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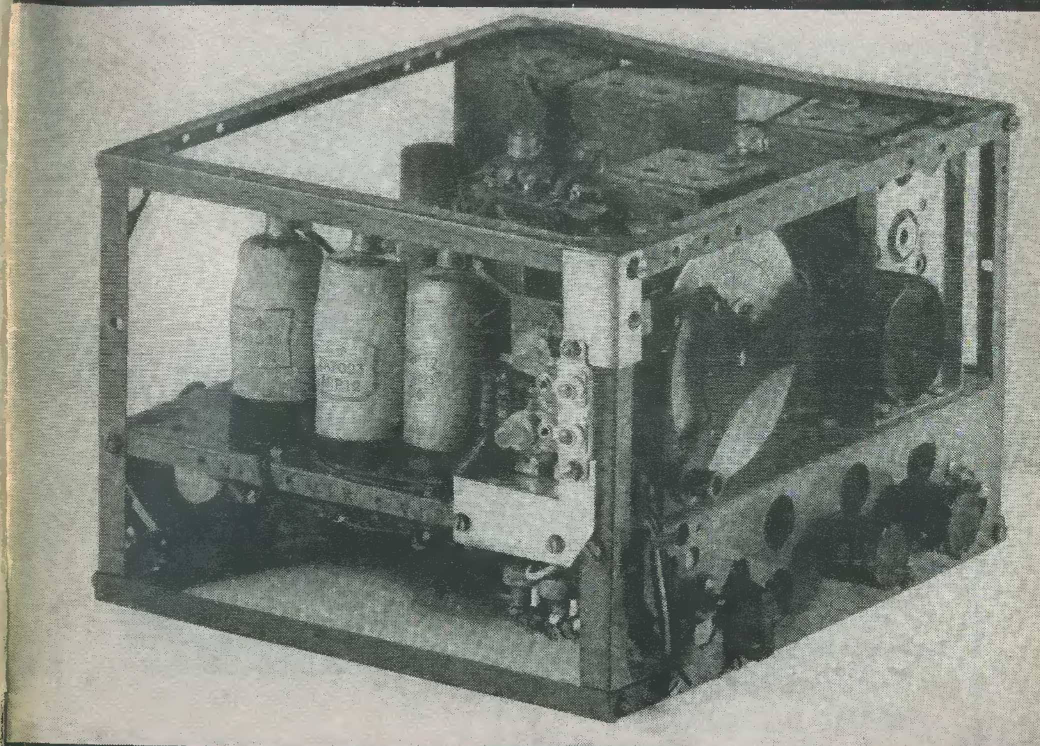
RADIO CONSTRUCTOR

for the Radio and Television Enthusiast



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Radio Constructor

Vol. 5, No. 5 — Annual Subscription 18/- — December, 1951

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Edited by C. W. C. OVERLAND, G2ATV

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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 or 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. 6518.

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. 13: A Heterodyne Capacitance Meter

This month's circuit is that of a heterodyne capacitance meter capable of measuring values of capacitance from less than 10 pF to greater than 0.01 µF. Accuracy is good, but the scale is liable to become cramped for readings above 0.001 µF.

Principle of Operation

The principle of operation is very simple. V1 is an RF oscillator, across the grid coil of which (L1) various values of unknown capacitance may be connected. V2 is also an RF oscillator, being tuned by a variable capacitor, C5. It is loosely coupled to the circuit of V1 by suitable positioning of the coils. To find the value of an unknown capacitor, it is first of all connected across L1, whereupon C5 is adjusted until a zero beat is heard in the phones. The two oscillators are then working on the same frequency and the value of the unknown capacitor may be read from a previously-calibrated scale fitted to C5.

To expand the range of the meter a two-way switch, S1, is included in the circuit. When this switch is set to Range 1, the unknown capacitor is connected directly across L1. When Range 2 is selected, the unknown capacitor is connected in series with a fixed capacitor, C2, and acts more or less as a padder. Assuming that C5 has a value of 500 pF, Range 1 then measures capacitances nearly up to this figure, whilst Range 2 allows readings to be taken to the probable maximum (with accuracy) of 0.01 µF. There will be a certain amount of overlap between the two ranges, but there is little point in calibrating Range 2 below 300 pF.

A small fixed capacitor, C1, is connected permanently across L1, this helping to reduce the effects of varying stray capacitances. It also allows C5 to swing over the zero test capacitance position when its vanes are unmeshed.

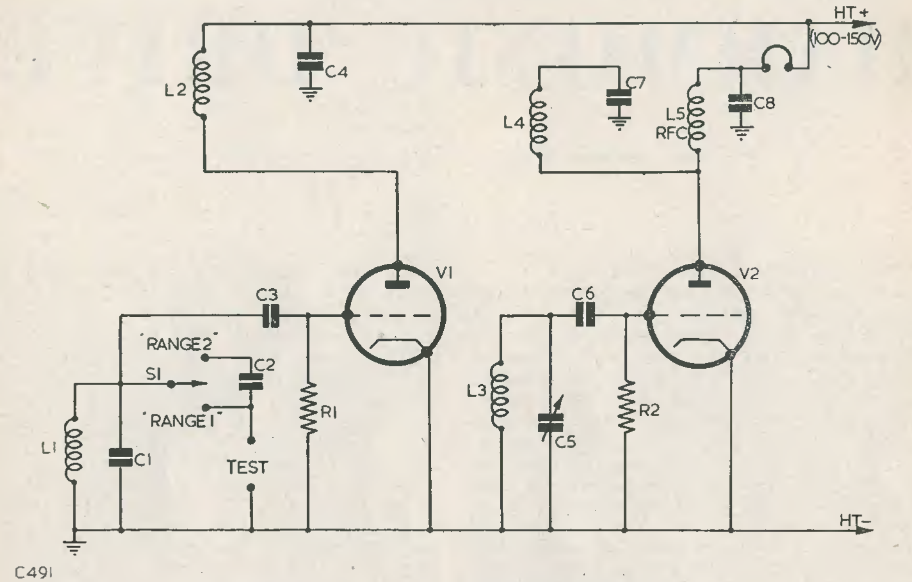
Both L1,L2 and L3,L4 are similar coils, and it is recommended that medium-wave superhet oscillator coils be used in these positions. With such coils, stable oscillations should be obtained without too much self-capacitance. L5, the RF choke, need not be elaborate. A single-bobbin "reaction-type" component would probably cope quite well.

Practical Details

The construction of the meter should present little difficulty. It will probably not be necessary to screen the coils L1,L2 and L3,L4 away from each other; but it would be advisable to have them some distance apart, with their axes at right angles If this does not give sufficient coupling, their positions may be altered so that their axes are brought more in line. On the other hand, should coupling be too tight (and this may result in "pulling") it may be necessary to fit a small screen between the two coils.

When the meter has been completed, calibration may be carried out by measuring the values of known capacitors, and completing the scale with the aid of a graph.

ACTON, BRENTFORD AND CHISWICK readers are invited to attend meetings held every Tuesday for radio enthusiasts at the A.E.U. Rooms, 66–68, High Road, Chiswick, W.4. Time, 7.30 p.m. onwards. Practical construction is planned, and part of the evening is given to Morse classes. Everyone is welcome, particularly newcomers to radio.



HETERODYNE CAPACITANCE METER

Component Values

Capacitors

C1—10 pF; Silver-mica.
C2—400 pF; Silver-mica.
C3—200 pF; Mica
C4—0.1 µF; Paper.
C5—500 pF.
C6—200 pF; Mica.
C7—.001 µF; Mica.
C8—.001 µF; Mica.

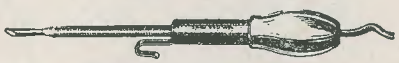
Resistors

R1, R2—20 kΩ.

Valves

V1, V2—6J5, or any suitable equivalent.

Please Mention . . .
THIS MAGAZINE WHEN WRITING TO ADVERTISERS



HARMONIC DRIVE

Part Three

By P. TURNER

Where Harmonic Drive Comes From

Do you remember that bit about vectors and how they do what we tell 'em. We found out that a vector which is used to represent a varying waveform can be imagined to be like a spoke of a wheel. It is easier if you just imagine one spoke and throw the rest of the wheel away. Because it is mostly mathematicians who write about vectors, and because they always take the precaution of reducing a waveform to sine waves before they start calculating, it is usual to think of a vector of this kind as rotating at a constant invariable speed, and therefore as describing a sine wave. There is no reason why a vector should not speed up and slow down, though, if you care to think of it as doing that.

Look at Figure 3. Here you see a vector rotating to produce a sine wave when its apparent height is made into a graph with time for the horizontal part. Shown above it is another waveform, but this is a distorted wave. Now we know that the peak value of a waveform is equivalent to the maximum height of the vector, or really the other way round, the vector is made just high enough, or long enough if you like, to represent the peak value of the wave. It is obvious then that the peak value is shown by the vector when it is upright, or at ninety degrees, as they say. (A vector is usually agreed to start lying down and pointing to the right. This position is made the zero degrees position or the start position). The term 'ninety degrees' only means that the vector has made a quarter of a revolution as determined by the waveform. Here is a funny thing. Although the vector in Figure 3 A has made a quarter of a revolution as shown by the waveform, the vector of a sine wave having the same frequency has not made a quarter of a revolution. The vector of the distorted wave must be going faster than the vector of the sine wave, then.

Now look at the second ninety degrees of movement. The sine wave vector carries on at the same old speed quite unchanged, but the vector for the distorted wave has to slow down because the two vectors reach one hundred and eighty degrees or half a revolution at exactly the same moment. The same thing happens in the next half of the waveform. The vector of the sine wave goes on at the same old speed, while the vector of the distorted wave goes slow at first, and then speeds up to catch up the

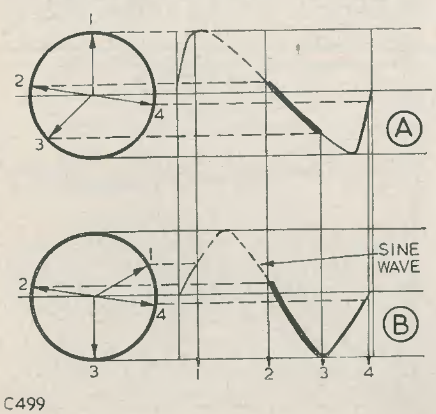


Fig. 3: The vector at 'A' travels rapidly through 90° and at the instant of time '1' is well in advance of the vector at 'B'. Then it slows down and they reach 180° together, shown at instant of time '2' at almost 180°. The vector at 'A' is then overtaken by the vector at 'B', shown at instant of time '3' during the negative half of the waveform, and finally speeds up again to reach 360°, or the end of one complete cycle, at the same time as the vector at 'B'. The vectors are shown at instant of time '4' at almost 360°.

vector of the sine wave so that they both reach the end of one complete wave at exactly the same instant.

Now look at Figure 4. Here we have two sine waves, one a large amplitude one, and one a smaller one of twice the frequency. The vectors are shown with a common spindle here, but as vectors are only imaginary things this is quite OK. They will not bang into each other. The vector of the little wave will be going round twice as fast as the vector of the big wave. Its frequency will be the 'second harmonic frequency' of the big wave form frequency. Let us say that these two waveforms are the result of one of M. Fourier's analyses. The original waveform, before it was broken down into sine waves, would have been like Figure 5. This happens because at first the two sine waves are helping each other and so the voltage, or current, or whatever it is that the waveform is describing, quickly rises to its peak value. The combined vector describing the original wave is going round fast. A little later the two sine waves are working against each other, and the fall from the peak is a good deal slower. The vector slows down in the same way.

Now let us see if we can reason out why it is that a sine wave variation of current cannot be used to drive a circuit tuned to a multiple of the sine wave frequency, or the fundamental frequency. We are once more in debt to the Romans for that word 'fundamental', by the way. It comes from a Latin word, fundus, the bottom (meaning the base or lower portion). The Roman word for 'foundation' was 'fundamentum' and this is the way in which we use our version of the word. When we say 'the fundamental' we mean the 'foundation wave' of frequency, say, f cycles per second, which we use to build up our structure of related or harmonic frequencies.

Look at Figure 4 again. It shows a big sine wave, and a little one of twice the frequency. Say the big sine wave is the output waveform of a very good signal generator, and the little one is the waveform of a circuit that we are trying to drive. We are trying to get some second harmonic drive from the signal generator, then. At the start of the first wave everything is alright and the fast circuit is in step with the slow one. Half a wave later (in the fast circuit) the driver waveform is changing in exactly the opposite direction to that in which the driven waveform is trying to change. In other words, if your oscillator has a pure sine wave output and you couple it to a circuit tuned to the second harmonic frequency, it will give the faster circuit a wallop in the right direction during one half of a cycle and a wallop in the *wrong* direction during the next half of a cycle. This results in an *average* transfer of energy which is exactly NIL at twice the frequency of the driver current variations (or at any other multiple). Consequently, ordinary transformer action is set up, and the waveform which occurs in the coupled circuit is the same frequency as the oscillator waveform. It won't be an exact sine wave, though.

The fact that the coupled circuit is tuned to twice the frequency of the oscillator means that it has a *preference* for going twice as fast and it will try to do so all the time. This will distort the output from the coupled circuit a little. Now look at Figure 5 again. Here we have a distorted waveform, and we have shown the second harmonic frequency sine wave on the same base line. Suppose the distorted wave is the output from a crystal oscillator and we couple a coil to it in the ordinary way. Suppose that the coupled coil is tuned by means of a capacitor to twice the frequency of the oscillator. At the start, the two vectors will be going at *nearly* the same speed. This means that

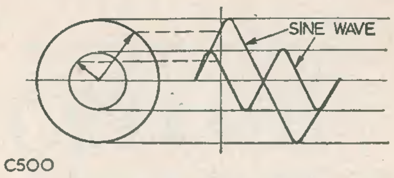


Fig 4.

