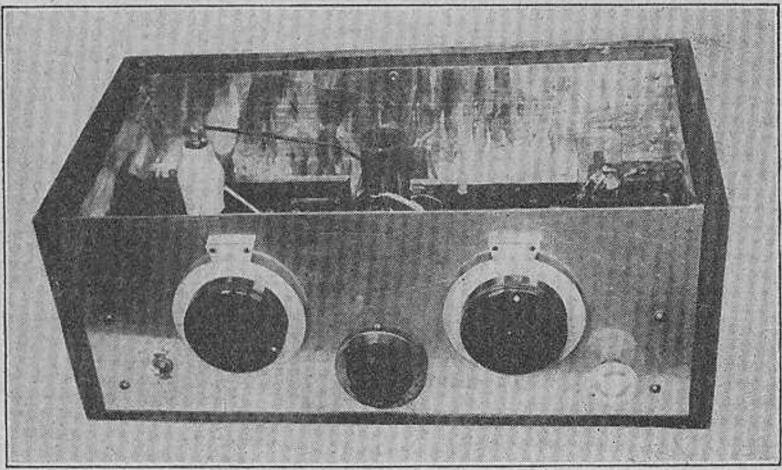
and the ratio is seen to be 50 to 1. In other words, the primary (anode circuit) will need to have 50 times as many turns as are used for the secondary (speech coil circuit). For example, again using typical figures, Primary 2,250 turns, Secondary 45 turns.

Another example :—It is required to match a pair of phones of 60 Ω each earpiece to a 6,000 Ω output valve. The earpieces are in series remember!

$$\frac{\sqrt{6{,}000}}{120} \text{ or } \sqrt{50} \text{ equalling approx. 7 to 1.}$$

If the impedance of the speech coil is unknown and cannot be otherwise ascertained it can usually be reckoned as being approximately 1.5 times its DC resistance.

(continued on next page)



Battery 1-V-2

By W. Jordi

An easily built Four-valver for the DX'er

JUST about a year ago, the writer decided to modify his existing receiver. The receiver in question was built in 1938 and was a 1-v-1, constructed on breadboard lines. Though it was considered "just the job" when first built, and was efficient enough in its way, a more up-to-date layout was finally decided upon. The subsequent addition of another audio stage plus a more business-like construction and wiring resulted in a vastly improved receiver, not only in "punch" but in selectivity and stability.

The circuit I finally chose was based mainly on the existing receiver, though certain refinements were added and of course the extra stage. Despite the obvious advantages of a superhet receiver, the writer is one of those individuals, and there must be very many, who find that a good battery straight receiver takes a lot of beating when it comes to pulling in the DX!

The existing set, though only a three-valver, was spread out on a baseboard measuring 18 inches x 10 inches, which could hardly be called portable! Therefore, the aim in the new receiver was to cut down space and to rebuild on an aluminium chassis. The set was eventually built to much smaller dimensions than the original despite the addition of the LF stage with its complementary components.

The Circuit.

Fig. 1 shows the theoretical circuit diagram, which will show the receiver as a 1-v-2. The RF stage is untuned, and whilst perhaps some extra gain could be had by tuning this stage it was decided to leave it untuned, since with two audio stages more than ample volume is obtainable. The RF stage, then, is to provide that extra selectivity which is advantageous on today's crowded bands and for the usual improvements obtained in the way of minimising effects of swaying aerials, elimination of "dead spots" in the reaction, and so forth. The

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(*CENTRE TAP—continued from page 256*)

When calculating the transformer ratio for push-pull output, the load resistance is taken as twice that of one of the valves. It need hardly be pointed out that when using push-pull, both valves have to be identical.

Another point, correct matching of a pentode, is more important from the point of view of quality than it is in the case of a triode, but it is hoped that the constructor is quite convinced that a reasonably correct match is not only highly desirable, but quite easily obtainable. Mis-matching should never be tolerated, even by beginners.

valve used was a Z21, a screen-grid valve with a four-pin base and top-cap anode one of my favourite types. Voltage on the screen-grid is dropped through R1 and decoupled by C1. Full voltage is applied to the anode. The RF stage is coupled to the detector stage by means of standard six pin coils, using RF transformer type coupling.

The detector valve is also a Z21 and is used in a leaky-grid reacting circuit. C2 and C3 are the bandset and bandspread capacitors, respectively. Reaction is obtained by the now recognised method of varying the screen-grid voltage (variation of the potentiometer R6). The capacitor CT2 is a trimmer and this, once set for maximum effect, is not again touched. R3 and R4 are the anode decoupling and anode load resistors, respectively, with C4 as decoupling capacitor. C6 is a large capacitor inserted to prevent extraneous AF noises when the potentiometer is being adjusted.

The detector stage and first audio stage are resistance/capacitance coupled, through the coupling capacitor C7. An RF choke is inserted in series with the coupling as a filter. The potentiometer R7 is the volume control, with the precautionary R8 as a grid stopper. The last stage is transformer coupled, series fed.

Automatic grid bias is applied to the two audio stages, the components R10/R11/C10/C11 providing the necessary voltages and decoupling. And that about covers the circuit. Various other ideas were tried but mostly were found to be either a decided loss in efficiency or else making no appreciable difference. The components shown in the circuit herewith are all more or less essential for the maximum results -- all superfluous items being deleted during tests.

Construction.

The first thing to obtain is, of course, the chassis and panel. In the writer's case, it was decided to retain the existing wooden cabinet and the chassis therefore measured 18 ins. x 10 ins. x 1½ ins. The panel is 7 ins. high. These dimensions are not the ideal, but as the metalwork had to fit the cabinet certain restrictions were necessary. Any constructor wishing to build the receiver can easily reduce the overall sizes to good effect and the sub-chassis space could be increased to the more normal 2½ ins. or so. Actually, the 1½ ins. was sufficient, but a little more room would have been an advantage.

The next job was to lay out the components, such as coils, valves, etc., on the top of the chassis and to juggle them around to find the best positions to give short leads and ease of wiring up. When the final positions had been fixed, they were marked off with an indelible pencil. The panel was then fitted to the chassis. Being such a narrow sub-chassis -- giving little support and also being of aluminium and thereby somewhat flexible, the chassis and panel were fitted by two metal brackets (purchased at the local multiple stores) with 2BA screws. These were found to give adequate rigidity.

Drilling then commenced. On the chassis the fixing holes for the valve holders, coilholders and transformer were made. On the panel: holes for the variable capacitor drives, switch, reaction potentiometer, phone jack and volume control were drilled. The large capacitors, C1, 4, 6, 9, 10 and 11 were then fitted underneath the chassis, making use of the coilholder bolts to secure C10 and C11. Next to be fitted were C5, C7 and CT1. This latter, the aerial trimmer, was mounted alongside the transformer with a hole drilled in the chassis for easy access and adjustment.

The panel controls next received attention and the potentiometers, switch, jack, capacitors and slow-motion drives were placed in position. The vernier attachments for the drives were fixed after the main drives had been assembled in order to ensure that they lined up with them. The actual fixing holes were drilled slightly larger than was necessary for the screws in order to allow some "play" to make any slight errors in drilling easy to rectify.

With most of the larger components now in position, the longest job of all was commenced—the soldering. Priority was given to the filament leads to the valves, using multi-strand flex. When these were wired, all earth points were dealt with and all components that return to earth wired in. It was deemed advisable to connect all earth points in each circuit (stage) to a common tag. Thus in the detector stage C6, R2, C4, R6 and the earthy ends of the coils were all taken to a common tag on the chassis. Finally all the common earth tags were joined together. This procedure may sound a trifle "fiddly" to those not accustomed to such detail, but these little points all add up and the benefits are noticed especially when one comes to start tuning on the higher frequencies. Eventually, the wiring was completed and after the usual preliminary tests, the batteries were connected, phones plugged in and the set switched on.

Naturally, one or two minor faults were found, but these were mostly sorted out by experimenting with various component values. The values shown in the circuit diagram are those finally selected. The overall performance of the receiver is estimated to be about 75 per cent. better than in the original set, and it certainly has plenty of punch. A speaker can be run off the receiver quite easily. The set is not intended to compete with an elaborate communications receiver, obviously, but it can be recommended as a good set for the SWL who wants to hear the DX and has not a lot of cash to spare.

Query Corner

A "Radio Constructor" service for readers

Short Circuited Bias.

"I have a battery receiver which is powered by a 120 volt battery and 2 volt accumulator. Recently, the HT line was accidentally short circuited to earth for a few seconds. Upon the removal of the short the receiver was found to operate but the quality of reproduction was not up to the usual standard. I have checked all likely components but cannot trace the cause of the trouble.

R. *Dunne, Glasgow.*

We assume from your comments that the receiver has an automatic biassing system of the type in which the total receiver HT current is passed through a resistor of low value connected in the negative HT line. This resistor is normally by-passed by a low voltage electrolytic capacitor to prevent any transient fluctuation in current from producing similar fluctuations in the bias voltage. Should the HT be temporarily short circuited the total battery voltage will be developed across the bias resistor and the working voltage of the electrolytic capacitor will be exceeded. This will result in the breaking down of its insulation, thereby short circuiting the bias resistor and hence the bias voltage.

This type of trouble appears to be quite common in battery receivers using automatic bias and results in an increase in the normal HT current coupled with a noticeable reduction in the quality of reproduction.

Coupling.

"I wish to boost the output of my battery receiver by means of a universal amplifier. As the chassis of the amplifier is live to the 'mains,' I decided to use a 1 : 1 coupling transformer in order to avoid any direct connection between amplifier and receiver. However, upon switching on I was disappointed to find that the quality of reproduction was very poor, there being virtually no base response. Can you suggest a possible cause of the trouble?"