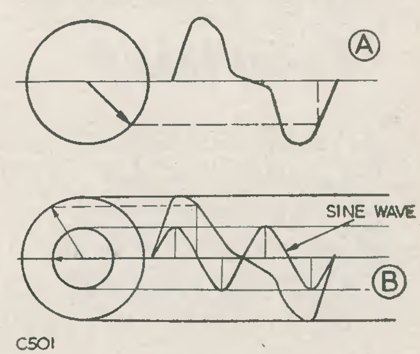


Fig. 5

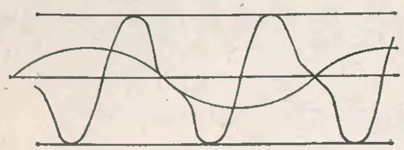


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Fig. 6

the coupled circuit will get a good big wallop in the right direction to set it oscillating. It will be a bigger wallop than it would get from a sine wave current because the vector of the distorted wave is going faster, which means that the current it is describing has a greater rate of change of current against time. Now, half a cycle later the vector of the distorted wave is slowing down, and although the second harmonic tuned circuit gets a wallop in the wrong direction it is not such a big wallop as it got at the start in the right direction, so only some of the energy is cancelled, and the circuit has a bit of energy left over and goes on oscillating at its own fundamental frequency, which is twice the oscillator frequency. This is commonly called 'extracting the second harmonic', but it really ought to be called 'obtaining second harmonic drive'. The same sort of thing holds good for any other harmonic. It all depends on the fact that if you distort a sine wave anywhere or any how, you cause its vector to vary in speed. It either speeds up and then slows down again to let Old Father Time catch up, or it does it the opposite way round and lags behind a little and then speeds up again.

This is repeated every cycle of current, and the corresponding variations in the rate of change of current when plotted against time allow the unequal transfer of energy to take place, with the result that a circuit tuned to an exact multiple of the fundamental frequency is caused to oscillate at the multiplied frequency when it is coupled to the circuit having a distorted waveform.

If a vector is speeded up, relative to a sine wave of the same fundamental frequency that is, it is obvious that it must slow down *below* the normal rate of rotation of the sine wave vector—so it would appear at first sight that it ought to be able to drive circuits of a lower frequency also. If you look at Figure 6 you will see at once that this cannot happen. The lower frequency circuit (the second *sub*-harmonic in this case) will be driven in the correct manner in one half of its cycle, and in the opposite manner the other half of its cycle. The net result again is ordinary transformer action.

When we talk about a vector speeding up and slowing down we mean that the current which is being described by the vector (or the voltage or any other varying quantity), is varying in a manner which would not give a sine wave if it were made into a graph with time as the horizontal part of the graph.

(To be continued)

Converting the 21 RECEIVER

By J. R. DAVIES

The first of a series of three articles describing the conversion of this well-known ex-Government receiver.

ONE of the best bargains offered at present on the Government surplus market is the ex-Army No. 21 Receiver. This is a 9-valve battery receiver working on the two ranges 4.2 to 7.5 Mcs and 19 to 31 Mcs. The receiver functions as a double superhet on the higher frequency band, and as a single superhet on the lower frequency band. The IF is 456 kcs (when used as a double superhet, this is the second IF), amplification being carried out over two stages. The IF response is flattened on the higher frequency band by means of auxiliary circuits connected to the wavechange switch.

The receiver is intended to operate from a separate vibrator pack driven by a 6-volt battery. The 6-volt battery also supplies filament current to the valves in the receiver. As these are 2-volt types, each valve is fitted with a filament dropping resistor (with the exception of several valves in the RF section whose filaments are isolated from chassis by chokes or tuned circuits). Only two types of valve are used in the receiver (presumably to facilitate replacement during war-time action); these being the ARP12, a vari-mu RF pentode, and the AR8, a double-diode-triode. Frequency-changing (to 456 kcs) is carried out by using a separate ARP12 as oscillator, its output feeding into the suppressor-grid of another ARP12 which functions as a mixer. The ARP12 and the AR8 are both Mazda-octal types.

AF output is provided by an AR8 feeding into a special output transformer, a third winding of which is employed to provide noise suppression. Another AR8 is used as a BFO, it being operated by switching its filament.

As it stands, the receiver can be immediately connected to a 6-volt LT and a 150-volt HT supply, whereupon it will provide headphone reception on the two bands for which it is designed.

The Conversion

The object of the conversion described in these articles is to alter the receiver in such a manner that it will cover the conventional all-wave bands with good-fidelity loudspeaker output, whilst at the same time retaining the high sensitivity, selectivity and, so far as is possible, the other refinements which are inherent in its orginal circuit. The receiver is also modified so that it may be operated from 2-volt and 120-volt battery supplies.

Such a conversion necessitates an alteration to the output stage, and also the removal of the RF and mixer tuned circuit components, the latter being replaced by an all-wave circuit. The IF stages are left as they are. The wave-change switching circuits which were used originally to alter IF selectivity for the two different bands are retained; thus providing a panel control of variable selectivity in the completed receiver.

An Osmor HO coil-pack, together with an Osmor LM HF Stage, are used to provide the new tuned circuits. Apart from other considerations, this coil-pack and its HF Stage are ideal for this conversion owing to their small physical size and their ease of mounting.

The Osmor HO coil-pack is intended to work on the long, medium and short wavebands without an RF amplifier. When it is desired to provide RF amplification, a further three-waveband "HF Stage" can be connected to the existing wave-change switching circuits of the HO coil-pack. However, the layout of the 21 receiver makes it difficult to employ really short RF-carrying leads to the HF Stage, and the efficiency of the short-wave HF coil would then be correspondingly reduced. This trouble is overcome by using an LM HF Stage (identical to the three-wave band HF Stage which would normally be employed, except that it has long and medium-wave coils only), and, on the short-wave band, feeding the aerial tuned circuit straight to the signal grid of the mixer. There is therefore no RF amplification on short waves, but the single signal tuned circuit is still quite sufficient to give good sensitivity without undue second-channel interference. To effect the altered wave-change switching a very simple modification is made to the HO coil-pack before it is fitted.

It should also be pointed out that the HO coil-pack is designed for use with a mains-type oscillator. It has, however, been chosen for this circuit because an ARP12, pentode-connected, is capable of providing adequate oscillator power with this coil-pack even when its HT voltage is dropped to 70 volts or less.

A further point is concerned with the fact that the coils of the Osmor HF Stage are also intended for use with mains valves. As these coils are bottom-end coupled, a battery-type valve would not feed into them so well as would its mains equivalent. Nevertheless, in practice, the bottom-end coupling works quite well in this case and good results are obtained from the RF amplifier on both medium and long waves.

Whilst the HO coil-pack is intended for series-fed AVC control, the 21 receiver employs parallel-fed (leak and capacitor) grid circuits. These parallel-fed circuits are retained, the Osmor grid coils being taken to chassis via suitable resistors. It should be noted that, whilst the value chosen in the circuit for these resistors (100 kΩ) is sufficient to maintain the coils at chassis potential so far as DC is concerned, it also prevents any detrimental effect on the performance of the end-coupling capacitors with which the resistors are connected in parallel.

Also necessitated by the conversion are modifications to the original HT and LT circuits used in the receiver. The unmodified receiver employs two HT lines. After conversion, a single HT line, suitably decoupled, is used instead. The filament dropping resistors are also removed. Owing to the presence of anode voltage test points and other circuits, a fair amount of HT and other wiring has to be removed before the conversion can really get under way.

Accompanying this article is a table showing the additional parts needed for the modification. Also shown is a list of the components which are removed from the receiver, and which are not used again. As may be seen, apart from the coil-pack, the components which are removed more than comfortably balance those which must be added to the circuit. Some constructors will have many of the extra components needed already on hand.

When the conversion is completed, the set offers a selectivity and sensitivity well in advance of that given by the usual all-wave battery receiver. Despite the fact that the IF transformers are fairly loosely-coupled, the IF stages give a very high gain, the variable selectivity circuits being extremely useful for differing conditions of reception. In addition, these IF stages are very stable, and there is no evidence of "sideband-screech", lopsided response curves or any other similar fault whatsoever.

The circuits of the altered AF section, and of the new frequency-changer and aerial stages, are shown in Fig. 1.

Practical Points

Although there is nothing difficult in this conversion there is, nevertheless, quite a fair amount to do. Assuming that there were no complications, the whole process would probably take up four or five evenings, working comfortably and unhurriedly. The writer has taken great care to reduce the amount of chassis alteration to the minimum; and it will be found that it is necessary to drill only one hole, that being the one used for mounting the HO coil-pack. Three small but very easily-made coil and trimmer brackets are also required. No special tools are necessary, and the writer used an ordinary 65-watt Solon soldering-iron (without a pencil bit) for all the connections needed.

In the instructions which follow it will be noticed that quite a few wires have to be disconnected from their various tags. In some cases it will be found more advisable to cut these wires at the tags rather than to attempt to unsolder them, this being due to the subsequent possibility of damage by heat. Unless it is definitely stated that a wire should be cut or unsoldered, it is left to the reader to use his own judgment.

To facilitate the conversion, the various processes have been split up into numbered "steps". Apart from the advantage of knowing the point at which one has arrived, this method of presentation also helps considerably in providing a basis for cross-reference.

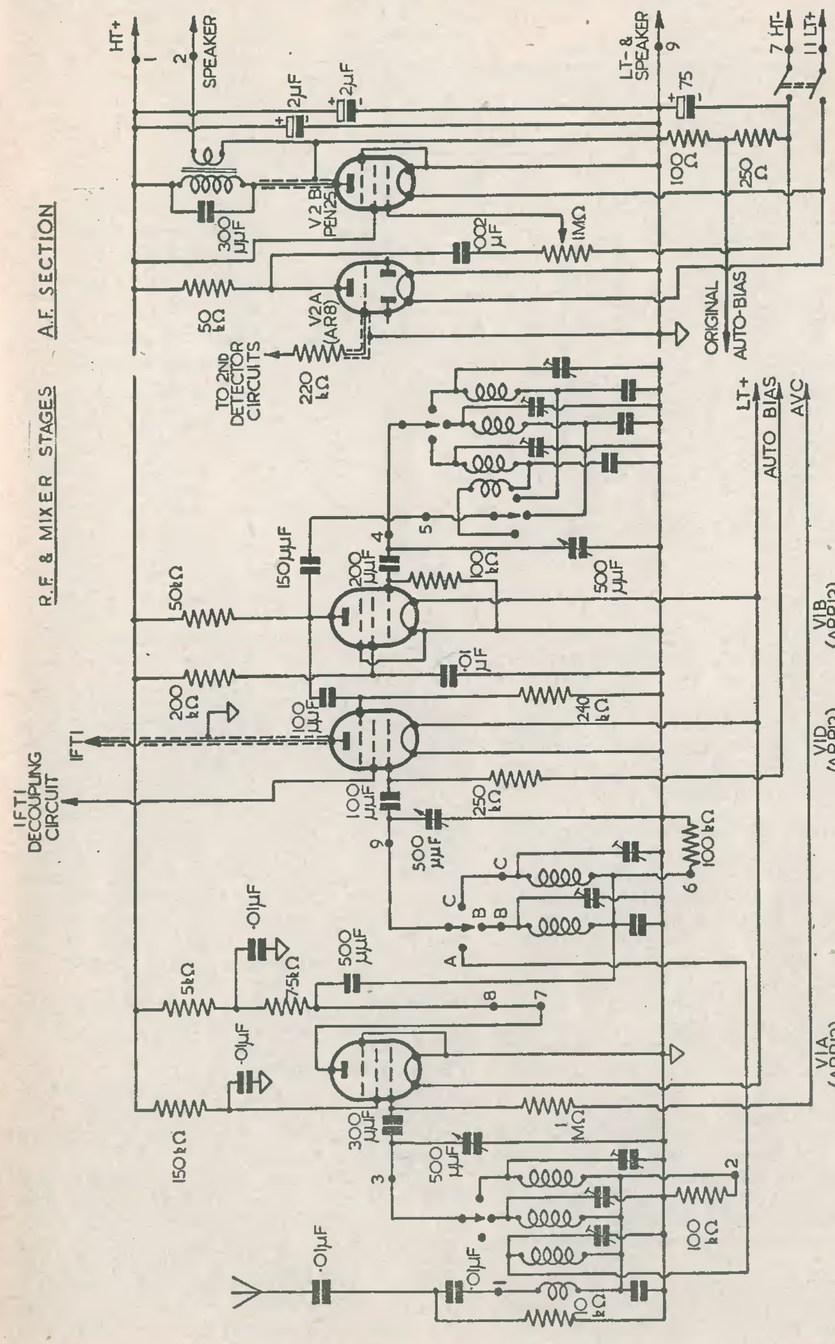

Fig. 1: Circuit of the altered AF section, and of the new RF and mixer stages. (The Osmor padding capacitor values are not shown).

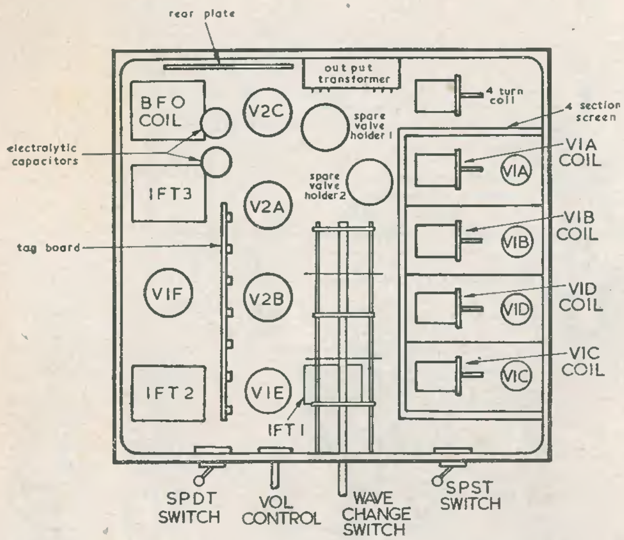

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Fig. 2: The under-chassis layout of the receiver before conversion. The references "V1A", "V1B", etc., indicate valveholders thus designated.

During the conversion, and unless it is otherwise stated, the receiver should be placed upside-down with the controls facing the reader. The directions, " left ", " rear ", etc., will then apply whilst it is in this state. In addition, with the receiver upside-down, the " top " of a vertically mounted component will then be that end furthest away from the chassis.

Fig. 2 shows the position and nomenclature of the various components under the chassis before modification. The references V1A, V1B, etc., which are applied to the various valveholders, correspond with those marked on the chassis itself. In the text it would be wasteful of space to continually refer to " valveholder V1A " or " valveholder V2A ", etc., and so the word " valveholder " is often omitted. Thus, for example, " a connection to pin 3 of V1A " can automatically be understood to refer to pin 3 of that particular valveholder.

In the same way, the four screened coils on the coil chassis are referred to as the " V1A coil ", the " V1B coil ", and so on. These coils, incidentally, are provided with tags which hold the decoupling components for the various valves to which they correspond. (The IF decoupling components are mounted inside the IF cans).

At the rear of the receiver is what is described in the text as the " rear plate ". As the printing on this plate may, in some cases, be partly obliterated, its layout is reproduced in Fig. 3. The writer presumes that the small tags were used originally as test points.

As some of the components removed during the conversion may be needed for refitting later in another part of the circuit, all parts taken out should be kept ready for re-use.

It will be noticed that references are made in the text to certain resistors which are already fitted to the unmodified receiver. It could conceivably happen that the values of these resistors may vary very slightly for different models (the variations being occasioned by war-time shortages), and this point should be borne in mind. The colour-coding of the various inter-connecting wires should be constant for all models.

The pin connections of all the valves used in the modified receiver are given in a table accompanying this article.

Checking the Receiver

Before commencing the conversion the receiver should first of all be checked. If it has just been purchased it should be examined for superficial damage.

In particular, each valve type ARP12 and AR8 must be inspected to ensure that the glass has not come free from the base. These valves (probably due to storage conditions) are very prone to this fault, and should always be handled carefully, especially when removing them from their holders. Their top-caps are also liable to come away from the glass; and

top-cap connectors should be fitted and removed with care. If the metallising of any of the valves has become disconnected from its earthing pin, another earthing connection will have to be made. (Thin wire wrapped around the bottom of the glass will usually make an adequate connection).

Temporary supply leads should next be connected to the rear plate as follows:—LT positive (6-volt)—tag 6; HT negative—tag 5; HT positive (150-volts)—tag 1. LT negative is taken to a convenient chassis bolt. A 100 ohm resistor should be connected between chassis and HT negative. An aerial is connected to tag 4, and a pair of low-resistance phones to tag 2 and chassis (or to tags 8 and 9).

It should then be possible to receive signals on both bands of the receiver. AF volume will probably be low with output overloading occurring fairly easily; but the RF sensitivity should be high. The signal-noise ratio of the receiver should be very high indeed. The BFO should operate when tags 10 and 6 of the rear plate are connected together.

Having checked the receiver we may now be satisfied that its circuits and valves are in working order. The external supplies should be disconnected and the conversion can be commenced. The temporary HT and LT battery leads may remain connected to the receiver.

Starting the Conversion

1. Turn the chassis upside down (controls to the front). Remove the two long securing rods at either side of the chassis, also the two triangular mounting pieces at the front corners of the outside frame.

2. Disconnect the internal leads (one each) from tags 8 and 9 of the rear plate. Pull out these leads to reach pins 5 and 3 of the output transformer. Unsolder here and remove the leads from the chassis. Remove the two 4 BA bolts holding the output transformer and allow it to "hang" in the wiring.

3. Unsolder the 300 pF capacitor across pins 1 and 6 of the output transformer. Unsolder the lead connecting pin 6 (output transformer) to chassis, disconnecting also at its other end and removing. Unsolder the orange lead from pin 1.

4. Unsolder the red and white lead from pin 2, and the two red leads from pin 4 of the transformer. Indentify that one of the two red leads which travels to tag V2B of the rear plate, disconnect there and remove the lead.

5. Unsolder the 1kΩ resistor across pins 4 and 8 of the transformer, also the black lead from pin 7 and the red lead from pin 8.

6. Remove the output transformer from the chassis.

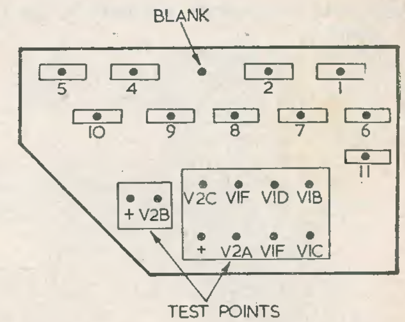

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Fig. 3: The layout of tags on the "rear plate". It is presumed that the small tags are test points.

7. Remove the 5-section screen over the RF coils at the right of the chassis. (The screen is held by five 6BA screws on the side of the chassis and by two underneath).

8. At the rear of the coil-chassis is a 4-turn coil (see Fig. 2), under whose trimming screw uns a 5-lead harness. Cut this harness at a point directly under the trimming screw.

9. Pull out that part of the cut harness which runs along the back of the chassis. Cut away the thread lacing the wire together. Identify the red and white lead connecting to a contact on the rear wave-change switch wafer; disconnect and remove this lead.

10. Similarly disconnect and remove the orange and blue lead of the same harness which travels to tag V1B of the rear plate.

11. Similarly disconnect the red and blue lead of the same harness at pin 2 of spare valveholder 2 (see Fig. 2), and remove.

12. Similarly treat the orange and brown lead at tag V1D of the rear plate; also the remaining red lead at the bottom tag second from the rear on the tagboard (where it connects to a 5 kΩ resistor).

13. Identify the red lead from tag "+" (adjacent to tag V2A) of the rear plate which travels to a tag on the top section of the tagboard. Disconnect and remove this lead. At the same tag on the tagboard will be found another red lead connecting it to the tag immediately below it. Disconnect and remove this lead also.

14. Identify the white and brown lead joining the rear bottom tag of the 4-turn coil (mentioned in Step 8) to a contact of

Additional Components required for the Conversion

1 Osmor HO Coil-pack.
1 Osmor HF Stage (for LM Coil-pack).
1 Valve type Pen25 (Mazda).
1 Knob (quarter-inch).
1 DPST tumbler switch.
1 3-gang 500 pF tuning capacitor. (Must have standard 2-BA mountings at front.
1 Output transformer for battery pentode. (Premier OP-10 or similar type).

Resistors (All ¼ or ½ watt)

1—200 kΩ.
1—150 kΩ.
2—100 kΩ
1—50 kΩ.
1—10 kΩ.
1—7.5 kΩ.
1—250 Ω.
1—100 Ω.

Capacitors

1—500 pF.
1—200 pF.

Miscellaneous

1 ft. flexible screened wire.
7 inches wide diameter sleeving for screened wire.
Connecting wire and sleeving: as required.

Main Components left over after the Conversion

Valves

1 Valve type ARP12.
2 Valves type AR8. (1 if BFO is required).

Switches

1 SPDT tumbler.
1 SPST tumbler (unless required for BFO).

Capacitors

1 3-gang variable (approx. 200 pF); ¼ inch spindle one end.
1 2-gang variable (approx. 100 pF); ¼ inch spindle.
6 5-35 pF silver-ceramic trimmers.
1 .01 μF; waxed paper.
2 Waxed mica (value unknown but probably about 100 pF).

Resistors

1—2 Meg Ω.
1—1 Meg Ω.
1—100 kΩ.
1—75 kΩ.
1—25 kΩ.
1—20 kΩ.
1—15 kΩ.
2—5 kΩ.
1—1 kΩ.
7—71 Ω.
2—66 Ω.

Inductors and Formers, etc.

1 3-winding output transformer (Low- impedance phones and noise limiter).
1 RF choke.
4 Coils wound on ½ inch formers with adjustable iron cores.
1 Unsupported coil with adjustable iron core.
1 Coil on ½ inch former (No core).

Miscellaneous

1 Metal rectifier.
1 Universal coupling (¼ inch spindles).
1 Mazda octal valveholder (and 2 top-cap connectors).

Paxolin, standard tuning capacitor brackets, tapped angle brackets, etc., etc.

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the rear wave-change switch wafer. Disconnect and remove this lead.

15. Trace a black and white lead from tag 6 of the rear plate to the coil above the chassis at its right hand rear corner. Disconnect and remove this lead.

16. Trace a red lead from tag 7 of the rear plate to pin 2 of spare valveholder 2. Disconnect and remove this lead.

17. Remove the 100 kΩ resistor bridging pin 2 of spare valveholder 2 and pin 4 of spare valveholder 1. (This resistor is too large physically to be re-used later on).

18. Above the chassis at the rear, and adjacent to valve V2C, is a 75 μF capacitor. Trace the underchassis lead from this capacitor which travels to tag 11 of the rear plate; disconnect at tag 11 and reconnect the lead to pin 5 of valveholder V2C, shortening as necessary. The capacitor's other lead is connected, above the chassis, to an earthing tag. Disconnect this lead at the tag, lengthen it, and take it (below the chassis) to tag 8 of the rear plate.

(This 75 μF capacitor, originally used for smoothing the 6-volt LT supply, now decouples the additional bias needed for the new output valve).

19. Trace another red lead from tag "+" of the rear plate (adjacent to tag V2A) to a contact on the rear wafer of the wavechange switch. Disconnect and remove this lead.

20. Identify a green and red lead from the other "+" tag of the rear plate (adjacent to tag V2B) travelling to the top end of a 6 kΩ resistor on the tagboard. Disconnect and remove this lead. (The resistor is that nearest the front).

21. Identify a red and white lead from tag V2A of the rear plate connecting to the rearmost top tag of the tagboard. Remove this lead from tag V2A and reconnect it to the top end of the 6 kΩ resistor mentioned in the preceding step.

(*To be continued*)

HOME MADE TEST PRODS

by **W. E. THOMPSON**

For some time I have used a pair of knitting needles insulated with systoflex for a pair of test prods and, although they have served the purpose quite well, it was thought some time ago that something more in keeping with good instruments could be made up. The prods now in use are described in this short article, and it is possible that readers may wish to make some up themselves.

It was the neat and slender shape of Biro Minor ball-point pens that gave me the idea—they also have nice finger-grips at their writing ends. Remove the pen-tubes, and you have the basis for a couple of good prods. Purchase a 12-inch length of 4-BA screwed rod together with a few inches of 0-BA ditto; take a couple of short 6-BA brass cheese-headed screws from stock, and the job is half done. Although access to a lathe will make the work simple it is by no means essential, for with due care all drilling can be done in the vice with a hand-brace. In my case, a bench drill and drilling vice made it easy.

At one end of the pen there is a screw-thread for securing the ink-tube. Drill down this end 0-BA tapping size (No. 11 drill) for about an inch, and carefully tap 0-BA with a taper tap followed by a plug tap, so as to get the thread well down the hole. Drill a 5/32-inch hole through the pointed end of the cap. This is all that needs to be done to the pens, and as writing instruments they are now, of course, completely ruined!

We now tackle the 0-BA rod. Drill down the centre for about an inch with a 6-BA tapping size drill (No. 43), then cut off a ¾ inch length and square off the ends. Enlarge the hole for half its length in this piece to 4-BA clearance size (No. 27 drill), and tap a 6-BA thread in the smaller hole. Cut a screw-driver slot across the end of this hole. Two such pieces are required.

Cut the 4-BA rod in half and taper one end of each piece to a sharp point. Those who wish to have a more durable point can drill a fine hole down one end before tapering, and then force a steel gramophone needle in the hole; this must of course be a driving fit for the needle. The prepared short lengths of 0-BA are then soldered on the other ends of the 4-BA rods. This method of securing the rods is considered to be easier than a screw fitting, which would involve tapping a 4-BA thread in a short-stopped hole in the 0-BA piece. It can be done, of course, and is really not so very difficult. The whole rod can then be passed through the pen and screwed home, leaving the brass flush with the end of the pen. A match stick in the 6-BA hole will prevent solder running into it, and if solder flows on to the 0-BA thread it can be cleaned off with an 0-BA die.

Flex leads are passed through the pen-caps (pointed ends first) and soldered to the heads of the 6-BA screws, which are then run into the threaded holes in the ends of the prods, and the caps pushed on to complete the insulation. Wander plugs, or other suitable connectors, are fitted to the remote ends of the flex leads.

The 6-BA screw terminations were provided so that the prods could be taken off and crocodile clips substituted when required. I have soldered some 3/16th brass rod in the cord-grip ends of some Bulgin clips and tapped them 6-BA. When screwed on the end of a lead and clipped in place, the pen-cap can be slipped over the clip to insulate it

These pens can be obtained in four colours red, blue, black and green. Red is the obvious one for positive, whilst black is perhaps first choice for negative. I happen to have used red and blue, but only because they both ran short of ink at about the same time! The completed prods have a nice "feel" and weight, and the bright colours tend to reduce the possibility of reversal of test-meter connections.

IN YOUR WORKSHOP

In this month's article J.R.D. concludes his discussion on a subject which has proved to be of interest to many readers—that of Modernising Old Receivers.

The IF Stages

When, in last month's article, we reviewed the question of what was offered by the original IF circuits of the old receiver, we stated that it may sometimes be possible to retain the original IF transformers. If these transformers are designed to work on 465 kcs., and appear to offer a good response curve, then this statement is true enough. Transformers of unconventional design, with aperiodic couplings, with only one tuned circuit and so on, must, however, be removed.

When it is intended to continue using the original IF transformers, they should be carefully checked for damage. The trimmers especially require examination, since these are very liable to suffer with time and use. They should be inspected to insure that their vanes still have plenty of springiness (assuming a compression type), that the mica dielectric is in good condition, and that they are free from dirt. The adjusting screws will sometimes be found a little stiff; and their heads may have become rather "chewed-up" (this latter usually being caused by the pre ious attentions of those gentry to whom trimmers present an inescapable attraction).

Iron-dust cores should also be checked to see that they are not broken, and to ensure (when applicable) that they are still fastened to their brass adjusting screws. If the receiver which is being modernised has been subjected to any rough usage, it would be definitely advantageous to make certain that all the strands of the Litz wire used in the separate coils are still soldered to their tags, and have not broken away. An ohmmeter test will confirm this point: similar coils should have the same resistance. Referring to iron-cored transformers again, a final check should be made on the serviceability of the parallel fixed capacitors; in early models these had a habit of becoming open-circuit.

The Frequency-Changer

Apart from the frequency-changer circuit and its components, there now remains little else in the receiver to merit attention here. So far as the frequency-changer components are concerned, the constructor has again the choice of using those fitted originally, or of installing new ones. In this stage, of course, the tuned circuits are of primary importance.