K. Rogers, Canterbury.

The poor reproduction experienced when feeding the output of the receiver into the amplifier is undoubtedly due to the mis-matching of the output valve in the receiver. It is noted from the circuit diagram that the transformer is connected directly in the anode circuit of the output valve and the secondary feeds straight into the grid circuit of the amplifier. This arrangement presents an effective load to the output valve which is approximately equal to the load across the secondary of the 1 : 1 transformer. It is therefore necessary to load the secondary of the transformer such that the impedance reflected into the primary is equal to the optimum load of the output valve. The value of the secondary load resistor may be calculated from the formula—

$$R = \left(\frac{T\,1}{T\,2}\right)^2 \times Ra.$$

where $\frac{T\,1}{T\,2}$ represents the turns ratio of the coupling transformer and Ra the optimum load of the output valve.

It is preferable to safeguard the receiver against the possible breakdown of the insulation of the coupling transformer by including condensers in the input loads to the amplifier. Reference to Fig. 1 should make the method of connection clear.

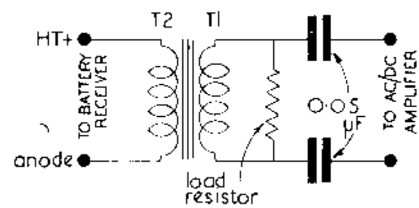


Fig. 1. Coupling the battery receiver to the AC/DC amplifier.

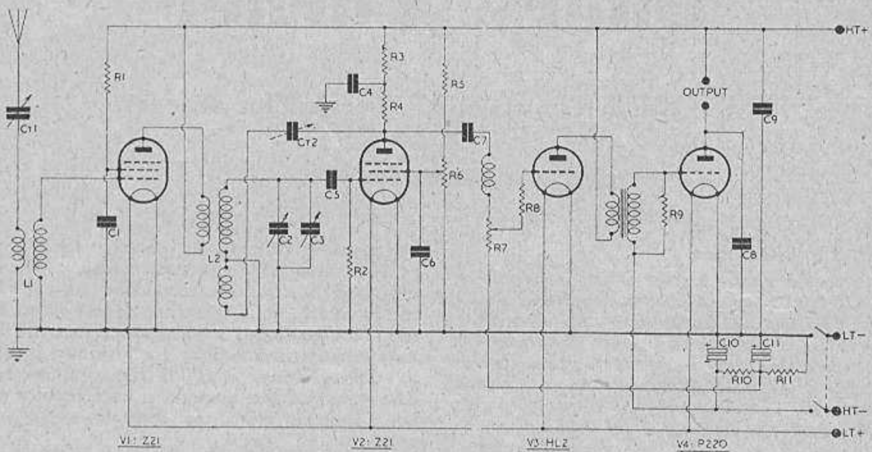
Aerials.

"Can you please recommend an efficient yet simple aerial for use with my SW receiver?"

W. Bennett, Cardiff.

The choice of aerial depends largely upon three factors: the frequency at which it is required to operate; whether or not directional properties are required; and whether or not it is to be used in areas of strong local interference.

Undoubtedly, the simplest form of aerial is the horizontal wire with a single wire feeder, which may be used in country districts where there is a minimum of local interference. The horizontal wire should have a length of approximately 30ft. if optimum results are required



LIST OF COMPONENTS.

R1 100,000 Ω
R2 1 Meg Ω
R3 20,000 Ω
R4, 8, 9 250,000 Ω
R5 40,000 Ω
R6 50,000 Ω
R7 250,000 Ω pot.
R10 400 Ω
R11 200 Ω

C1, 4, 6, 9, 10, 11 : 1.0 μF
C2 : 160 μμF
C3 : 20 μμF
C5 : 100 μμF
C7 : 0.006 μF
C8 : 0.001 μF
CT1, CT2 : 140 μμF
L1 : 4-pin plug-in coil.
L2 : 6-pin plug-in coil.

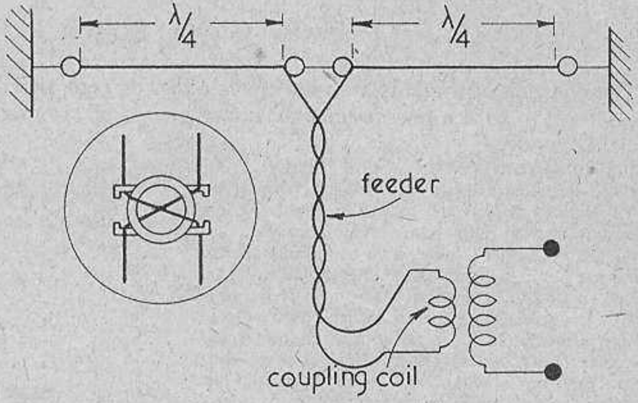


Fig 2. A half-wave doublet aerial system. The inset shows the method of crossing feeders when transposer blocks are used.

on the 20 metre band or a length of approximately 15ft. for use on the 10 metre band. The tapping point from which the lead-in is taken should be about one-third of the total length measured from one end of the aerial.

However, better all round performance will be obtained by the use of a simple dipole or doublet type of aerial with a twin lead feeder (Fig. 2). This type of feeder has the advantage that interference induced in one lead is cancelled out by that induced into the other lead. This means that effectively no interference will be picked up by the feeder, which is a great asset as the zone of maximum interference is invariably found to be in or near a building. Each limb of the aerial should be approximately quarter wavelength in length on the band at which maximum response is required. This means that if the aerial is primarily intended for use on the 7.5 Mcs. band each limb will be approximately 32ft. in length. The feeder may consist of twisted rubber covered wire, but we strongly recommend the use of one of the twin feeder cables which are at present readily available.

Another and possibly equally effective feeder may be made up by the use of transposer blocks (inset Fig. 2), the blocks being spaced at intervals of approximately 18ins., the feeders should be crossed over one another at each block. With aerials of the type described maximum response will be obtained from signals approaching the aerial at right angles and therefore, whenever possible, the aerial should be erected so that it is at right angles to a line drawn from it to the area from which signals are required. The dipole type of aerial may readily be mounted in a vertical plane whence it has unidirectional properties, but it is usually rather more difficult to erect in this position, unless of small dimensions and intended for use on the ultra short waves.

"Query Corner" Rules

(1) A nominal fee of 1/- 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 the more general interest will be reproduced in these pages each month.

THE EDITORS INVITE . .

- **Constructional articles suitable for publication in this journal. Prospective writers, particularly new writers, are invited to apply for our "Guide to the writing of Constructional Articles" which will be sent on request. This guide will prove of material assistance to those who aspire to journalism and will make article writing a real pleasure!**

Notes on the 6B8 Valve

By G. W. Bolton

(The question of the possible uses of the 6B8 was recently raised in "Mailbag." Here are a few circuits that have proved of practical value—Ed.)

BEING one of the "Old Brigade," my affections for the sturdy 4.0 volt British valves were hard to shake, until a friend presented me with some American 6.3 volt types. Amongst these was a 6B8 and after delving among the data sheets, decided to give this valve a try-out. The 6B8 valve is an HF variable-mu pentode with two diodes incorporated. The variable-mu characteristics as given in the data sheets show a fairly short grid base but a maximum of -21 v. enables one to get fairly good automatic volume control.

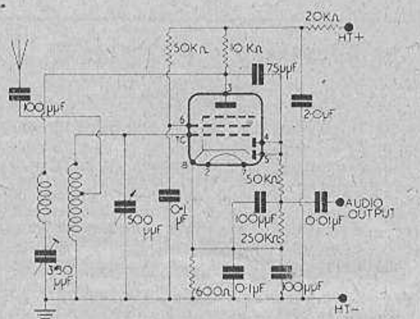


Fig. 1. The 6B8 as an HF Amplifier.

The first experiment (see Fig. 1) was using the pentode section as an HF amplifier. The grid was tuned and resistance capacity coupled to the diodes. A little regeneration was used to improve selectivity. Results from this simple unit, used with a 25 watt amplifier, were very encouraging. The "locals" gave excellent results, but, due to slight regeneration, there was some top cut. The coil used was hand wound to cover the medium waveband on a one inch former, the regeneration winding being approximately 10 turns and was wound on the earthy end. The regeneration was fairly constant over the entire medium waveband. Some experiment may be needed with the tapping on the grid coil, but should be approximately one-third of the way up from the earthy end.

The second experiment is shown in Fig. 2. Here we have the start of a simple, yet effective, single valve tuner unit. Standard coils can be used here as both the anode and the grid are tuned. Screening becomes important. The layout adopted was a chassis just large enough to take the gang capacitor and valve holder. The grid coil was mounted above the gang and as near to the grid as possible, whilst the anode coil is placed well away and near the anode pin under the chassis. Selectivity was found to be ample and the output from this unit is enough for any amplifier. Of course, a fairly steep slope output pentode could be incorporated on the same chassis, thereby forming a very compact little set.

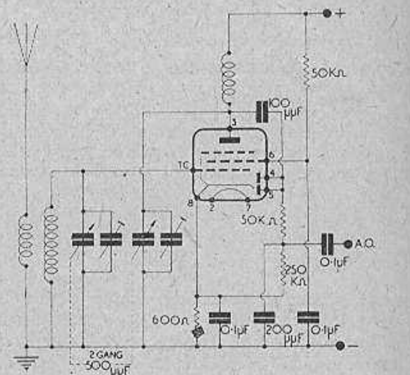


Fig. 2. The 6B8 as an HF Amplifier and Diode Detector.

A more ambitious layout is shown in Fig. 3. In this circuit, we have added a further RF stage (a 6K7) but still employ the two-gang capacitor. This unit will give excellent signals in any part of the country. AVC is shown in the circuit diagram but a large aerial must be used if this is to be really effective. AVC may well be dispensed with by deleting the 50 μμF capacitor, the two 1 Meg Ω resistors and by earthing the coils direct instead of through the 0.1 μF capacitors, and strapping the two diodes together.