Provided that they cover the frequencies required, the original coils can often be retained. It will in many cases be found, however, that the wave-change switch has become worn, or is of an obsolete design. An improvement might result if such a switch were replaced. Most old receivers were fitted with medium and long wave coils only; and the provision of a new wave-change switch of the appropriate design would enable an additional short wave range to be added as well. Alternatively, the original coils and their trimmers could be completely removed, a modern all-wave coil-pack being fitted in their place.

A further improvement can often be made by modifying the frequency-changer circuit itself, this necessitating the use of a new and more modern type of valve. Before any changes are carried out on this stage, a note should be made of the connections to the existing valve, as this will then enable the new signal and oscillator circuits to be more easily wired up. It may sometimes be necessary to reduce the value of the oscillator grid leak when the new valve is fitted, the change in value being occasioned by the possibly greater efficiency of the oscillator.

The tuning capacitor will also need examination. Although most of the early models appear to be bulky and clumsy by present-day standards, they can sometimes be given a new lease of life after a quarter of an hour's checking and cleaning. When a short wave band is being added, however, it will nearly always be found that the rigid vanes of these capacitors will give trouble due to their inherent microphony. (This will cause howling as the sound waves from the speaker impinge upon the vanes). If the shape of the capacitor vanes does not correspond to modern standards, a replacement is practically essential.

The oscillator section of some of these old types of tuning capacitor will be found to have a smaller capacitance than that given by the signal frequency sections. This design was used in order to obviate the padding capacitor on the medium wave band. A tuning capacitor of this type could be retained for medium and long wave use (although it is necessary to ensure that the IF transformers are aligned to the exact frequency for which it was designed), but will have to be replaced by a normal model when it is intended to add a short wave range. A new tuning capacitor would also necessitate the use of an extra padder for medium waves, and one of a smaller value for long waves.

When the writer was invited last year to contribute a regular feature for the RADIO CONSTRUCTOR under the title of "Your Workshop" (the word "In" was added later), he accepted with a great deal of pleasure and enthusiasm. This was mainly due to the fact that workshop practice and procedure were subjects in which he was extremely interested. It must be confessed, however, that he felt also some misgivings as to whether he could find enough material each month to fill a full-length article.

These misgivings disappeared very quickly and he soon found that the contrary state of affairs held true. Indeed, the available space tended to be insufficient for the discussion of the thousand-and-one subjects which he wished to include in the series.

Shortage of paper also resulted recently in the space devoted to modernising old receivers in this series being elongated to three issues instead of the two originally planned. Articles on this subject have been requested by many readers, and so no harm can be said to result, except, perhaps, in the writer's own pedantic mind!

This month we would like to discuss a more varied assortment of topics and would like also to give space to some of the letters which have been sent in by readers.

Rubber Fittings

Of these letters, one of the most interesting comes from R. S. Barton of Brighton. He starts by giving a detailed description of his own workshop which he has fitted up mainly for servicing and experimental work. His gear includes, at present, a home-made signal generator (built, he says, from W. G. Morley's design), a BC221, and a Weston Analyser. He hopes to be making, or buying, a wobbulator in the near future.

"Re your recent article on wires and wiring," he carries on, "the following hint may prove to be of use. Rubber or plastic covered wire is often rather difficult to pull through rubber fittings, such as glands and grommets, as the wire tends to bind and stick. The solution to this problem consists of lubricating the wire before inserting it, preferably with a volatile liquid such as methylated spirits, which will soon evaporate afterwards. If such a liquid is not available, water (or spit!) can sometimes be used, but it should not be applied too heavily."

Many thanks, R. S. Barton. A very useful hint.

Changing Components

Whilst on the subject of wires, it might be interesting to consider the case which is encountered when one finds it necessary to replace a component to which several wires are connected. A volume control affords a good example. One usually finds that the tags of such a component are used also for anchoring purposes and that four or more different leads are soldered to its terminals.

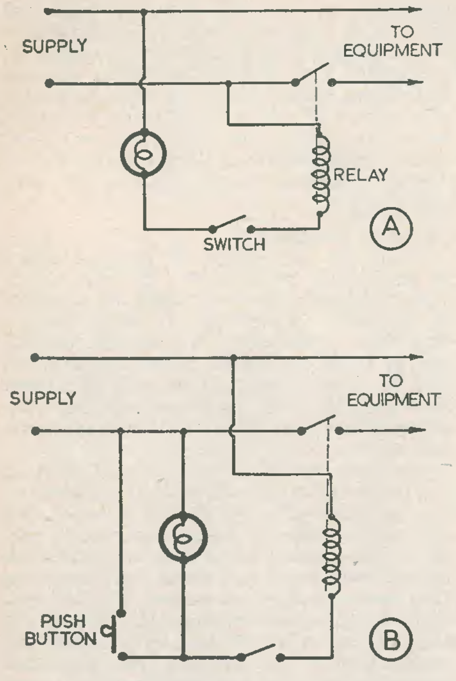
The best approach consists of making a quick note of the various connections on an odd piece of paper before the wires are removed. Mistakes cannot then occur. An alternative method which may be used occasionally with advantage consists of removing each lead separately and immediately soldering it to the corresponding terminal on the new component. After all the leads have been transferred in this manner, the new component is mounted on the chassis in place of the old. Such a procedure can, of course, only be used when the connecting wires are flexible and are sufficiently long to enable the new component to be moved about in the process of mounting.

Low Voltage Switching

The writer was recently confronted with the task of devising a switch for a low-voltage circuit (12 volts in this instance) which would be called upon to carry a large amount of current; possibly up to the order of 60 amps or so. (The supply was needed for some experimental gear).

The writer was informed that the switch would not be required to switch *on* such a large current, and that it was needed only to cut off the low-voltage supply in case anything went wrong. The switch would be used also to turn off the supply in the evenings or whenever work ceased. The switch contacts should, of course, be capable of carrying the heavy current used and should introduce no volts drop into the circuit whatsoever.

The writer set about this task in a slightly unconventional way by using a relay. The actual relay chosen was a 12-volt car starting solenoid; the contacts of this were more than heavy enough for the current they would have



C479

Fig. 1 (a) and (b) Two ways of using a relay to switch a low-voltage high-current circuit.

to carry. The starter relay was wired up in the circuit shown in Fig. 1 (a). The lamp in series with the coil was used to reduce the current flowing through it and thus prevent its overheating. It was found that the solenoid would "hold down" quite comfortably with only about a quarter (or even less) of the recommended voltage applied to the coil.

Most types of relay need a higher initial voltage across the coil to start the armature moving than is required to maintain it in the energised position. This is due to the fact that the magnetic circuit is usually completed when the armature has been attracted to the core. In the circuit of Fig. 1 (a) this requirement is satisfied to a certain extent because the lamp in series with the coil has a lower resistance at the moment of switching it on than it has when its filament has warmed up.

The circuit of Fig. 1 (a) is not practicable for all cases as the lamp would not have a sufficiently low initial resistance (nor would it have such a value of resistance for a long enough time) to "start" the armatures of the many different types of relay which could be employed. An alternative circuit is shown, therefore, in Fig. 1 (b). To operate the relay in this diagram the switch must first of all be closed, whereupon the lamp in series with the coil lights up. The relay does not close yet, however, as the current flowing through its coil is not sufficient to start the armature moving. The button is then pressed, applying the full voltage to the coil. On releasing the push-button the relay remains closed because the current flowing through its coil, via the lamp, is now sufficient to maintain it in this condition.

Apart from starter solenoids, low-voltage high-current relays may often be found in Government surplus motor-generators.

The Drop Test

Talking of motor generators brings up a subject which seems to interest some of those readers who have converted these machines for various jobs in their cars or homes. What, they ask, is the proper way of carrying out a "drop test"?

A drop test is a check which can be carried out on the windings of any motor or generator (which is fitted with a commutator) to ensure that none of its windings have become open- or short-circuited. There is not adequate space here to describe the various and complicated systems of winding which are used on the armatures of these machines; but it is sufficient to state that the windings are always laid out symmetrically in such a manner that an identical length of wire is fitted between each segment of the commutator and its immediate neighbour.

To carry out a drop test a source of low-voltage (say, a 2 to 6 volt accumulator) is connected between two opposite segments of the commutator in the manner shown in Fig. 2. A sensitive voltmeter (usually one with a full-scale deflection of round about 500 microvolts) is then used to read the voltage existing between each segment and its neighbour, working from segment to segment all the way around the commutator. The voltage between each two segments should be the same: any discrepancies point to a fault in the windings connected to the particular segment being tested.

The low voltage applied to the armature can often be connected directly to the brushes of the machine, thus obviating the necessity of removing the armature. If the armature is turned through 90 degrees after the accessible segments have been checked, it will usually be found possible to reach the remainder. It should not be necessary to disconnect any shunt fields which may be connected across the brushes, as their resistance will probably be comparatively high and they will not therefore pass an excessive amount of current.

To the writer's mind, a drop test as described above seems to be a rather complicated way of doing a simple thing. When the occasion arises, he usually checks an armature by the easier method of measuring the resistance between segments with an ohmmeter. The applied voltage is not then required. The meter must, of course, be capable of accurately reading low values of resistance.

Owners and Their Ways

There is an old saying which goes: "You can always persuade a woman but you can never convince her." As the readers of this magazine are predominantly of the male sex, there is no necessity to expand such a statement. Indeed we can (with impunity) refer to its manifest truth.

However, the writer is sometimes of the opinion that the word "woman" could be conveniently replaced by the phrase "radio-owner". There have been many occasions when the writer has been confronted with a very ancient receiver from which (apart from re-building it to modern standards) it is almost impossible to obtain any useful quality or selectivity, and has been told by the owner how well it "used to work". Repairing such a receiver is often a waste of time. It can never compare with the modern sets which the owner sees and hears in other houses and so he remains permanently dissatisfied, refusing grumblingly to relinquish his memories of how good the set, in his imagination, "used to be".

There is also the well-known tale of the person whose set sounded infinitely better after a "repair" which consisted solely of polishing the cabinet!

The ways of some (but. not, of course, all) set-owners are familiar enough. Nevertheless, the writer would like to give some useful advice to anyone who is just beginning to dabble in radio servicing. If it is at all possible, never repair a set in its owner's house. Always try to get it back to the workshop.

There are many very good reasons for this. Let us quote a few. There is first of all the fact that a repair in someone-else's house must nearly always consist of a "kitchen-table job". This means working without proper facilities on a table which is usually highly polished and which is bound to get scratched despite the many thicknesses of newspaper which are placed over it. It also means resting the soldering iron in some such place as the grate with the result that the valuable Persian cat probably becomes branded for life. Furthermore there is the existence of the various progeny of the household; these appearing either in the form of little Willy who nearly electrocutes himself at the match-stick connections which the single mains socket necessitates; or in the form of the infant upstairs who wakes up when the final flush of victory has caused the repairer to turn the volume control fully on.

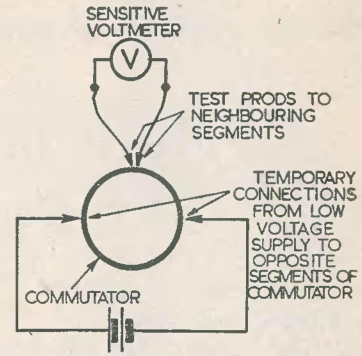


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Fig. 2: How to carry out a drop test on a generator or motor.

In any case, and when all is fully considered, it is nearly always necessary to carry test gear from the workshop to the house; and this usually weighs just as much, and is just as awkward to handle, as would be the faulty receiver if it were carried in the reverse direction.

Before finally concluding this month, the writer would very much like to pass on the Compliments of the Season to his readers. To everyone, therefore, best wishes for a Merry Christmas and for a truly prosperous and Happy New Year; and may you have everything which you would wish yourself!

QUERY CORNER

(*Continued from Page* 191)

It is not normally necessary to stabilise the HT supply to the oscillator, but it is most important that the supply should be taken from the maximum HT line and not from some intermediate point such as the screen resistor of another stage. The use of a separate dropping resistor for the oscillator is well repaid by improved stability.

Mainly for the Beginner . . .

More about the Valve

By H. E. SMITH, G6UH.

A Practical Experiment

IN order to gain a clear idea of the action of the valve as an amplifier, a simple practical experiment is suggested. Fig. 1 depicts the components required. The high resistance pick-up is first of all connected direct to the headphones, and when placed on a record the music will be heard at fairly comfortable volume. "Audio frequency" voltage is being generated by the pick-up, and in turn is actuating the diaphragms of the headphones. If the pick-up is now connected between the grid and filament of the valve, and the headphones inserted in series with the anode and HT battery, a much louder signal is heard. The small alternating voltages from the pick-up are regulating the electron flow within the valve and, as stated previously, are causing greater changes in "anode current", the result being a "magnification" process. This is known as audio frequency amplification, and will be dealt with more fully later on.

Detection

In order to "detect" a high frequency (or radio frequency) signal, usually referred to as a modulated carrier wave, rectification must take place. Reference to Fig. 2 will make this more easily understood. The modulated carrier wave appears on your aerial containing equal amounts of positive and negative energy at any given moment. The "bumps" on the carrier wave represent the "modulation envelope" of speech or music, and the process of rectification is to detach this modulation envelope from the carrier wave (or de-modulate it), turn it into direct current, and apply it to the grid of the valve. The valve will thus be controlled by the variation of the modulation envelope.

Leaky Grid Detection

The "leaky grid" detector is the best arrangement to use in simple receivers, as it gives a better response to weak signals.

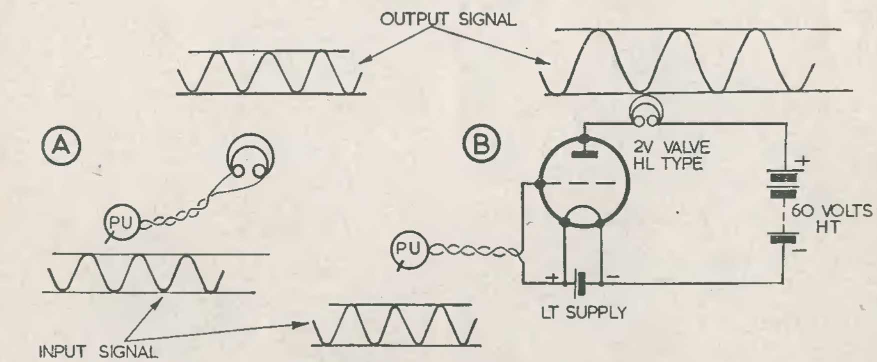

FIG. 1
A PRACTICAL EXPERIMENT IN AMPLIFICATION

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(Fig. 3). The circuit LC is tuned to resonance with the signal, which is then passed along to the valve via the grid condenser (as it is a high frequency voltage, the grid condenser does not obstruct its passage). The modulation voltage on the carrier swings the grid alternately positive and negative. The flow of grid current increases far more during the positive swings (remember the electron is *negative* and is attracted to *positive*), and the grid current being DC now represents the rectified voltage necessary to control our valve. This voltage is developed across the grid leak, and the grid condenser acts as a miniature reservoir for the varying voltages as they are developed. If the grid condenser were absent, the voltages would not be developed, as the grid would be shorted to earth via the tuning coil. If the grid leak were absent, a voltage would build up on the grid side of the grid condenser, and this condenser would remain charged with the consequence that the valve would "block" and cease to function.

The Audio Signal

An important point to bear in mind is that the signal you are hearing in the headphones is caused by alternating currents, superimposed on the direct current flowing from the HT battery through the valve. As these alternating currents vary in amplitude, so the direct current through the valve varies. With leaky grid detectors as described, more *negative* voltage is applied to the grid on heavily modulated signals, and there will, therefore, be a fall in anode *current* on loud passages. This can be observed by inserting a milliammeter in series with the headphones, and watching the pointer dip in time to the music.

The Anode Load

The headphones represent the "anode load" of our valve. Every type of valve has an "anode load" figure, and in order to obtain the best performance it is necessary to get as near as possible to this figure. A valve can only amplify if the associated components are correct. The anode load is the means of transferring the anode current variations into useful power. The anode current variations cause a voltage drop through the load, and when alternating voltage is applied to the grid, a corresponding alternating voltage is developed *across* the load. If then, a much lower value of load resistance than specified is used, the output will be correspondingly less. If a much higher value of load resistance is used, the output will still be less, because the anode

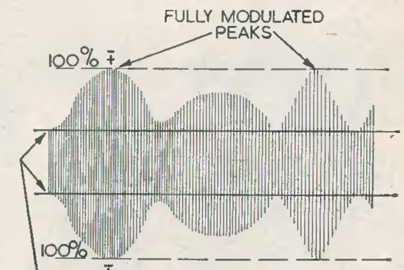

FIG. 2
THE MODULATED CARRIER WAVE

C493

will now be deprived of HT voltage and, being "less positive", loses some of its attracting power.

The value of the load resistance (or 'impedance") is, therefore, an important factor governing the ability of the valve to amplify signals, and this becomes a more important point when Audio frequency amplification is being considered. The wrong value of load resitance may cause not only a loss of power, but severe distortion of the signals, due to the valve being unable to deal with the large swings of alternating voltage in its anode circuit. This will be dealt with at a later stage. Having dealt with the major factors involved in the operation of the valve, we shall next see how to recognise the associated components when wired into the receiver, and as shown in circuit diagrams.

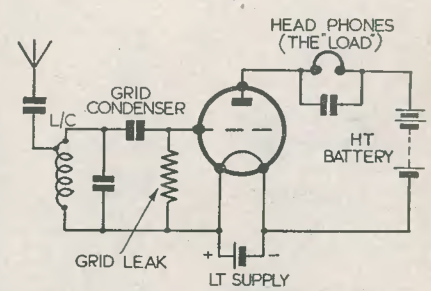

FIG 3
A LEAKY GRID DETECTOR

C494

ELPREQ PAGES

ENAMELLED WIRE.
(On wooden reels).

S.W.G.	2 oz. Reel.	4 oz. Reel.	8 oz. Reel.
16	1/3	1/10	3/9
18	1/3	2/–	—
20	1/4	2/2	3/9
22	1/5	2/4	4/2
24	1/6	2/6	4/2
26	1/7	2/8	4/6
27	1/8	2/9	4/6
28	1/8	2/10	4/6
30	1/9	3/–	4/8
31	1/10	3/1	4/11
32	1/10	3/2	4/11
33	1/11	3/3	4/11
34	1/11	3/4	4/11
36	2/–	3/6	—
38	2/2	3/10	—
40	2/4	4/2	7/6

TINNED COPPER WIRE.

S.W.G.	2 oz. Reel.	4 oz. Reel.	8 oz. Reel.
16	1/3	1/10	3/7
18	1/5	2/–	3/11
20	1/4	2/2	—
22	1/5	2/5	4/–

DOUBLE SILK COVERED WIRE.

S.W.G.	2 oz. Reel.	4 oz. Reel.
16	1/3	1/10
18	1/3	1/11
19	1/5	2/3
20	1/6	2/6
22	1/8	2/10
23	1/9	3/–
24	1/9	3/–
26	1/11	3/4
27	2/–	3/6
28	2/1	3/8
29	2/2	3/10
30	2/3	4/–
31	2/4	4/2
32	2/6	4/6
33	2/9	5/–
34	2/10	5/2
35	3/–	5/6
36	3/2	5/10
38	3/6	6/6
39	3/9	—
40	4/–	7/6
41	2/3	—
42	2/6	—

GROMMETS.
¼", ⅜", ½", 1d. each.
¾", 1", 1¼", 1½d. each.
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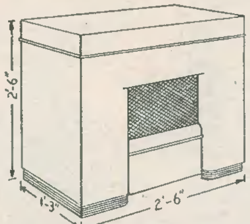
SHEET PAXOLIN.
Invaluable for when you are experimenting. Size 6in. x 6in., 1/–. Size 12in. x 8in., 2/–. Size 12in. x 12in., 3/6. Size 24in. x 12in., 6/–.



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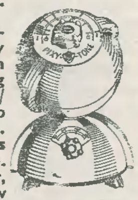
Full size console type; well made with highly polished walnut finish. Designed to take standard type autochange gram unit and radio chassis. Available at **£12. 10s. 0d.** each which means a brand new radiogram for less than £30; for we can supply a 5 valve 3 wave-band chassis at £10. 0s. 0d. (some adaptation will be necessary, of course), and gram units from **£5 5s. 0d.** upwards. Please note as our storage is limited, it is as well to confirm that these cabinets are actually at the branch before calling specially. Also note we can deliver these only within our van area, delivery charge depending on distance.

EXCELLENT XMAS PRESENT



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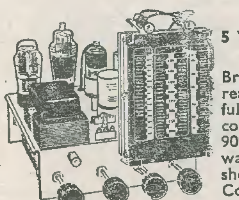
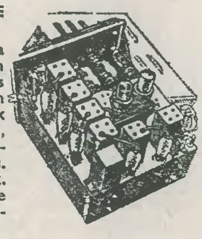


3 WAVE-BAND 5 VALVE SUPERHET CHASSIS.
Brand new, tested and ready for instant use, full vision scale 6" x 8" covering the long wave 900/2,000 m., medium wave 185/550m., and short wave 16/50m. Complete with valves and covered by our six months guarantee. First class parts, Parmeko mains transformer, Erie resistors, Hunts condensers, etc. Special points include (1) Flywheel tuning. (2) Dust cored I.F.'s. (3) Sockets for extension speaker and pick-up. (4) 4 watts output. (5) Coil assembly removable as a unit. Price complete with 8" speaker **£10 10s. 0d.**, carr. pck. & insurance 7/6d. extra.

10 VALVE 1½ METRE SUPERHET.



Ideal for conversion into a Midlands or London region Televisor. Contains 6 valves type 2—SP61, and one each RL7, RL16 and EA50. Six I.F. Transformers of 12 mc/s, 4 mc/s band width, and hundreds of other useful parts. Price 59/6 plus carr. & pck. 5/–. These receivers are unused and in original wrappings.

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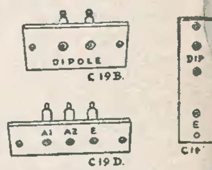
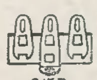


SOCKET STRIPS. Paxolin mounted.
Two socket engraved L.S. **6d.** each. Bin. C16B.
Two socket engraved A.E. **6d.** each. Bin. C18A.
Two socket engraved P.U. **6d.** each. Bin. C19B.
Two socket engraved Dipole **6d.** each. Bin. C19B.
Two socket plain **5d.** each. 8 in. C18B.
Three socket engraved DIP and E. **9d.** each. Bin. C16D.
Three socket engraved A1, A2 and E. **9d.** each. Bin. C19D.
Four socket engraved AE Pickup, **9d.** each. Bin. C16E.
Four socket engraved P.U. Ext. L.S. **9d.** each. Bin. C16E.
Five socket plain. **9d.** each. 8in. C16C.

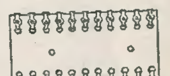
TAGSTRIPS. Paxolin mounted.



C17B.

Two lugs, one earthed, **3d.** each. Bin. C17A.
Three lugs, centre earthed, **4d.** each. Bin. C17B.
Four lugs, one end earthed, **5d.** each. Bin. C17C.
Six lugs, two ends earthed, **6d.** each. Bin. C17E.

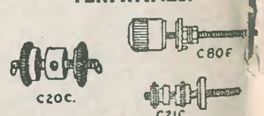
GROUP PANELS. Paxolin mounted.



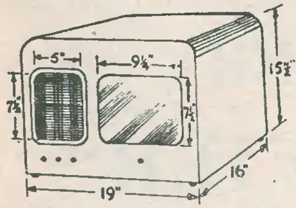
C18CR.

5 components (10 lugs), **7d.** each. Bin. C18CL.
6 components (12 lugs), **8d.** each. Bin. C18CC.
11 components (22 lugs), **1/–** each. Bin. C18CR.

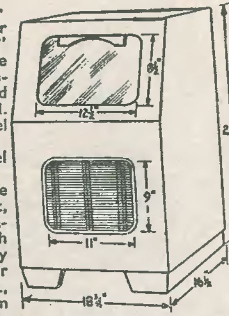
TERMINALS.



Earthing screw terminals, 2BA. also used for connecting two spades (as C20A), together, **9d.** each. Bin. C20C.
Screw down terminal 4 B.A. with plain insulated head. **5d.** each. Bin. C80F.
Screw down terminal all metal, 6 B.A., **4d.** each. Bin. C21C.



T.V. CABINETS.



Suitable for "Viewmaster." etc., well made and nicely finished, veneered and polished. Console Model **£10/19/6.** Table Model **£6/19/6.** Except where you can collect, these are available only with the delivery area of our own van, e.g., 50 miles from London. Delivery charge will depend upon distance.

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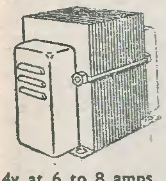
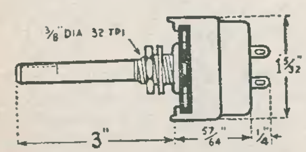


Really beautifully made transformers, fully shrouded upright mounting, with plated and polished shrouds. **TYPE 1.** Primary 10-0-200, 220, 240. H.T. secondary 350-0-350v at 250 m.A. L.T. 4v at 6 to 8 amps, and 4v at 3 to 4 amps. Dimensions are 4½" x 4" x 4½". Price **27/6** plus 2/6 postage and packing.
TYPE 2. Primary as type 1, H.T. secondary 300-0-300v at 150 m.A., L.T. 7.5-0-7.5v at 3 amps, and 4v at 3 to 4 amps. Dimensions are 4¾" high x 4" x 3¾". Price **17/6** plus 2/– postage and packing.



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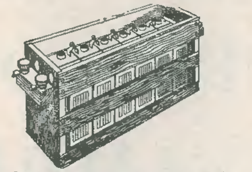
We carry a full range of standard-size volume controls from 2K, to 2 meg. Prices are: less switch, 3/–; Single pole switch, 4/–; double pole switch, 5/–. We can also supply midget-type controls, less switch, 4/–; single pole switch, 5/9; double pole switch, 6/6. Each of these midget controls has a serial number and carries a 12-month guarantee by the makers; they are made on the new moulded track principle and really do perform well.



12-CELL ACCUMULATOR.
This accumulator can be coupled up to give 24 v. with all cells connected in series or 12, 6 or 2 volts by series parallel arrangements. They were originally made for the Admiralty by a leading manufacturer, have never been filled, and are in excellent condition. Each is contained in a wooden crate as illustrated. Price **27/6** each. Postage and insurance 5/–.

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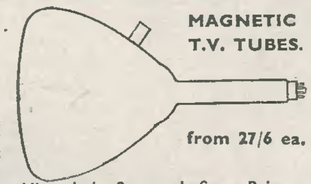
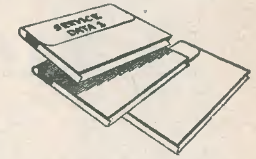
Made from polished aluminium, an excellent material for fronts of cabinets or for special cabinets you are making, and air conditioners, etc. Close mesh 8 holes to the inch. 24" x 12", 10/–, 12" x 12", 5/3, 6" x 6", 1/9. Wide mesh 4 holes to the inch. 24" x 12", 9/–, 12" x 12", 4/9, 6" x 6", 1/6. Postage and special packing 1/6 extra for any quantity up to 12 sheets. Over 12 sheets post free.

MAGNETIC T.V. TUBES.



from 27/6 ea.

All made by first grade firms, Brimar, Mazda, Mullard etc. They have been slightly used but will probably give years of service.
TYPE A. Only fault is low heater to cathode insulation. These will give perfect picture in grid modulated circuit:— 9" price **£3. 15. 0** each, 12" price **£5. 15. 0** each.
TYPE B. Have small ion burns but good cathode to heater insulation. Will be quite suitable in any type circuit:—9" price **£2. 15. 0** each, 12" price **£3. 15. 0** each.
TYPE C. Have combination of both above faults, but will still give reasonably good picture. 9" price **£1. 7. 6** each, 12" price **£2. 15. 0** each.
NOTE. Callers to our Ruislip branch can see these tubes demonstrated, but whether you see it or not we guarantee a 'working' tube. If not calling please add 7/6 each tube for packing and postage.