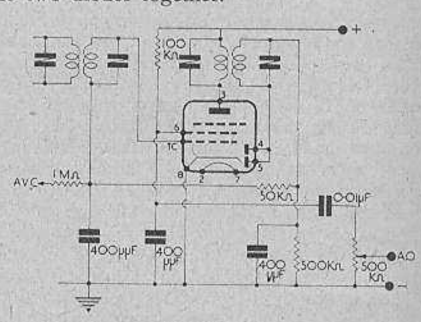


Fig. 5. As an IF Amplifier, Diode Detector and Audio Amplifier.

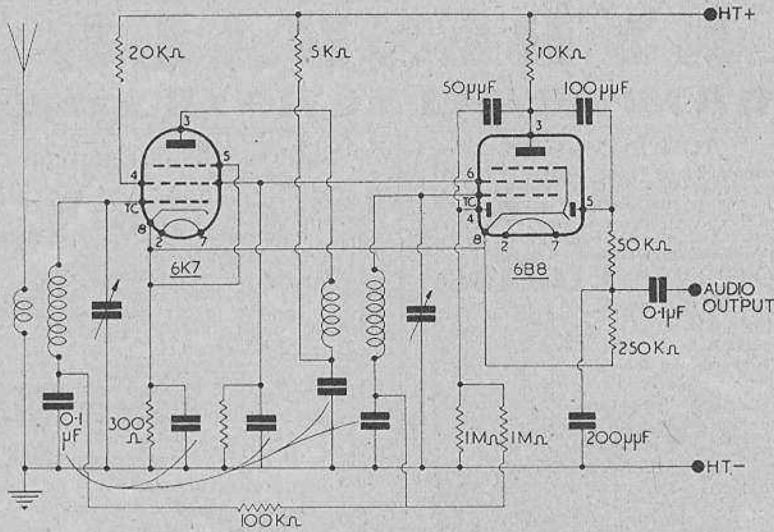


Fig. 3. A 6K7 and 6B8 giving 2 HF stages and Diode Detector with AVC. (N.B. Resistor, unmarked, from screen of 6K7 is 30k Ω).

Fig. 4 shows the next stage in the forward direction—superhets! Here the 6B8 really does help. The pentode section is the IF amplifier, coupling into the diodes. The addition of a frequency changer valve and an output valve gives you a really excellent three valve superhet. The resistors and capacitors can easily be grouped around the valve holders so that the space used is confined to the two IF transformers and the 6B8 valve. Earth pin No. 1 and take all components' earths back to this point. If the screen and anode volts are correct, there should be no trouble whatsoever with instability.

The latest development by the author with the 6B8 valve is shown in Fig. 5. A reflexed IF amplifier, diode detector-AVC and audio output is the line up. Signals are fed on to the grid, amplified and then rectified by the diodes, the audio voltages being fed back into the grid. The screen (now used as a triode anode) is

(*continued on page* 273)

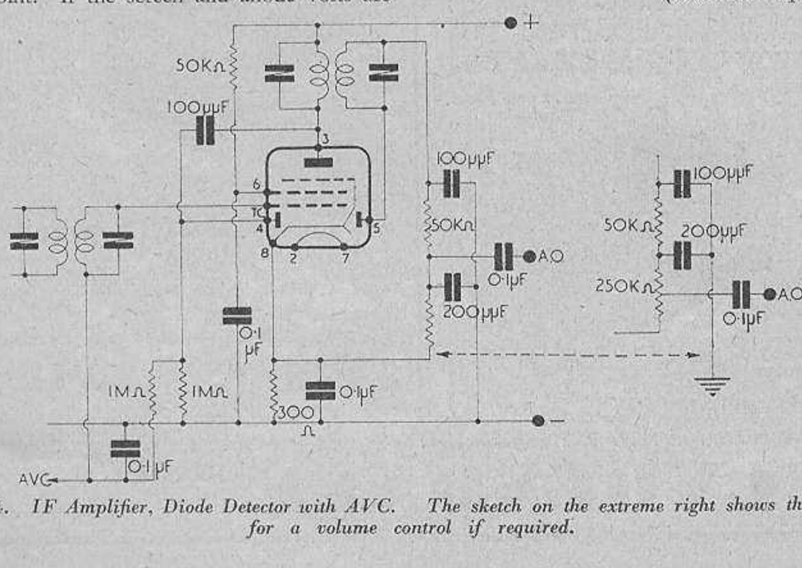


Fig. 4. IF Amplifier, Diode Detector with AVC. The sketch on the extreme right shows the circuit for a volume control if required.

Radio Simplified

Part 1. By A. J. Duley

DON'T get the wrong idea about these articles; they are not starting from scratch, talking of movements of atoms and molecules. The intention is solely to point out the reason that certain components are included and others left out of radio circuits.

Being a very ordinary type of person, I often had to work things out from first principles, step by step; the insight that one gets by doing this repays the time so spent.

To start this series I went back as far as electrical units, reasoning that any person having the interest to buy this magazine would be well enough informed on the conducting properties of metals and similar electrical facts. Let us begin with the unit of current :—

The Ampere.

Scientists define the ampere as the flow of electricity that will deposit a certain weight of silver from a solution of silver nitrate in a specified length of time. Actual numbers are not important to us, as most amateur experimenters calibrate against a commercial instrument, the important thing being to understand what a current is.

An electric current may be compared to a flow of water in a pipe, the flow there being measured in gallons per minute; in our electrical circuit amperes take the place of gallons per minute.

The Ohm.

This is the unit of electrical resistance, and is defined by the scientist as the resistance of a column of mercury of a certain length and area at a specified temperature. Once more, from our point of view, it is more important to know the function of resistance than its exact definition, as we usually buy our resistors ready-made.

Going back to our water circuit, resistance may be considered as length of small diameter piping inserted in the circuit, making a barrier to the flow of water. Electrical resistance similarly limits the flow of current.

The Volt.

The electrical unit of pressure, or voltage, as it is called, is linked with the ohm and amp. The rather neat way in which the scientist defines this unit is this: firstly he fixes the amp and ohm, then he defines the volt as the electrical pressure needed to push one ampere through a resistance of one ohm.

In our water analogy, voltage is represented by a pump delivering the pressure in pounds per square inch.

Ohms Law.

The relationship between volts, amps and ohms can be taken as represented by :—

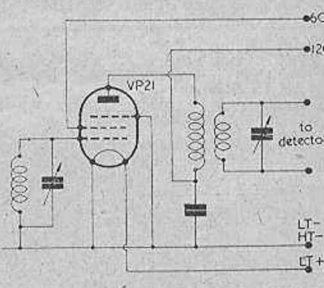
$$\frac{\text{Voltage applied to a circuit}}{\text{Current flowing in the circuit}} = \text{Resistance of the circuit.}$$

Or, it may be more simply expressed as :—

$$\frac{\text{Volts applied}}{\text{Amps.}} = \text{ohms.}$$

Hence— Amps. x ohms = volts.

This relationship helps us to find most of the resistances in a radio circuit, enabling us to calculate resistances for voltage dropping, automatic bias, AVC and countless other devices. Imagine for example that the HF valve in the circuit below is to be made to run off a battery only, having a 120 volt socket;



let us see how we can eliminate the 60 volt supply.

The anode is supplied with 120 volts, and this is the point from which we get our screen supply; let's see how it can be done. The valve is an Osram VP21, and from the makers' data book we see that the screen current is 0.7 milliamps. If we put in a resistance the voltage dropped by the resistance is 60 volts, this is given by subtracting the screen voltage from the HT line voltage :—

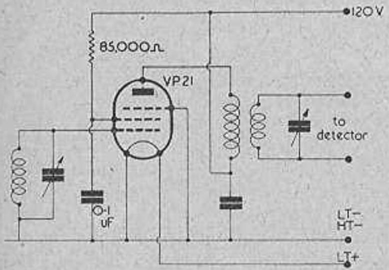
$$120-60=60 \text{ volts.}$$

To get the resistance, we divide volts by amps. A milliamp is a thousandth part of an amp, hence our resistance is given by :—

$$\frac{60}{\frac{7}{10,000}} = \frac{600,000}{7} = 85,714 \text{ ohms}$$

(or 85,000 to the nearest one dealers stock).

The circuit now becomes—



The 0.1 μF capacitor is included to bypass any RF currents to earth.

Resistances in Series.

I think it will be obvious that two resistances of 50,000 Ω and a 35,000 Ω connected in series would have taken the place of our 85,000 Ω resistance.

My pet nephew, the plague of my life, was building a set with such an HF stage followed by a detector, the operation of which was smoothest at 80 volts HT. Working as we have just done, he worked out that his 85,000 Ω could be made of a 50,000+30,000+5,000. He reasoned that—

$$\frac{0.7 \times 50{,}000}{1{,}000} = 35 \text{ volts, and } 120-35=85 \text{ volts.}$$

He decided to get the anode voltage for the detector from the end of the 50,000 Ω resistance. He wired the circuit and then tested it. Total absence of signals brought him seeking my advice—it seemed OK to him; where had he gone wrong?

Look at the diagram below:—

The anode circuit was connected correctly as far as the 50,000 Ω resistor, but he hadn't considered the anode current of the detector, an Osram HL2. Data sheets give this current as 1.75 mA, therefore, total current through the resistance is 1.75+0.7=2.45 mA. Voltage drop in this resistor alone is—

$$\frac{2.45 \times 50{,}000}{1{,}000} = 122.5 \text{ volts.}$$

Thus, no anode voltage was applied to the detector anode, and no screen voltage to the HF valve.