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A TAPE RECORDER AMPLIFIER

By EDWIN N. BRADLEY.

MAGNETIC tape recording, popularised and made available to a wide public in a surprisingly short space of time, has, in the writer's considered opinion, been presented in some sections of the technical press in a rather unfortunate light. A good deal has been written on the construction of recording desks or decks themselves, with but scant attention to the amplifiers to be used with such recorders, and there are probably many like the author who feel that this is tantamount to placing a very unwieldy cart before a rather highly-strung horse.

In short, the construction of a recorder itself—the mechanical unit which supplies, drives and takes up the tape, with its erasing, recording and playback heads—is an extremely difficult matter and one not to be undertaken by any but experienced model engineers, if acceptable results are required. The tape-pulling or capstan head alone presents a problem in precision lathework if wow and flutter are to be avoided, and it is hardly to be expected that a home-made record-playback head, sometimes built up from a strip of mumetal wound with a few turns of wire, can compete with a commercial model. There can be no doubt that the beginner in tape recording should confine his experimental and constructional work to the recording amplifier and erase-biasing systems—that is, to the electronic side of the apparatus—using a commercial tape desk for a trouble free mechanical system; the difference in cost between purchasing a ready made recorder and building a recorder from separate parts is surprisingly small.

The amplifier shown in Fig. 1 was designed and constructed round a "Qualtape" recording deck, a precision unit which can be very highly recommended both for price and performance to the newcomer to home recording. In developing the design several points were borne in mind—the amplifier should be quiet and hum-free, with high gain and reasonably high power output; it should be small in size so that it could be built, with the deck, into a transportable carrying case (half the pleasure and interes) in recording lies in possessing portable gears and it should be as nearly foolproof at possible. It should have simple but effective equalising circuits without employing inductances, it should cater for both microphone and radio inputs, and an effective recording level indicator was considered an essential; an indicator, moreover, which could have no effect on the operation of the circuit. Some level indicators, employing small incandescent lamps, can act as volume expanders or compressors depending on how the lamps are connected. In Fig. 3a for example, where a lamp is connected in series between two transformers, it will act as a compressor, since the filament resistance will rise with an increase in current, whilst in Fig. 3b, where a lamp is connected in parallel with the recording head, it will act as an expander for the same reason. If matters are so arranged that the lamp glows only on peaks, the effect will probably be small but, nevertheless, it will still be present.

The final circuit chosen employs three triode voltage amplifiers for microphone recording (a "Ball" moving coil microphone was used in trials) and a single voltage amplifier for recording from radio. The tuner unit fed into the amplifier had a single triode stage after the diode detector; in good reception areas this would be unnecessary. Volume control and equalisation are at high signal levels and a single-ended output stage has a degree of negative feedback introduced between its anode and grid—the feedback cannot be extended to earlier stages of the amplifier as the equalisation stages would

Circuit of the Power Pack.

For Component Values see List overleaf.

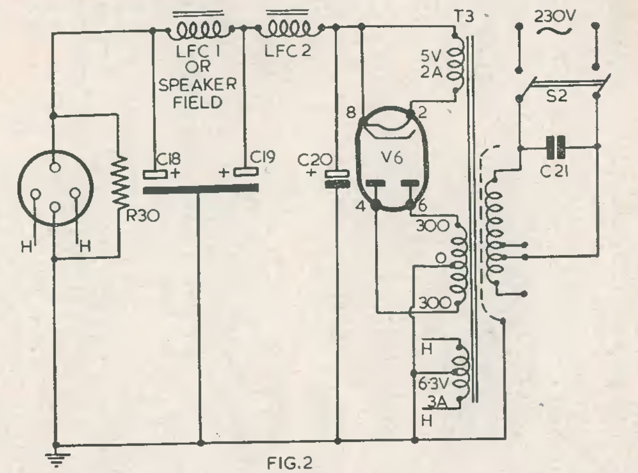


FIG.2

C513

then be included in the feedback loop, but more negative feedback is applied to the second and third stages by the omission of cathode bypass capacitors. The "Qualtape" record-playback head is of low impedance and is therefore very easy to feed; for recording, a plain resistive load is switched across the output transformer secondary and the head tapped onto this load through the normal constant-current resistor R21. For playback the head is matched into the first amplifier stage through the shrouded microphone transformer T1.

Permanent magnet erase is a feature of the "Qualtape" deck and the bias oscillator has therefore to feed only the recording head, into which it is coupled by the secondary of the oscillator coil and C12. To obviate any slight possibility of oscillator hiss during playback, the oscillator's HT line is broken and the circuit put out of action until further recording is desired.

Headphone monitoring is provided when the resistive load is switched onto the output transformer, and this arrangement is favoured for two reasons. In the first place it is difficult to avoid audio feedback and consequent howling when recording from the microphone if the loudspeaker is left in circuit; admittedly, this is not the case when a radio input is being employed, and the loudspeaker could then be left in circuit as the monitor. There seems to be no point, however, in reflecting undesired speaker resonances and impedance variations into the recording head when a plain load can be coupled in and the head fed from that, and the circuit of Fig. 1 is therefore preferred. Headphone resonances are totally swamped out by the relatively high series resistor R20.

The recording head is tapped down the plain load since nothing like the total output from the amplifier is required for a full depth recording, although it is desirable to run the amplifier at a reasonably high level to give a good signal/noise ratio, and to operate the level indicator at a sensitive point. The ratio of R18 and R19 is best determined by trial, whilst the most convenient form for these two resistors to take is a single high wattage resistor with a tapping band. The original amplifier drives a 15 ohm speaker, and a semi-variable resistor of this value was not difficult to find. When R18 and R19 total 3 ohms only (substituting for a 3 ohms speaker) it will probably be more difficult to obtain a suitable component, but then it would by no means be difficult to build up such a resistor. Suitable 4 watt resistors, 3.5 or 15 ohms, with tapping bands, may be ordered from Messrs. Bulgin's list, types P.R. 141 or P.R. 145 respectively.

A single ended output stage rather than a push-pull circuit is used in the interests of portability, and because only a small speaker is mounted in the recorder case. Such a speaker cannot do full justice to the recorded range, and so for home use an extension speaker, with its own mains energisation and mounted on a heavy baffle, is plugged into the extension socket, automatically switching off the internal speaker.

Components List for the Tape Recorder Amplifier.

R1,	470,000 ohms, 1 watt.
R2, R22,	68,000 " ½ "
R3, R12, R20,	100,000 " ½ "
R4,	3,300 " ½ "
R5,	470,000 " ½ "
R6,	47,000 " ½ "
R7, R10,	220,000 " ½ "
R8, R11,	4,700 " ½ "
R9,	1 Megohm variable, Volume Control.
R13,	1 Megohm variable, Playback Tone Control.
R14,	2.2 Megohms, ½ watt.
R15,	330,000 ohms, ½ watt.
R16, R23, R24,	10,000 ohms, ½ watt.
R17,	330 ohms, 1 watt.
R18, R19	See Text.
R21,	47 ohms, 3 watt.
R25, R27, R28,	1 Megohm, ½ watt.
R26,	6,800 ohms, ½ watt.
R29,	100,000 ohms variable, Level Indicator Control.
C1, C10,	50 μF 12 V wkg. Electrolytic.
C2, C5,	0.01 μF 500 V wkg. Tubular.
C3, C4,	8 plus 8 μF 450 V wkg. Electrolytic.
C6, C8, C12, C16,	0.1 μF 500 V wkg. Tubular.
C7, C9,	100 pF 500 V wkg. Mica.
C11, C13,	0.001 μF 500 V wkg. Mica.
C14,	0.002 μF 500 V wkg. Mica.
C15, C17,	0.25 μF 500 V wkg. Tubular.
T1,	Mic. Transformer, 15 ohms to grid. Well screened.
T2,	Output transformer, 8,500 ohms to voice coil. (15 ohms preferred).
Speaker,	Permanent or energised field (low resistance) or high resistance field with own power supply.
S1a-g,	Two-Bank, Four-Pole, Three-Way rotary.
Rec.	SenTerCel B5 or similar.
4	Co-axial input sockets with plugs.
V1,	6J5 GT.
V2,	6SN7 GT.
V3,	6V6 GT.
V4,	6V6 GT or Metal.
V5,	Mullard EM34.

5 International octal valveholders.
Chassis. (Original size, 9½" × 4½" × 2½").
3 Control knobs.
Extension speaker socket with switch (internal speaker off with plug in).
L1, Oscillator Coil, Messrs. "Qualtape".
Wire, solder, nuts, bolts, soldering tags, screened sleeving and screened cable, etc., etc.

Components List for the Power Pack.

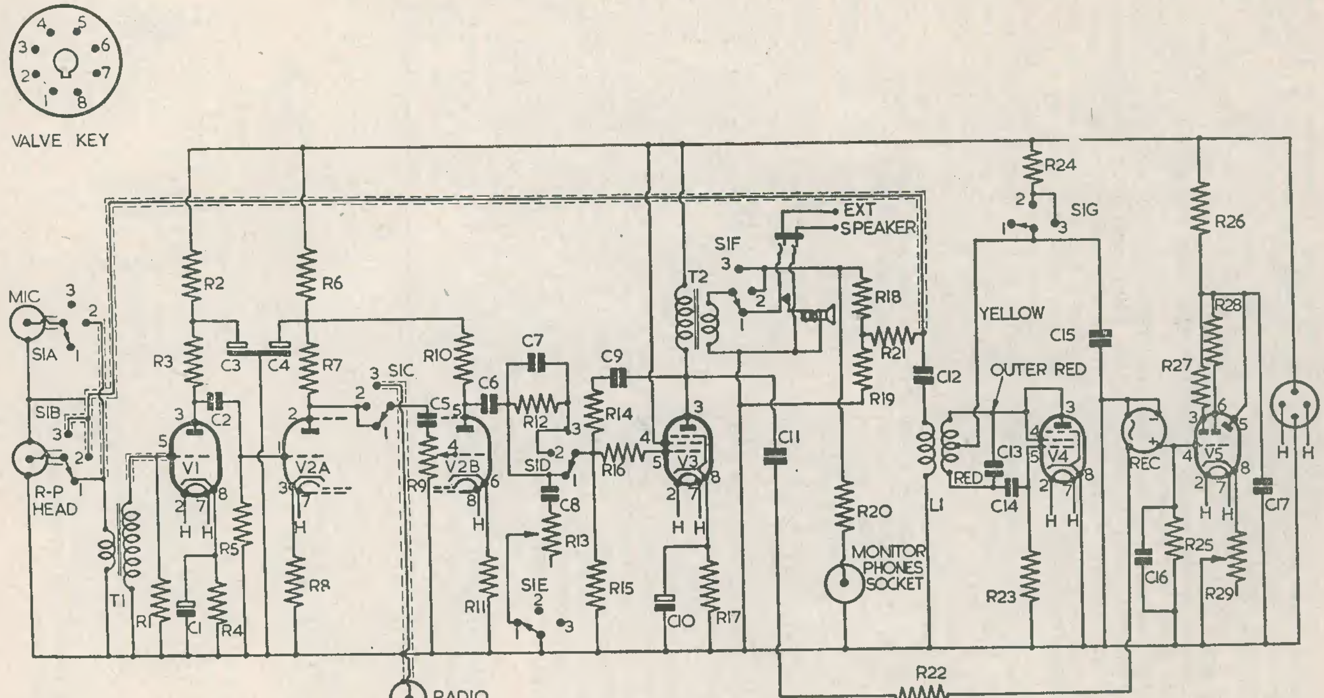
R30,	33,000 ohms 3 watts.
C18, C19,	8 plus 8 μF 450 V wkg. Electrolytic.
C20,	8 μF 450 V wkg. Electrolytic. Heavy Duty.
C21,	0.01 μF 1,000 V wkg. Tubular.
V6,	Mullard GZ 32.

1 International octal valveholder.
LFC1, LFC2, 10 Henrys chokes, 80 mA.
T3, 300—0—300 volts 80 mA. 5V. 2A. 6.3V. 3A. CT.
1 Four pin output socket with plug. Power Output.
S2, DP on-off toggle switch.
Chassis to suit component sizes.
Aim at an output HT voltage of between 250 and 300 volts, correcting a high voltage, if necessary, with a resistor in series with LFC1 between the choke and C19.

The Recording Level Indicator

The recording level indicator employs a Mullard EM34 Magic Eye which has two shadows of different sensitivities, the more sensitive shadow actually providing the level indication. The less sensitive shadow provides visual monitoring so that in a long recording session the headphones can be removed to prevent fatigue, flicker on the edges of the open shadow showing that the circuit is working correctly.

The indicator is fed from the anode of the output valve via C11 and R22, which feed into a small bridge rectifier of the instrument type. A SenTerCel 5B rectifier was chosen for this position since selenium rectifiers are, in general, more tolerant of their working conditions than are metal rectifiers, but a copper-oxide rectifier could probably be employed. No detectable tonal colouration is caused by the inclusion of the circuit between the anode of V3 and earth. The output of the rectifier is connected across R25 and C16, a relatively long time-constant circuit, so that the potential across the capacitor varies rather with volume than with the rapidly fluctuating signal. This potential is applied in the positive sense to the grid of the Magic Eye.



C512

FIG. 1

Circuit of the Amplifier.

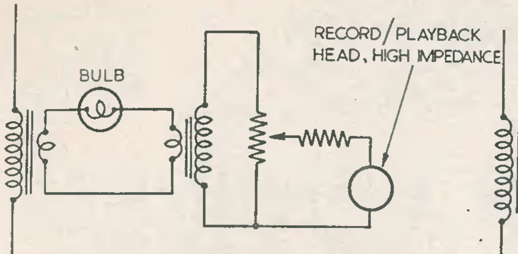


FIG. 3A
BULB LEVEL INDICATOR, SERIES CIRCUIT, TENDING TO ACT AS COMPRESSOR

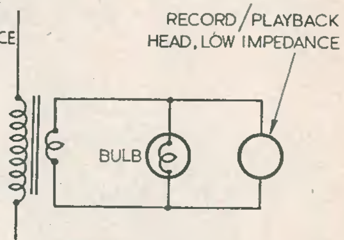


FIG. 3B
BULB LEVEL INDICATOR, PARALLEL CIRCUIT, TENDING TO ACT AS EXPANDER

C514

In their more normal applications as tuning indicators, Magic Eye valves are fed with negative potentials from AVC lines to give closing shadows, but in the present circuit a much more definite indication than a closing shadow is required. The Eye is therefore biased back by a variable resistor in its cathode line so that the more sensitive of the two shadows is completely closed, the positive potential across C16 and R25 then tending to open the Eye. By over-closing the Eye to a pre-determined extent a signal of the maximum recording level will just separate the two edges of the shadow; these conditions are established by trial when the amplifier is first put into commission, and the gain control thereafter set so that the shadow just opens on peaks.

Equalisation

The equalisation circuits, connected between the third and output stages, have been chosen by trial and suit the "Qualtape" head and Emitape. They will probably serve for other heads and tapes, but it is in any case a simple matter to alter the circuits to give a different response should this be required. It is generally sufficient to judge the response by ear, but a far more searching test can, of course, be made by employing a variable audio oscillator and a cathode ray oscilloscope, standardising a variable input into the recorder and inspecting the output on playback.

For recording, a high-pass filter, R12 and C7, is included in the circuit to give the required high frequency lift, this filter being replaced by a high frequency attenuator of variable characteristics, R13 and C8, for playback. In cases where a greater high frequency lift is required, it is possible to rearrange the switching so that the high-pass filter comes into use for playback as well as recording.

Power Supplies

A separate power supply chassis is employed in the original recording system, and this isolation of the mains equipment, together with the double smoothing shown in Fig. 2, although not absolutely essential is strongly advised in the interests of hum reduction. A four point plug and socket system provide for inter-unit coupling, whilst R30 gives some measure of protection to the power pack should it be switched on without the load of the amplifier plugged in.

Special attention must be paid to the method of heater feed and wiring, the heaters of all valves being carried by twisted leads to the heater winding and earthed only through the winding centre-tap. Untapped heater windings may be employed if a humdinger is connected across the winding and the variable arm taken to earth; if the amplifier shows any trace of hum it may be preferable to employ a humdinger instead of the heater winding centre-tap, setting the humdinger arm for minimum hum on trial.

The splitting of the smoothing system into two filters permits small chokes to be used, those in the original circuit having values of 10 Henrys each. A speaker field may take the place of one choke if desired, although the resistances of the chokes or the choke and field should not be greater than a total of approximately 1,000 ohms for a 300–0–300 volts transformer.

The power pack, and thus the amplifier chassis, should be taken directly to earth together with the main chassis of the recording deck itself.

Construction

No dimensioned layout for the amplifier chassis is shown, as it is felt that the construction of an amplifier of this type is a valuable opportunity for using up spare parts, particularly spare chokes, co-axial plugs and sockets, an odd mains transformer and spare electrolytic capacitors. New coupling capacitors should of course be employed, and a good component, well shielded, should be chosen for T1. A suitable type of layout is shown in Fig. 4.

Group board construction is not recommended; for this type of amplifier it is more desirable to mount the small components on and around their respective valveholders with all earthed connections for each stage made to a common earthed point. A soldering tag bolted down with each valveholder provides such a common earthing point for each stage. Remember that the valve heaters are not earthed except at the heater winding; heater currents flowing through the chassis give rise to excessive hum.

Whilst short leads are desirable in all stages, they are especially important in the bias oscillator stage round V4, since the fields around this stage must be reduced as far as possible to prevent interference with the radio tuner employed with the amplifier. For the same reason, the tuner aerial should not be near the amplifier; a screened or co-axial lead-in is of assistance in reducing interference. A metal type 6V6 valve is employed as V4 in the original circuit.

The single control switch Sla—Slg inclusive is made up of seven three-way switch sections, so that a two-bank four-pole three-way switch is suitable. On the first bank or leaf should be made the connections to the low level sections, Sla, Slb, Slc and Sld, the other three sections being wired up on the second or rear bank. This leaves a single three-way section on the rear bank unused, and this switch section may be pressed into use for one of a number of purposes. One obvious task is to switch in three pilot lamps to show clearly the function of the amplifier; suitable lamps would be Green for playback, Red for recording microphone and Amber for recording radio. Other possible purposes would be to switch out the level indicator on playback or to cut out the negative feedback over V3 on either recording or playback. The negative feedback is, of course, optional, and is sometimes switched out on the writer's amplifier as the main loudspeaker employed favours the lower frequencies, the high frequency accentuation given by the uncorrected beam tetrode then levelling out the overall response with no serious distortion.

All input leads to the amplifier from the record-playback head, microphone and radio tuner must be perfectly screened, although no such precautions are found necessary in the case of the monitor 'phone leads. High resistance 'phones are, of course, employed; if it is desired to use low impedance 'phones, the value of R20 should be changed experimentally. Belling-Lee co-axial plugs and sockets were employed in the original amplifier, but plugs and sockets from surplus gear are probably to hand in the constructor's storebox.

The screening of low signal leads must be extended to the internal leads where shown in Fig. 1.

With the amplifier constructed and tested,

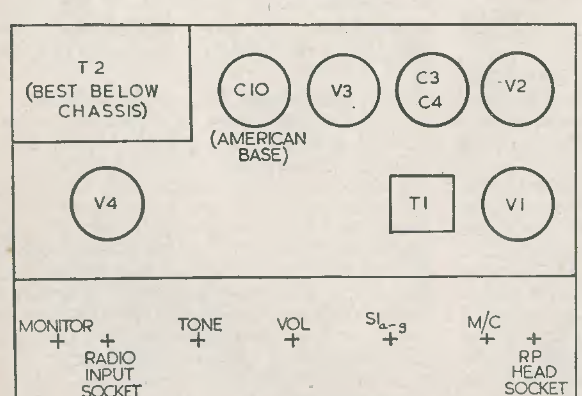
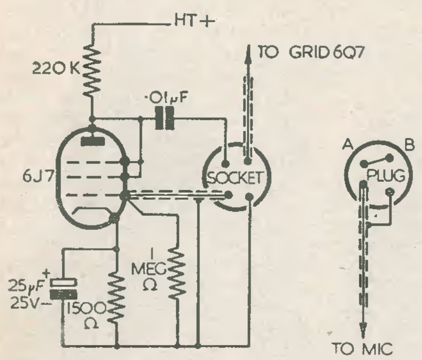


FIG. 4
GENERAL CHASSIS LAYOUT
(V5 MOUNTED ON BRACKET TO SHOW THROUGH PANEL)

C515

it remains only to adjust the output of the recording signal with reference to the level indicator. Commence with R21 tapped well down the combined R18-R19 chain, and turn up the gain control, whilst adjusting R29, for good indication on the Magic Eye, the shadow just opening on peaks. Take test recordings, re-setting the tapping point of R21 as necessary, until over-recording takes place (immediately identified by harshness, distortion, etc.). Set back the tapping point along R18-R19 to reduce the output slightly, when full recording without overloading will be achieved. These adjustments will take some little time, but care and patience here are amply rewarded.



C516

The "BASIC" AMPLIFIER

by

J. B. ANDERSON

Having had an urgent need for an amplifier with sufficient punch to operate a small crystal microphone, I decided that rather than build up the usual 6J7 - 6J5 - 6V6 line-up, I would try to make use of the triode section of the 6Q7 followed by the 6V6 which was already in the Basic Superhet, which meant that all I required was a suitable voltage amplifier such as a 6J7 to act as a pre-amp.

There was sufficient room on my chassis for another valve holder and, indeed, very little extra room is required, as the additional components amount to only two condensers and two resistors.

The 6J7 is triode-connected, as this was found to give sufficient gain in the first stage. The HT, which was tapped off from the receiver, was fed to the anode through a 220 kΩ resistor, and the output fed through a 0.01 μF condenser to one of the socket tags, and the grid is connected by screened lead to another tag, the screening being earthed. The third socket tag goes to the grid of the 6Q7 by screened lead, and the fourth tag is grounded.

The microphone plug is wired as shown in the diagram, the link between points A and B completing the circuit to the 6Q7 grid, on insertion of the plug, and also connects the mike to the grid of the 6J7.

The plug itself, which has a diameter of a sixpence, is the type used for the battery connections in many personal portables, and the socket was recovered from the battery used in these.

The microphone is a crystal insert from a deaf aid instrument, and with the amplification described has proved to be sensitive beyond expectations. It will give good voice pick-up from distances of 20 feet in the open air, with the loudspeaker of the Basic faithfully punching it out at good strength. Control is by the existing volume control which therefore does double duty, for both radio and amplifier. The 6J7 is left permanently connected in the receiver, as its current requirements are low, and the withdrawal of the microphone plug restores the receiver to its original function of pulling in the DX.

from our Mailbag

Test Card 'C'

Dear Sir,—Your approach to the BBC on the subject of Test Card transmissions is most praiseworthy, and I find it most gratifying to note that there is ample evidence of a strong unity among the sections of the Press which instruct, advise and inform the TV amateur, and now jointly represent him in this important issue.

Apart from the figures given in a recent analysis, the existence of several thriving publications, and the success of several published designs, should convince the BBC that the amateur constructor represents a very large section of its licence holders. If this fact has escaped the Corporation, it certainly has not been overlooked by the prominent manufacturers who sponsored a design which has passed into the hands of more than 50,000 enthusiasts. Nor has the Trade neglected to support the designs issued by the radio Press. At least one manufacturer with which the Television Service has contracted has deemed it fit to maintain an Amateur Division in its organisation, and other companies direct many of their products to the Amateur.

This support would hardly be forthcoming if the Amateur "movement" were not strong.

We are by no means a tiny minority, but if we were, has not the BBC demonstrated its eagerness to gratify a minority by the establishment of an entirely separate programme for the long-haired listener?

The excuses given by the Corporation are not convincing.

(1) *Interference with Rehearsal Times.*

It is unlikely that rehearsals are in progress up to the moment of opening. Note that two cameras and a film scanner are already available at 7.55 p.m. daily to transmit the Tuning Card, mix to the "Crest", and then send out the "Big Ben" film, without adverse effect upon rehearsals.

Furthermore, the transmitters are already "on the air" twenty minutes before the opening announcement every evening. One of the two cameras could be arranged to provide some more useful modulation during this period than the artificial cross which occupies our screen at present.

(2) *Adjustment of Salaries.*

The presence of a carrier and some modulation proves the presence of the staff at 7.40 each evening. Although there may be tests and adjustments to be made, would the substitution of (say) a 2.5 Mcs grid (a useful signal), as an alternative to the cross, be impossible?

The "adjustment" of salaries is merely the payment of half an hour, possibly at "overtime" rates. This does not represent a change in basic salaries, but merely a very slight increase weekly in the Corporation's pay-bill.

(3) *Additional Use of Electricity.*

I repeat that transmissions are already "on the air" twenty minutes before opening time. The period concerned is not a peak period, even in winter.

(4) *Possible Trade Union Activity.*

Has the BBC approached the Unions? Or is it admitting defeat before the battle (if any) commences? The difficulty would not be likely to arise if the BBC made a fair "adjustment to salaries".

Although there is at present no real substitute for Test Card 'C', it would have shown some willingness to serve a large section of its viewers had the Corporation offered some reasonable substitute instead of turning down your request with shallow excuses.

I suggest that the following useful substitute would entail no increase in man-hours or salaries, no interference with rehearsals or cameras, and little increase in electricity consumption:—

From 7.40 p.m., when the transmitter commences radiating, superimpose upon the artificial cross an artificial 2.5 Mcs "grid" —a composite pattern generated without a camera. This pattern would assist in checking horizontal definition and linearity; a reasonable check in the vertical direction and of interlace is possible by examination of the line spacing.

The suggestion is by no means perfect; it provides no check upon contrast, for example. But, with its disadvantages, had it been offered by the BBC, then that unyielding organisation would have stood in a better light than it does now.

The average "hobby" man is a pleasant type of chap who makes few demands, and who prefers to obtain a reasonable response to his reasonable request. His standard of intelligence is sufficiently high to see the futility of the BBC's excuses. —W. Groome (Birmingham).

FLASH

A reply from the B.B.C. gives cause for hope. The position will be reviewed when some "Monoscopes", which are on order, have been received.

QUERY CORNER

A "Radio Constructor" Service for Readers

Clear Note from BFO

I have added a beat frequency oscillator to my short wave superhet, and although the required heterodyne whistle is obtained the note is harsh and varies in pitch. Can you offer a possible explanation for this and suggest a cure?

D. Parker, Southgate.

In adding a BFO to a superhet receiver, difficulties are often encountered in placing the extra components in the part of the receiver where they are required. For example, it may be found that near the RF stage is a space which would accommodate the additional valve and components, but of course it is not the ideal position, which is somewhere near the second detector. Because of this space problem the inclusion of the BFO can produce disappointing results unless very great care is taken in screening the oscillator from the remainder of the receiver. The screening is important because radiation from the BFO can reach the RF side of the set and produce some queer beat notes, this effect being particularly marked if a large number of harmonics are present. The secrets of obtaining a clear note under most conditions may be summarised as follows:

(a) Very careful screening of the BFO is necessary.

(b) The output from the BFO must be substantially free from harmonics, and should approximately equal the signal level at the second detector.

When considering the screening, it must be remembered that any leads which enter or leave the screened compartment which houses the complete BFO must be either shielded or at earth potential as far as RF energy is concerned. For this reason, it is advisable to include the oscillator on/off switch in the HT line before the decoupling because this line does not then carry any RF. Also, the output lead must be as short as possible and must consist of screened cable. If it is required to adjust the beat frequency by means of a control on the front panel of the receiver, it is preferable to drive the tuning capacitor by means of an extension spindle, rather than remove it from the screening compartment in order to mount it on the panel. This is because there can be considerable radiation from the "hot" lead of the tuning capacitor, and any attempt to use screened cable at this point can easily result in poor frequency stability. The circuit diagram of a typical BFO is shown in Fig. 1; the components to be enclosed within the screened compartment being those contained within the dotted line. The HT decoupling resistor is mounted just outside the screen and its associated capacitor is located just inside the screen.