We removed the 50,000 Ω resistor and inserted one which we worked out as follows:—

The voltage across the 50,000 Ω resistance originally was, as my PN (short for "pet nephew"), worked out, 35 volts. The new current is 2.45 mA; therefore, new resistance is—

$$\frac{35 \times 1{,}000}{2.45} = 14{,}300 \text{ (approx.) or nearest stock size: } 15{,}000\ \Omega.$$

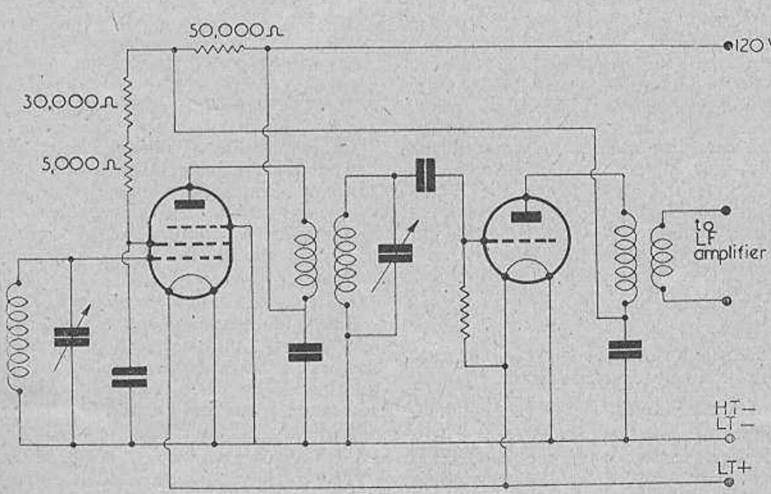
The substitution worked reasonably well, much to my relief and my PN went away quite satisfied.

BIASSING.

The application of a bias voltage to valves may be accomplished using a resistance, this being calculated by using Ohms Law. The method of applying the system to various circuits is as follows:—

Battery Valves.

The HT voltage is applied through a resistance in the negative lead, the other end of this resistance being connected to earth. In this way a voltage is produced across the resistance due to the HT current flowing through it (sum of all anode and screen currents). This makes the one end of the resistance more positive than the other, that is the end connected to the common HT line, or earth.



Consider the case of a set using the following valve sequence, W21, HL2 and a KT2 output. Taking each valve separately, let us find the screen and anode currents from the makers' data, and also the bias needed on each valve.

KT2. Anode current=7.5 mA; Screen current=1.7 mA; Bias= —4.5 volts.

HL2. Anode current=1.75 mA; No bias used on a leaky grid detector.

W21. Anode current=3.6 mA; Screen current=1.2 mA; Bias lead goes to —9 volts through a potentiometer.

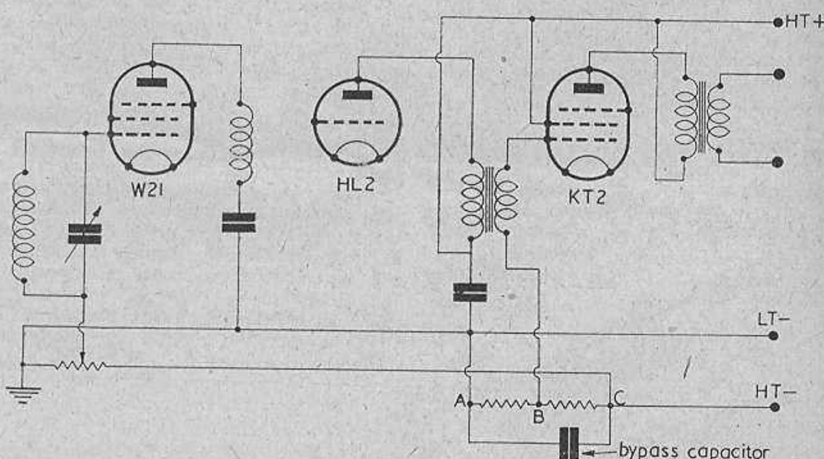
Total current flowing in the HT circuit is 7.5+1.7+1.75+3.6+1.2=15.75 mA.

Maximum biassing voltage required is 9 volts.

Resistance needed is given by—

$$\frac{9}{15.75} \times 1{,}000 = 572.2\ \Omega$$

570 Ω is the nearest stock size. In any case, this resistance will have to be in two parts since 570 Ω gives us 9 volts, and we want 4.5 and 9 volts so that we will have to use two resistances of 285 Ω giving 4.5 volts across each part. The circuit becomes—



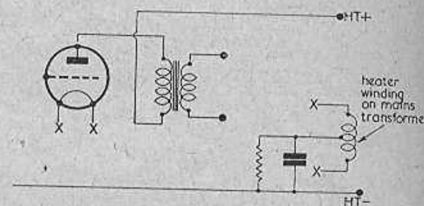
The large capacitor used is to smooth the bias supply. A is the point connected to earth line, B is the junction of the 285 Ω resistors, and is at 4.5 volts negative with respect to earth line. The point C is the junction between the second resistance and the HT negative line and is 9 volts negative with respect to earth on chassis.

Mains Valves.

These are split into two types, directly heated, and indirectly heated valves.

Directly Heated Valves.

The method of applying bias to these valves is to include a resistance in the connection between the centre-tap of the heater winding on the transformer, and HT negative line. The diagram beneath shows the method in circuit form :—



Once again, my PN rears his ugly head! He was using an Osram PX4 as an output valve, and using data tables he found that he had to apply —42 volts grid bias, and that the anode current was 50 mA. He worked out the necessary resistance thus :—

$$\frac{42 \times 1{,}000}{50} = 840\ \Omega$$

PN dashed gaily to the nearest dealer and bought an 850 Ω resistor, this being the nearest value the dealer had.

On completion of wiring, the set was tested, and after playing for a short while, an intense smell of burning gave an indication that something was amiss. Inspection showed that the bias resistor was burning out. I was called in to locate the trouble; it didn't need much locating.

Resistors are rated according to their power capacity, and usual ratings are 1/4, 1/2, 1, and 5 watts. Power rating is obtained as follows :—the voltage across the resistance multiplied by the current flowing in the resistance gives the power.

The resistor bought by PN was a 1/2 watt type. Let us work out the power in the circuit. The voltage across the resistance was 42 volts, the current flowing was 50 mA (for power this must be in amps). The power in the circuit was

$$\frac{42 \times 50}{1{,}000} = \frac{2{,}100}{1{,}000} = 2.1 \text{ watts.}$$

The reason for the burnt-out resistor was obvious, a minimum rating of 3 watts was necessary, and the component in the circuit in the first place had a rating of only 1/2 watt. A 5 watt component was wired into the circuit, and all was well once again.

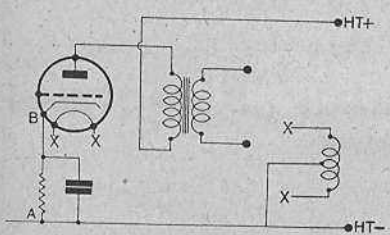
Another way of getting the power is to multiply the resistance by the current squared, that is, multiply it by the current, and then by the current again, using the last example :—

$$\frac{850 \times 50 \times 50}{1{,}000 \times 1{,}000} = \frac{850 \times 2{,}500}{1{,}000{,}000} = \frac{2{,}130}{1{,}000} = 2.13 \text{ watts.}$$

Indirectly Heated Valves.

This system is used when the valve to be biassed has a cathode separate from the heater. The heater winding centre-tap is connected to the HT negative or earth line, and a resistance is then connected between the cathode and the earth line.

This is the skeleton circuit :—



Point A is at earth potential and due to the voltage developed across the resistance, which in its turn is due to anode and screen currents ; Point B is negative with respect to Point A.

Taking the case of an Osram KT41, data shows that the bias voltage is 4.4 volts, anode current and screen current total 48.5 mA. To find the resistance, proceed as before :—

$$\frac{4.4 \times 1{,}000}{48.5} = 91\ \Omega$$

Rating.

This resistance will need to have a rating of

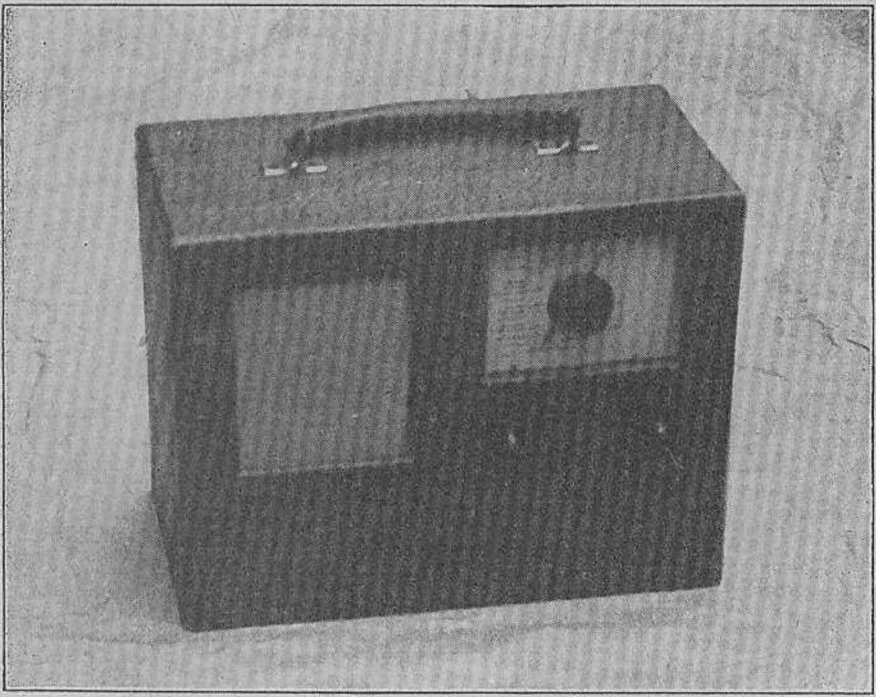
$$\frac{4.4 \times 48.5}{1{,}000} = 0.213 \text{ watts}$$

In this case a 1/4 watt resistor would do, but for safety sake a 1/2 watt would be better.

By-Pass Capacitors.

In all circuits, I have shown capacitors by-passing the resistor to earth. These capacitors are usually low voltage electrolytic types, the bias voltage determining the working. In a few radio receivers a degree of negative feedback is obtained by leaving the capacitor out of the bias circuit, but more of that later.

The writer hopes that this article has cleared up any difficulties in these Ohms Law problems. Next, it is intended to cover droppers in AC/DC circuits, power supplies, transformers, and types of meters.



An All-Dry Portable Superhet

By L. F. Sinfield

THE receiver about to be described was built with a view to covering the medium-waveband as a portable and to give short and medium wavebands on an external aerial. For external aerial operation, separate aerial coils are switched into circuit so as to keep efficiency at a maximum for each mode of operation.

Originally, the receiver used a 1A7GT frequency changer, but due to the rather low efficiency on the higher frequencies and the necessity of modifying the coils on the short waveband it has since been replaced by the 1R5 miniature button-base type. The latter valve has been found to be considerably more efficient and reliable on the high frequencies. The oscillator circuit has been designed to give a maximum stable oscillation on both wavebands, with subsequent freedom from whistles, instability and dead-spots.

The finished receiver compares favourably with commercially built sets of similar pattern in size, weight and performance. On the short waves, the set really does "go to town," and amateurs are receivable at good loud speaker strengths using an average external aerial.

The chassis is of 1/16 in. alloy, measuring 11¾ ins. long x 5 ins. wide x 2 ins. deep. The layout can be seen quite clearly from the photographs, but it should be noted that the 1A7 is shown and not the 1R5. All valveholders but one, are of the amphenol type as these ensure good contact and their tight fit eliminates any possible trouble due to the valves coming partly out of their sockets during transportation. The 1R5 valveholder is of the ceramic type and it is essential to take precautions against mircophony due to accoustic feedback from the speaker causing the electrodes to vibrate and thereby vary the oscillator frequency. The best method is to mount the 1R5 in a split brass tube lined with ⅛ in. felt. The split should give a smooth tight fit and the brass should be of a heavy enough gauge so as not to vibrate or resonate.

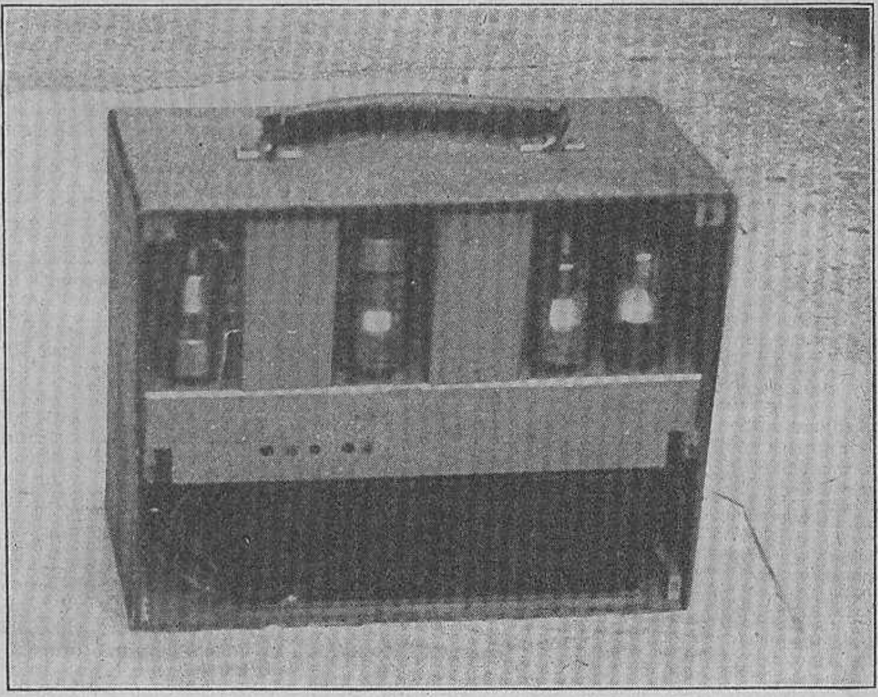
Along the rear of the chassis, from left to right (as seen from the rear) are the 1R5 frequency changer, the 1st IF transformer, the 1N5GT IF amplifier, the 2nd IF transformer, the 1H5GT detector, AVC/1st audio amplifier, and the 1C5GT output pentode. Looking at the front of the chassis, a 5 in. 2½ Ω permanent magnet speaker is seen bolted at the extreme left-hand side, and it will probably be necessary to cut away the chassis in order to secure it firmly. The twin-gang capacitor is mounted to bring the shaft more or less half-way along the remaining space, so as to allow a symmetrical appearance when the set is finished. The tuning capacitor is bolted on its side direct to chassis, first boring two holes, directly below the stator connections, for feeding the leads through to the sub-chassis. It is recommended that a twin-gang capacitor with ceramic insulation be used, since this type is better for short wave work.

Regarding dials, it is quite easy to obtain a dial which is calibrated for normal long, medium and short wavebands, has a radial calibration for 180 degrees, and is roughly the correct size for the job. The long wave marking can usually be removed quite easily from glass or plastic scales without scratching by rubbing with ordinary metal polish.

An epicyclic drive was fitted to the twin-gang, close to the frame. The scale was then bored centrally in such a way that the outer collar of the drive unit projected through the scale. The scale was then fixed to the frame of the tuning capacitor. The pointer fitted was simply a length of wire bent and sprung on to the collar of the drive. The central shaft should be left projecting so that about one inch remains beyond the front of the chassis.

The capacitor vanes should open on the speaker side as the two aerial coils are mounted between the twin-gang and the end of the chassis. The wavechange switch was mounted centrally on the chassis edge and so spaced that it "balanced" with the line of the tuning control (approximately two inches either side of a vertical line drawn through the tuning spindle is about correct). Note that it is important to mount the wavechange switch near the coils. The only other component on the chassis top is a 2 μF paper capacitor of metal block type, which is bolted in position near the speaker.

Below the chassis, the oscillator coils are mounted beneath the tuning capacitor. Leave sufficient space near the switch, coils, valveholders, etc., in order to get a soldering iron in without damaging components or wire insulation. Mount the short wave coils as near the switch as possible so that the length of connecting wire can be kept down to a minimum. The other components below chassis—capacitors, resistors, and so on—are mounted in the best position that will result in short direct leads. By keeping leads as short as possible, not only will a neater appearance result but performance will be considerably improved.



The all-dry portable, as seen from the rear, in carrying case.

When fixing the IF transformer, mount it so that the anode connection comes near the anode pin on the valveholder. The 1H5GT holder should be fitted so that the diode pin is near the IF transformer connection that feeds it. These details may appear to be minor ones but they are of great assistance in reducing pick-up and instability due to feedback. These points should, therefore, be observed when building *all* sets and they are of particular importance with regard to local oscillators in superhets and high gain RF and AF amplifier circuits.

The external aerial and earth connections are brought to sockets on the rear flange on the chassis. The frame aerial connections are of twin flex brought direct from the frame aerial trimmer (which is also at the rear of the chassis, and adjusted by means of a ¼ in. hole drilled at the rear) to anchor pins driven into the cabinet. This connection should be left just long enough to allow the chassis to be withdrawn from the cabinet, but not longer than is absolutely necessary.

The coil trimmers are of the " postage stamp " compression type, the short wave ones being the exception (ceramic). The padder for the medium wave oscillator coil is bolted below the chassis adjacent to the coil. A clear ½ in. should be allowed around all coils, since any metallic objects within this area will alter the inductance appreciably.

The frame aerial consists of 16 turns of 28 SWG enamelled wire, wound round the rear edges of the cabinet with the turns spaced to occupy a width of 1⅓ ins. The ends of the windings are brought through small holes to the anchor pins previously mentioned. The cabinet is of 3/16 in. plywood with ½ in. square strips at the corners for strengthening purposes. These square strips are also fastened to the inner front edges, but gaps are left to ensure that the chassis comes right up to the front of the cabinet. Runners are also fastened to the inside edges to hold the chassis up to the top section of the cabinet.

After cutting the holes for the speaker, dial and controls, the cabinet was covered in fabric. This was affixed by using Scotch glue as this does not damage the wire or stain the fabric. The speaker fabric was then fitted and a piece of 1/16 in. perspex fixed to protect the scale and pointer of the tuning control. A hole should be cut in the perspex to allow the tuning control to project. The finished cabinet measured 11¼ ins. long x 9¼ ins. high x 5¾ ins. deep, overall.

A standard 90 volt battery slides in below the chassis for the HT supply and four-unit type cells in parallel are used to supply the LT. Some saving in height can be accomplished by using the shallow type 90 volt block, but these are more expensive and not so easy to obtain. The writer definitely disapproves of the use of combined HT and LT blocks on the grounds that there is always a good workable voltage left in the HT section after the LT has become too low for use. This is particularly important to remember if the set has been designed to economise in HT current.

The case is fitted with a collapsible carrying handle and some additional internal reinforcing may prove to be necessary to distribute the weight more evenly. The back is of ⅛ in. plywood and is supplied with a series of large holes, covered by a grill, to prevent muffling of the speech quality. It is fixed by four wood screws driven into the corner braces which are recessed in by the thickness of the back, so that the back cover does not project beyond the rear edge of the case. A hole must be left in the back for using external aerial and earth.

The Circuit.

The wavechange switch has the following positions :—

(A) External aerial, internal aerial coil, short waveband.

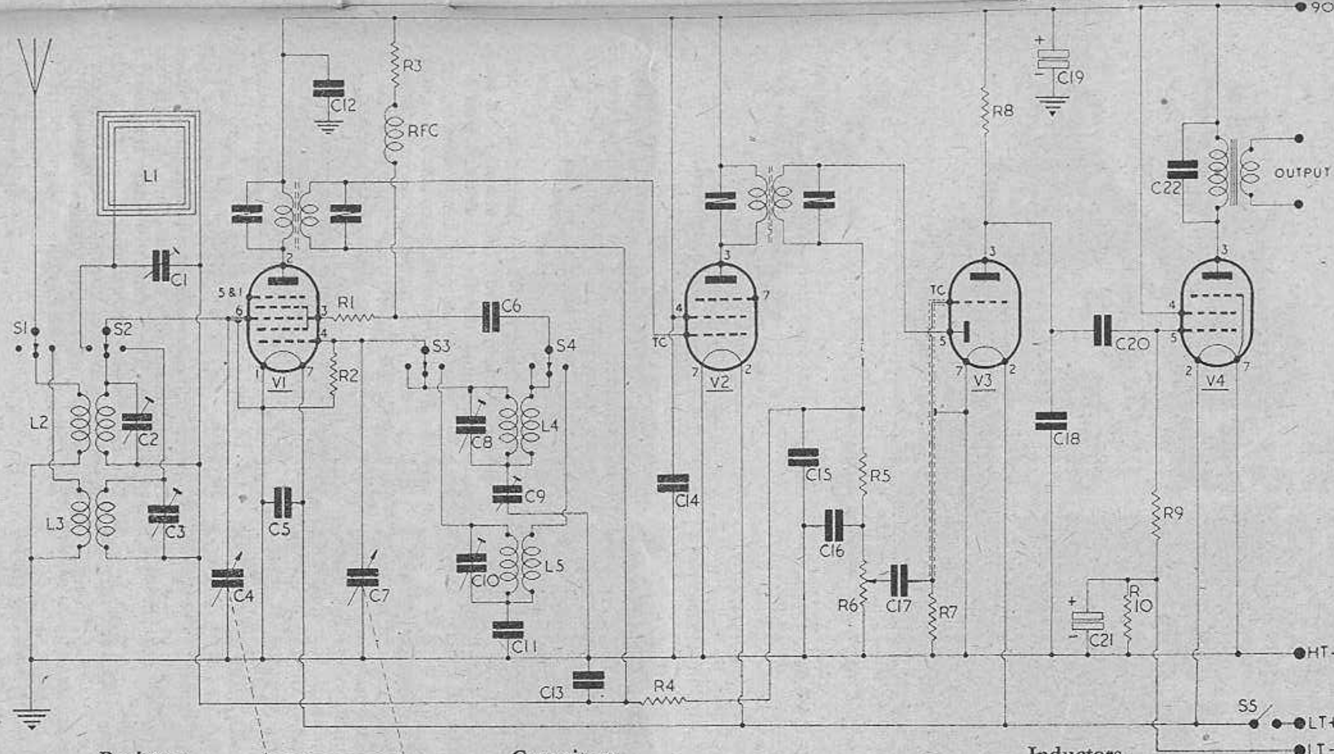
(B) External aerial, internal aerial coil, medium waveband.

(C) Internal frame aerial, medium waveband.

The input to the signal grid of the 1R5 frequency changer will be one of the three given above. Full AVC is applied to the signal grid at all times. This grid is screened when below chassis to prevent the local oscillations being picked up by the signal-grid lead. The local oscillator is parallel fed. The RF choke keeps the HT high on the 1R5 screen-grid and also reduces shunting of the oscillator coupling coil. The padders are common to both coupling and tuning coils to increase feedback. R1 is a parasitic stopper resistor. The local oscillator is 465 kcs. above the signal input frequency.

The IF output at 1R5 anode is via a high gain iron cored IF transformer to the grid of the 1N5GT IF amplifier via a screened lead and top cap to prevent feedback. Full AVC is applied to this stage. The output from the 1N5GT is fed through another iron cored IF transformer to a diode detector in the 1H5GT. This provides both the audio signal and the AVC voltage. The audio is fed by an RF stopper resistor to the volume control and then on to the grid of the 1N5GT. The grid has self-bias obtained by means of a high value grid leak and is screened to prevent pick-up and instability. The anode of this 1st LF amplifier has an RF by-pass capacitor to chassis and the amplified audio is fed to the grid of the 1C5GT output valve through C20.

The 1C5GT has bias provided by a dropper resistor in the common HT negative lead.



Resistors.

R1 : 33 Ω ¼ watt.
R2 : 100 K Ω ¼ watt.
R3 : 10 k Ω ½ watt.
R4 : 4 Meg Ω ½ watt.
R5 : 50 k Ω ¼ watt.
R6 : 1 Meg Ω potentiometer.
R7 : 10 Meg Ω ¼ watt.
R8 : 1 Meg Ω ½ watt.
R9 : 2 Meg Ω ½ watt.
R10 : 1 k Ω ½ watt.

Capacitors.

C1, 2, 3, 8, 10 : 3-30 μμF trimmers.
C4, 7 : 500 μμF twin gang.
C5, 12, 14 : 0.1 μF 500 v. tropical non-inductive.
C13 : 0.02 μF 500 v. paper.
C6, 15, 16, 18 : 100 μμF silvered mica.
C9 : 500 μμF maximum.
C11 : 0.005 μF silvered mica.
C17 : 0.002 μF mica.
C19 : 2 μF 250 v. paper block.
C20 : 0.005 μF mica.
C21 : 25 μF 25 v. electrolytic.
C22 : 0.005 μF 350 v. paper.

Inductors.

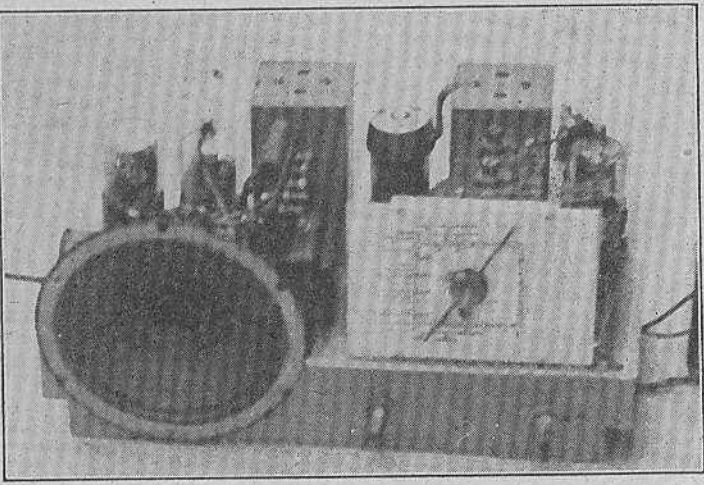
L1 : Frame aerial (see text).
L2 : Wearite PA2.
L3 : Wearite PA3.
L4 : Wearite PO2.
L5 : Wearite PO3.
RFC : 2.5 mH.

Switches.

S1, 2, 3, 4 : 4-pole, three-way rotary.
S5 : On/off switch (on volume control).

Speaker.

5 in. PM speaker. Output transformer to match speaker to 9,000 Ω.



Front view of the chassis showing disposition of main components.

This voltage has a large capacitor across it to prevent AC voltages being developed and causing instability. The 1C5GT feeds the speaker through a matching transformer, the primary of which is shunted by a capacitor to provide some degree of tone correction.

Alignment.

It will most probably be necessary to align the IF's with a signal generator unless they are bought pre-tuned. In the latter case, only a slight trimming will be needed. Taking it for granted that the majority of constructors do not possess a signal generator, here is a method of aligning the RF side.

Use a piece of wire, earthed, near the oscillator coils to simulate the effect of the HT battery shielding.

(*a*) Set tuning pointer so that tuning comes to the correct position at the ends of the scale.

(*b*) Connect aerial and, with wavechange switch at medium wave position, external aerial, tune for a weak station near the low frequency end of the band (the vanes of the capacitor will be almost fully meshed). This station should be of a known frequency.

(*c*) Set dial to the correct calibration for the station.

(*d*) Adjust C9 to bring in the station at maximum strength.

(*e*) Tune to a weak station near the high frequency end of the band.

(*f*) Set dial to correct calibration for this station.

(*g*) Adjust C8 for maximum signal. Then adjust C2 for maximum signal.

Then repeat from (*b*) to (*g*) in that order until both ends of the bands are correctly aligned. For the short waveband switch to "short wave." As a fixed padder is used it is not possible to align the low end of the band, but if wiring has been kept reasonably short it will be near enough for calibration purposes. Tune for a station somewhere around the 25 metre band and adjust C10 to bring it to correct position on the dial. Then adjust C3 for maximum signal strength. If it is found that some trimmers do not have a high enough capacitance, small fixed capacitors of around 10-20 μμF should be tried in parallel and the trimmers readjusted.

When all this has been carried out, switch back to medium waves and search for a weak station. Adjust the IF transformer trimmers, starting from the detector diode winding and working back to the frequency changer anode, in that order, for maximum signal strength. If considerable adjustment is needed, the trimming procedure should be repeated.

Now switch to medium wave position with the frame aerial and with chassis and batteries in cabinet in their correct working positions, tune to a weak signal at the high frequency end of the band. Adjust C1 for maximum strength.

More accurate alignment can be obtained by visual indication, by using an AC voltmeter in series with a 4 μF capacitor across the primary of the output transformer. To check the AVC, tune in to a strong station on medium waves and turn down volume. By shorting out C13 an increase in volume should be noted.

For use with a pick-up, the input should go across R6 and some means provided for disconnecting R5 from R6 to prevent break-through of radio programmes. R6 will function as a volume control in the normal way.

N.B.—When aligning receiver it is important to use a trimming tool and not the usual metallic screwdriver.

COMPONENT REVIEW

SURPLUS CASES.

We have received from Messrs. G. Barmaper, of 1, New Court, Carey Street, London, W.C.2, a somewhat unusual line in surplus equipment. The item in question is a Decca gramophone case, without fittings, and Messrs. Barmapers hold large quantities of these. Though they are surplus to requirements, the cases are all in brand new condition and consist of the top and lower halves, both attractively covered with rexine. The ⅜in. thick laminated pinewood construction makes a really sturdy job, capable of withstanding considerable pressure. The overall dimensions, with the two halves placed together, are 16in. × 11½in. × 6½in.

The applications to radio work are many, and our first impression was that, fitted with suitable hinges, a handsome and roomy instrument case would result. For multiple test units, these cases are ideal and would make an attractive looking addition to the radio shack. On the other hand, the cases would conveniently house a portable radio, with ample room for the receiver, speaker and batteries. A frame aerial could be fixed round the inside edges of the lid. It will be seen, then, that we consider these cases to be ideal for those who do not have the facilities to make their own wooden housings. Of course, for a portable gramophone or for using with a gramophone motor unit, they are "made-to-measure."

Some of the cases, we understand, are complete with motor board (also rexine covered), though, owing to limited numbers of these boards, only the first orders received will have these included.

Altogether, we foresee that these fine cases will be put to many uses by the radio enthusiast. The price is, we feel, reasonably set at 25/- per complete case (including packing costs).

TRADE NOTES

Taylor Electrical Instruments, Ltd., announce that in future their products will be sold under the name of "Windsor," instead of "Taylor." Each instrument will bear a plate stating that it is manufactured by Taylor Electrical Instruments, Ltd.

This change is being made to enable the firm to enter certain export markets which hitherto have been closed because their products were conflicting with those of the Taylor Instrument Co. of America, with whom there is no connection.

Incidentally, Easter week marked the tenth year of trading by the English Company.

Aerialite, Ltd., manufacturers of "Ashton" cables, "Aerialite" automobile cable, radio and television equipment, announce that they have taken over the business of Victor H. Iddon, Ltd., of Wythenshawe, Manchester (manufacturers of the well-known "Nettle" switches, lampholders and electrical accessories).

Henry's, radio component factors, have sent us their latest retail price list. Apart from the normal run of radio components, we note that kit sets for AC/DC midget receivers, midget coil packs and a comprehensive range of valves are offered. The list may be had on application to Henry's, 5, Harrow Road, London, W.2.

Mail Order Supply Co., of 24, New Road, London, E.1, have inaugurated a novel service for their mail order clients. It is a monthly news-sheet which contains not only details of surplus gear offered, but an editorial, "feature" columns, and so forth. A "Readers' Forum" is scheduled to commence with the May edition. The M.O.S. News Letter has four pages, and is obtainable from the publishers on request.

(*6B8—continued from page* 263)

connected to the audio output. The sequence becomes RF pentode amplifier—diode detector—AVC—triode audio output amplifier. It is important that voltages (especially on the screen-grid) should be as shown in the accompanying tables. Watch all earths and when using two tuned circuits, screening must be adequate.

PIN CONNECTIONS FOR THE 6B8G.

Octal Base.

Pin 1—Earth. Pin 5—Diode.
Pin 2—Filament. Pin 6—Screen-grid.
Pin 3—Anode. Pin 7—Filament.
Pin 4—Diode. Pin 8—Cathode.
Top Cap—Control Grid.

OPERATING CONDITIONS of the 6B8G

Anode Voltage... ...	100	180	250
Screen Voltage ...	100	75	125
Grid Voltage	—3	—3	—3
Anode Current (mA) ...	5.8	3.4	9.0
Screen Current ...	1.7	0.9	2.3
Amplification Factor ...	285	840	730
Grid Bias (for cathode current cut-off) ...	—17	—13	—21

Useful Formulae and Data

(**Editorial Note.**—*Last month we published data on the standard colour codings. We frequently receive requests for this type of data and we will periodically publish similar information as space is available. This month we list a few formulae that the constructor will find useful*).

Capacitance.

The capacitance of a parallel plate type capacitor is given by the formula :—

$$C = 0.0885 \frac{kA}{d} (n-1) \mu\mu F.$$

where C=capacitance in micro-microfarads.
,, k=constant of the dielectric, that is medium between the plates.
,, A=area of one side of one plate in sq. cms.
,, d=the distance in cms. separating the plates.
,, n=the total number of plates.

The dielectric constant is the ratio between the capacitance of a given capacitor using a certain dielectric or separating material, and the capacitance of the same capacitor using air as the dielectric. The value for commonly used insulating materials is given in the table below.

Material.	*Dielectric Constant.*	*Material*	*Dielectric Constant.*
Paxolin	... 2	Trolitul	... 2.2
Steatite	... 6.1	Micanite	... 7
Porcelain	... 6-7	Polystyrene	... 2.55
Mica	... 6-7	Ebonite	... 2.8
Isolantite	... 6	Quartz	... 4.7
Air ...	... 1	Pyrex	... 4.5
Tufnol	... 5	Bakelite	... 5-11
Frequentite	... 6	Celluloid	... 4-16

Capacitance can also be stated in terms of the quantity of charge required to cause a given potential difference between two conductors. Thus :—

$$C = \frac{Q}{E}$$

where C=capacitance in farads (F).
,, Q=charge in coulombs.
,, E=potential difference in volts.

When capacitors are connected in parallel or in series, the resulting capacitance is given by the following formulae :—

In parallel ... $Ct = C_1 + C_2 + C_3$, etc.

In series ... $\frac{1}{Ct} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ etc.

where Ct=total and C_1, C_2, etc.=individual capacitance.

Inductance.

If a varying current flows through any circuit, an EMF is induced, the value of which will depend on the *inductance* of the circuit and the rate of change of the current flowing. This is expressed as :—

$$L = \frac{E}{r}$$

where L=inductance in henries
,, E=induced EMF in volts
,, r=rate of change of current in amperes per second.

The inductance of air cored coils is given by:—

$$L = \frac{0.2\ A^2\ N^2}{3A + 9B + 10C}$$

where L=inductance in μH (microhenries)
,, A=mean diameter of coil in inches
,, B=length of winding in inches
,, C=radial depth of winding in inches
,, N=number of turns.

C may be neglected in the case of a single layer coil.

To calculate the number of turns required for a given value of inductance, where the coil is of the single layer type :—

$$N = \sqrt{\frac{3A + 9B}{0.2\ A^2} \times L}$$

When inductors are connected either in parallel or in series, the resultant inductance is given by :—

In parallel ... $\frac{1}{Lt} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$ etc.

In series ... $Lt. = L_1 + L_2 + L_3$ etc.

where Lt is the total, and L_1, L_2, etc., the individual inductances.

Resistance.

Every conductor opposes, to some degree, the passage of a current through it. The *Resistance* to a DC current depends on the material of which the conductor is made, the length and cross-sectional area, and the temperature. A conductor has a resistance of one ohm when the application of a potential difference across it of one volt causes a current of one ampere to flow.

When resistors are connected in parallel or in series, the resultant resistance is given by :—

In parallel ... $\frac{1}{Rt} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ etc.

In series ... $Rt = R_1 + R_2 + R_3$ etc.

where Rt is the total and R_1, R_2, etc., the individual resistances.

The change in resistance, due to an increase in temperature, of commonly used materials is given in the following table, where it is expressed as a percentage rise per degree Centigrade.

Material.	*Co-efficient.*	*Material.*	*Co-efficient.*
Aluminium	0.3/4	Copper	0.4
Silver ...	0.3/4	Eureka	—0.007/+0.004
Zinc ...	0.4	Manganin	0.0005
Brass ...	0.15	Tin ...	0.45

Reactance.

Reactance is the term used to indicate the opposition to the passage of alternating currents offered by inductors and capacitors. The reactance of an inductor is given by:—

$$X_L = 2\pi fL$$

The reactance of a capacitor is given by:—

$$X_C = \frac{1}{2\pi fC}$$

The reactance of an inductor and capacitor in series is given by:—

$$X = X_L - X_C$$

where X = reactance in ohms
,, X_L = inductive reactance in ohms
,, X_C = capacitive reactance in ohms
,, $2\pi = 6.28$
,, f = frequency in Mcs. (Megacycles per second).
,, L = inductance in μH (microhenries)
,, C = capacitance in μF (microfarads).

In a future issue we will give useful values of capacitive and inductive reactances at audio and radio frequencies.

Impedance.

This term denotes the opposition to the flow of current when a circuit contains both resistance and reactance. The impedance of such a circuit is given by:—

$$Z = \sqrt{R^2 + X^2}$$

where Z = impedance in ohms
,, R = resistance in ohms
,, X = reactance in ohms.

Ohms Law.

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

where E = EMF in volts
,, I = Current in amperes
,, R = Resistance in ohms.

Resistance of Meter Shunts.

$$\text{Value of shunt required} = \frac{\text{meter resist'ce}}{(N-1)} \text{ ohms}$$

where N = the number of times the scale reading is to be multiplied.

Speaker Transformer Ratio.

$$N = \sqrt{\frac{R_L}{Z}}$$

where N = Turns ratio
,, R_L = Optimum load of valve
,, Z = Speech coil impedance.

Cathode Bias Resistor.

Where a valve is biassed by virtue of the voltage developed across a resistor in series with the cathode, the value of the resistor required is given by:—

$$R = \frac{Eg \times 1{,}000}{It}$$

where R = resistance in ohms
,, Eg = required bias voltage
,, I = total electrode current in mA (milliamps).

Conductance.

The capacity to conduct, that is the inverse to resistance, is known as *Conductance*, the unit being the *mho*. A conductor with a resistance of one ohm, therefore, has a conductivity of one mho. The relative conductivity of commonly used materials is given in the table below, and is based on copper as 100 per cent.

Material.	*Conductivity.*	*Material.*	*Conductivity*
Copper ...	100	Brass ...	25
Silver ...	106	Aluminium ...	40/60
Cadmium ...	20	Tin	14
Zinc ...	28	Chromium ...	55

Oscillatory Circuits.

The wavelength of a tuned circuit is given by—

$$\lambda = 1{,}885\sqrt{LC}$$

where λ = wavelength in metres
,, L = inductance in μH (microhenries)
,, C = capacitance in μF (microfarads).

The resonant frequency of a tuned circuit is given by:—

$$f = \frac{10^6}{2\pi\sqrt{LC}}$$

where f = frequency in kcs. (kilocycles per second)
,, $2\pi = 6.28$
,, L = inductance in μH (microhenries)
,, C = capacitance in μμF (micro-microfarads).

"Q."

The term "Q" indicates the efficiency of an oscillatory circuit, and can be expressed as:—

$$Q = \frac{2\pi fL}{R}$$

that is, the reactance of the inductance at any given frequency divided by the effective resistance of the circuit.

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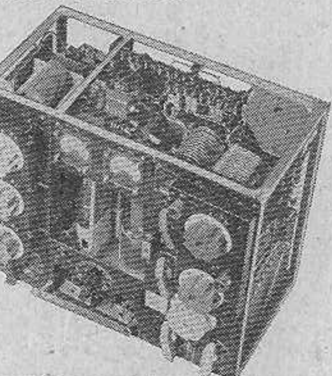
T1154 TRANSMITTER

...mplete Tx. for "Fone", C.W. and M.C.W. ...n valves ML6 (VT105) Hartley M.O., ...T15's (VT104) parallel P.A., ML6 mod. ... side tone, suppressor grid modulation, ...plified tuning, etc., etc., with circuit less ...wer pack, in metal case 14" x 16½" x 8½".

...YDESDALE'S ...ICE ONLY **£10 10s.**

Carriage and Packing Paid.

...wer supply required H.T. 1200 v., 200mA ...oothed D.C., L.T., 6.3v., 4a. Circuit ...ilable at 2/3 post free.



R1155 RECEIVER

...communication Receiver for 18.0-7.5 ..., 7.5-3.0 Mcs., 1500-600 kcs., 500-200 ... 200-75 kcs., with 10 valves. S.M. ...ng, calibrated dial, etc. Complete ...iver unit in metal case 16½" x 9" x 9", ... circuit, less power pack. Tested in ...ation before despatch.

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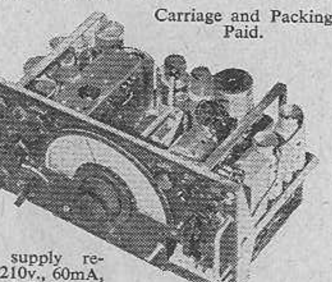

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Range.	Resistance ohms.	Whitescale Flush Mounting.	Price each Post paid
Micro Ampmeters.			
0/500	75	2½" round	25/-
0/500	500	2" round, piece cut off top flange	8/6
500-0-500	500	2½" round plug-in	12/6
Milliammeters.			
5-0-5	6	2½" round	10/-
0/5	10	2" square marked battery lines	5/6
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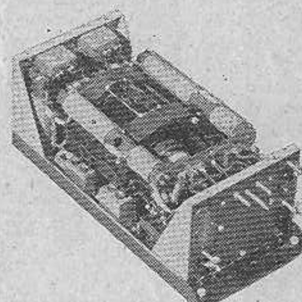
0/120	0.42		
0/500	2	2" round	9/-
Thermo-Coupled Ammeter.			
0/0.5	0.7	2" square	7/6
Volt Meters.			
0/30	6000	2" square	5/6
0/40	8000	2" square	5/6
0/40	8000	2" square, black face	5/6



POWER UNITS for T1154 Tx.

Output 1200 volts at 200 mA.

Type 32 10K17.
„ 32A 10K13063.
Input 12 volts. 32 amps.

Type 33 10K1470.
„ 33A 10K13064.
Input 24 volts. 16 amps.

ALL AT CLYDESDALE'S PRICE ONLY

26/11 each

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Outputs: L.T., 7.2v., 13 amps. H.T., 225v., 11^ mA.

Type 34, 10K19. Type 34A, 10K13065.

Input: 9.3 volts, 23 amps.

Type 35A, 10K13066. Input 18 volts, 12 amps.

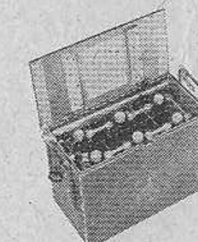
CONDENSERS

All tested before despatch

Cap.	V.D.C. Wkg.	Size.	Mtg.	Price ea.	Dozen
ELECTROLYTIC, ALI CAN.					
8 mfd.	750	1¼" dia. 4" high	Clip	6/-	59/6
8 mfd.	500	1" dia. 4½" high	Single hole	6/-	59/6
8 mfd.	350	1" dia. 2¼" long	Tubular	2/-	20/-
4 mfd.	350	1" dia. 2¼" high	Single hole	2/3	21/6
MAINSBRIDGE, METAL CASED.					
8 mfd.	750	4¾"×4" ×2"	Upright	6/-	55/-
8 mfd.	500	4¾"×3" ×1½"	Upright	5/-	45/-
4 mfd.	250	2½"×1¾" ×1½"	Upright	1/9	15/-
2 mfd.	600	2½"×2" ×1½"	Upright	1/9	15/-
2 mfd.	400	2½"×2" ×1"	Upright	1/3	9/-
1 mfd.	2,000	4¾"×2½"×1½"	Upright	3/6	30/-
1 mfd.	750	2¼"×2" ×1"	Upright	1/6	13/6
0.3 mfd.	1,500	2" ×2¾"×2"	Upright	2/-	17/6
0.25 mfd.	2,000	2½"×2" ×1¼"	Upright	2/6	20/-
U.S.A. METAL CASED, OIL FILLED. Ceramic S.O. Insulators.					
4 mfd.	350	3¼"×2½"×1½"	Upright	3/-	22/6
1 mfd.	600	2" ×2¼"×¾"	Upright	1/6	13/6
CERAMIC HIGH VOLTAGE TRANSMITTING.					
750 pF	15 KV	3¾" long 1½" dia.	Hanged pot	3/11	36/-
750 pF	15 KV	3½" long 1¾" dia.	Hanged pot	3/11	36/-
500 pF	15 KV	3¾" long 1½" dia.	Hanged pot	3/11	36/-
500 pF	15 KV	3½" long 1¾" dia.	Hanged pot	3/11	36/-
25 pF	4 KV	2¼" long 1¼" dia.	Upright	3/11	36/-

BRAND NEW

12 VOLTS 75 A.H. ACCUMULATOR



In Waxed Teak Box with hinged lid, metal carrying handles at side. Connections brought out to 2-pin socket. Size 16½" x 8" x 11' 4" high.

CLYDESDALE'S PRICE ONLY **£5**

Packed in a Wood Box. Carriage Paid.

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BC Series (Western Electric). Models available BC453 (190-550 kcs.), BC454 (3.0-6.0 Mcs.), BC455 (6.0-9.0 Mcs.), each a 6-valve superhet 12SK7's, 12K8, 12SR7, 12A6. Complete Rx for 24v., less dynamotor. Used, Good condition, in metal case.

CLYDESDALE'S PRICE ONLY **50/-** each. Post Paid.

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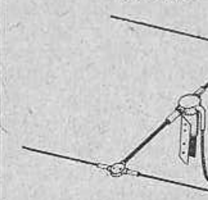
Triple control unit for BC453-454-455 Rxs, with geared tuning drives and calibrated dial plates, volume controls on-off switch plug/sockets, jacks, in metal case. Less Bowden cables.

CLYDESDALE'S PRICE ONLY **5/-** each. Post Paid.

THE GROUP OF ...

BRAND ...



Half-wave Dipole Aer... and crossarm, for appr... vertical or horizontal m... wall bracket or mast. Dipole 9' 3". Crossarm 9' 7" with 39' of co-axia... plug.

CLYDESDALE'S PRICE ONLY

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CO-AXIAL ...

Coil (12 yds.) first-cl... approx. 80 ohms. at ...

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MICROPHONE AN... ASSEMBLY—In...

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SALE, MCR1 midget receiver, complete with phones and power pack. £7/10/0. Box 107.

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Ham Library of 16 books £3. MCR1 £8. Box No. 108.

SALE. Battery 1-v-1 in smart metal cabinet, grey; with full set coils, 10 to 160 metres. £9. Also 28 Mcs. converter with built-in power pack. Professional job—offers over £10. Exchange following valves for 807s:—T40, PT15, "Stonehaven," Horncastle Rd., Boston, Lincs.

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Ceramic.	Silver Mica Type.	Mica Type.
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8pF ± .2pF	200pF ± 20%	
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VALVES. NEW BOXED, U.S.A. 6AC7, 6AB7, 6SH7, 9003, 6H6, 6J5.—**7/6.** 5U4G, 2X2/879. **9/-**, 807, **12/6.** Twin 100*ua* meters **10/-**. 8-day Clocks, super timekeepers, **30/-**. Telescopes, **15/-**. 9ft. Telescopic Aerials, **6/6**. Condensers, .01mfd 1,000vdc, **4d.**, 4-50 pf. 3/- doz. 10mfd 25vdc, 1/6. .1mfd 1,500vdc, 2/-. All plus carr. 41, Hospital Road, Riddlesden, Keighley, Yorks.

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SALE. 100 watt multiband TX. Xtal/vfo-pp 807s Class B modulator and xtal mike. A neat, smart, efficient table top rig. SAE for details. **£40** or near offer. Box 115.

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