Turning to the problem of reducing the harmonics which may originate in the oscillator, this is largely concerned with the choice of time constant in the oscillator grid, the tapping position on the coil, and the HT voltage which is supplied to the valve. Taking these items in turn, the grid circuit constants indicated in Fig. 1 will be found to be optimum whilst the feedback tapping point on the coil should be approximately 10% of the way up from the earthy end. Many constructors will, however, wish to purchase the coil ready wound, and the one manufactured by Wright and Weaire (type B.F.O.) can be recommended. In passing, it is of interest to note that this coil has an inductance of 1000 μH and therefore requires a tuning capacitance of 118 pF to produce a 1000 cycle beat in a receiver having an intermediate frequency of 465 kc/s. The optimum value of the HT voltage will be largely dependent upon the type of oscillator valve which is used. The HT can be controlled by means of the decoupling resistor, which should be as high as possible consistent with steady maintained oscillation. Using a 250 volt line, the value indicated on the circuit diagram should be suitable with most valves; if a 100V line is available the resistor may be reduced to 15 kΩ.

Finally, a note regarding the method of connecting the output from the BFO to the IF amplifier of the receiver. This connection is best made at the second detector via a small capacitor of between 2 and 10 pF. Such a capacitance is readily obtained by twisting the lead from the BFO around the lead to the detector diode. A little experimental work will soon indicate the optimum length of the twisted section, which should then be coated with glue to prevent any further movement.

QUERY CORNER "Rules"

(1) A nominal fee of 2/- 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.

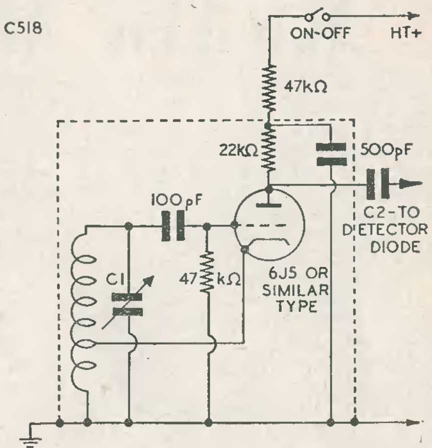


Fig. 1: Typical circuit of a BFO. For values of C1 and C2, see text.

Advantage of Valve Voltmeter

I am a newcomer to radio, and whilst having had some experience in the use of standard voltmeters I am not clear as to the advantages which the valve voltmeter has over such instruments. Can you enlighten me on this point?

R. Coulson, Weybridge.

Standard voltmeters require a certain amount of energy to deflect the pointer, and in taking this energy the meter can alter the conditions existing in the circuit which is being examined, thereby providing inaccurate results. This applies largely to measurements which are made in high impedance circuits or to those made at high frequencies, and to overcome the difficulty the valve voltmeter was developed. With this instrument the voltage to be measured is applied to the input circuit of a valve, in the anode circuit of which is the indicating meter. Thus the power required to deflect the meter pointer is obtained from the power pack which supplies the valve, and is therefore not required from the circuit under measurement. As a result of this, the input impedance of valve voltmeters can be made very high so that they present negligible damping on the test circuit. A simple valve voltmeter was described in the October 1950 issue of the Radio Constructor.

Local Oscillator Stability

My recently completed communications receiver works satisfactorily but for one fault. After a short period of use the station goes off tune, and must be restored by adjustment of the tuning knob. As I spend most of my listening time on the crowded 10 *and* 20 *metre bands this minor defect can be most annoying. Can you suggest its cause and cure?*

W. West, Bradford.

The tuning stability of a superhet is dependent almost entirely upon the stability of the local oscillator. When constructing the receiver it is important that this section should receive special attention, in particular to points which may effect the oscillator stability. Perhaps the most important item in this connection is the necessity for rigidity in the mounting of the components. A heavy gauge metal chassis must be used and the front panel securely bolted or welded to it, angle brackets being used to support the upper part of the panel. Coils must be secured firmly in position, and the wire on the formers treated with a varnish or glue to prevent movement.

Components which are normally suspended in the wiring, such as resistors and small capacitors, should be fixed to tag panels, and the whole oscillator section wired with 18 swg tinned copper wire.

The oscillator section should be located away from all heat generating components to minimise frequency drift as the receiver warms up. Generally a warming-up period of at least ten minutes is necessary before the oscillator can be expected to have reached in stable condition. (Contd. on P. 177)

Radio Miscellany

Many readers will recall that some months ago I recounted an amusing incident where someone impersonating Ambrose Fandermere telephoned to ask me to get him a packet of assorted-sized holes. It seems now that if he is still in need of them one of our readers can fix him up!

It is no idle boast either. I have actually got a sample in front of me as I write, and a very nice clean hole it is, too.

It has come to me direct from the hole-King himself, Mr. P. Turner of 14, Byron Street, Mansfield, who has already started producing holes on a moderate scale and is ready to supply them to readers at a reasonable price. If the demand is big enough, he is prepared to tool up to produce them in a big way.

It sounds like a constructor's dream. Holes where you want them, any shape, any size. If it is too big, you just take it out and put a smaller one in its place. And that is not all. You do away with drilling, boring, punching, hacking, filing and noise. In fact, you simply spread the evening paper on the dining room table and in complete silence plot out just where you want the holes to be—then get on with the wiring up.

No, gentle reader, I have not taken leave of my senses. In fact I have not dwelt upon all the advantages yet. These holes are also non-expendable. When you decide to re-build, you simply re-shuffle the holes around and you have a fresh chassis to suit the new constructional job. If you don't really want a hole at all, you merely fill up the space where the hole was with a bit of solid chassis.

It sounds to be too good to be true, but for all that it IS true.

Wide Range of Uses

For some reason (beyond my guessing powers) Mr. Turner has called his ingenious system of standard chassis and panel sections, the System Schultz. The sections are bolted together through standardised holes in the flanged sides and a wide range of patterns is already available including 3" × 3" sections with 2" holes (for meter mounting) or with three louvres (for ventilation purposes or for midget speakers). To the wide range of sections already available mountings for 3" and 6" cathode ray tubes are being added.

The finish of the specimen, which is of stouter gauge metal than most readers would normally use for home engineering, is clean and accurate and the exposed surface is finished in black crackle enamel.

The versatility of the scheme is self-apparent. Inter-stage screening can easily be added and with a little ingenuity the constructor should be able to design chassis, panel and case from such sections. The flanges, of course, add to the rigidity and any holes not required for bolting the unit up solid, could be utilised after lining with suitable grommets, for the wiring etc.

The idea will not only appeal strongly to the constructor with limited workshop facilities and those interested in experimental work, but is ideally suited for use in the laboratory and training school where special or "short-life" apparatus is frequently needed.

Other Ideas

In his interesting letter Mr. Turner also mentions his tentative plans to introduce a full vision tuning scale and dial with a hinged escutcheon on the lines I suggested a couple of months ago. It will incorporate geared driving mechanism and he is not content to leave it at that. He is also breaking it down into a number of separate parts so that a start can be made with a plain dial with extensions that can be added, including a choice of gear ratios, as required.

He has printed his own pamphlets on the silk screen process (with cotton for cheapness) and plans to print the exchangeable scales and panel titles himself by the silk screen method.

This sort of enterprise always cheers me, as no doubt it does most readers. It is in keeping with the best traditions of our hobby—particularly the readiness to experiment in aspects less directly linked with radio. Probably your experience is similar to mine. All the best radio men I have ever met have had more than a passing interest in other practical things, and it is surprising just how many other hobbies and occupations link up usefully with radio and electronics.

Made to Measure

I recently had a most interesting discussion with a leading sound engineer, who remarked upon the fact that a high proportion of older radio constructors develop a keen appreciation of serious music. He was inclined to think that they became interested in the technical side of radio largely because they were music lovers. My view is rather different. I believe that when they begin to give careful attention to the quality of their reproduction their latent feeling for music is developed.

A symphony, for the music lover, contains more than melody, rhythm and harmony just as an arrangement of words is something more than a mere sentence. It possesses beauty and meaning.

We can, if we wish, make music in the laboratory by simply shading lines on a strip of sound film, but it would merely be sound with the music left out. The mathematician, too, could put together a perfect sequence of harmonies but it would not become a Concerto or a Sonata.

Harmonics

In analysing sound we soon discover that two or more notes blend harmoniously when their frequencies are in exact ratio. Thus the notes C, E and G with their respective frequencies of 256, 323 and 384 cycles, have a common ratio and please the ear. Notes with unrelated frequencies when played together jangle with discord.

This was fully appreciated centuries ago, but mathematicians were for years puzzled that while it worked out perfectly for some types of instrument, these chords clashed badly on others. It was not until nearly 200 years ago that it was satisfactorily proved that the secret lay in the harmonics. The harmonics are not in the same proportion for the same note when played on different types of instrument. It is their presence or absence and their relative strengths that gives each instrument its character and musical quality. When the higher harmonics are present in strength they do not always coincide, producing a "beat" and cancelling each other out. When they vibrate in sympathy they re-inforce and give colour one to another, but in getting out of step, or beat, their cancelling out results in a jarring, paralysing effect.

CENTRE TAP *talks about*

SYSTEM "SCHULTZ" – THE GREEKS & HARMONICS

Acclimatisation

To-day we listen with complacency to chords, harmony and close-harmony which would have horrified the great composers of last century, which indicates we are steadily attuning ourselves to wider ranges of harmonic ratios.

Probably most of us have already noted just how we have adjusted ourselves to appreciate sounds and chords which at first hearing seemed woefully dissonant. Many of the modern composers probably jarred you at the first hearing, and then in a diminishing degree, until you learned to accept it, and perhaps, eventually, to like it.

Looking back into musical history we find that anything other than the simplest harmonics were distasteful to the Romans and the Greeks. They seem to have only managed to bear with frequencies which were simple fractions of one another.

The Greeks were the first to divide the octave into seven intervals—the eighth note being, of course, double the frequency of the first. They discovered that by putting a bridge at half the length of a taut string a note an octave higher was produced in each length. They also noted that by removing the bridge when the two halves were vibrating, a slip of paper could be made to balance on it quite comfortably. This point is called the "node", and we use the term with little difference in significance in describing the behaviour of our aerials. Just as with aerials, we can have many more than one node in a length of vibrating string.

Reformers

Before the Pythagorean division of the octave (the first standardisation of notes based on the frequency of vibration) the earlier Greeks are believed to have had a three note scale based on notes approximating to C, F and G. Try them out for yourself and see what sort of melody you can get out of them!

Other civilisations used a five note scale, of notes which roughly correspond to the black keys of the modern giano. Some Scottish traditional music appears, too, to have been written in this scale. If you want to amuse your friends with a spot of "Oriental" music, you can easily do it by ignoring the white notes and using frequent repetitions of the same black notes mingled with an appropriate wailing intonation.

The octave of our modern scale consists of twelve semi-tones, but the harmonics of it are slightly wrong from the mathematical standpoint. Reformers have from time to time attempted to bring into use a more mathematically perfect scale by cutting the octave in divisions of forty-one or fifty-three! A scale of 306 notes has also been suggested.

Mercator, whose map projection we remember so well from our schooldays, and which is still used almost daily, was the first, I believe, to want to bring in the 53 note scale.

Loudspeaker Baffles *and* Enclosures

PART 3

By J. R. DAVIES

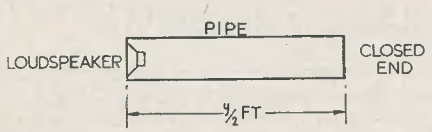
Sound in Pipes

The behaviour of the labyrinth may be more easily examined if we consider the effect of sound waves travelling in pipes.

Fig. 9 shows a labyrinth extended into the shape of a pipe, and fitted at one end with a loudspeaker. The remote end of the labyrinth is closed and we presume that it has no internal lagging.

A single AF tone is then fed to the loudspeaker, its wavelength in air being equal to y ft.[1] The length of the pipe is $\frac{y}{2}$ ft.

Let us assume that, at one particular part of the AF cycle, the speaker diaphragm is moving backwards, thus causing a pressure wave in the air immediately behind it. This pressure wave travels down the pipe and is reflected back again by the closed end. By the time it travels back to the diaphragm it will have traversed twice the length of the pipe; in other words, it will have covered y ft. As the pressure wave has therefore travelled over one wavelength before it returns, it can be seen that it will arrive at the diaphragm at the same point in the following AF cycle at which it left. The pressure wave will now be reflected back down the pipe again by the loudspeaker diaphragm (and the speaker mounting) whilst the speaker is, itself, forming a further pressure wave. It may be appreciated, then, that the reflected pressure wave is added to that formed by the loudspeaker, and the pipe becomes resonant. This resonance, therefore, occurs when the loudspeaker is handling a tone whose wavelength is equal to twice the length of the pipe.



C495

Fig. 9: A closed labyrinth opened out into the shape of a pipe.

1. The wavelength of a sound may be calculated by dividing the velocity of the sound in air by its frequency. The speed of sound at normal atmospheric pressure is approximately 1,125 ft. per second. Thus, to take an example, a sound wave whose frequency is 100 c/s would have a wavelength, in air, of 11.25 ft.

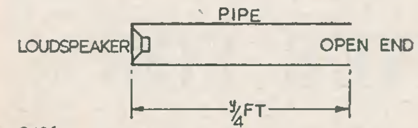
It must be remembered that the behaviour in a pipe of this type (which is closed at both ends) is not the same as occurs with a pipe which has the "sound source end" open. In the latter case the pressure wave, on reaching the open air, causes a rarefaction to pass down the pipe and the pipe therefore *attenuates* wavelengths equal to twice its own length.

Returning to the pipe of Fig. 9 again, it may be noticed that, although the pipe accentuates frequencies whose wavelength is equal to twice its length, it has an attenuating effect for wavelengths of four times its length. In the second case the pressure wave, on returning to the speaker, reaches the diaphragm as it is forming a rarefaction wave; in other words the reflected energy is out of phase.

We may therefore reach the following conclusions. Firstly, the closed pipe *accentuates* sounds whose wavelength is equal to twice its length, and *attenuates* sounds whose wavelength is equal to four times its length.

How may these effects be put into practical use? If we had a loudspeaker which is resonant at, say, 20 c/s, and we designed a labyrinth which would attenuate that frequency, it would, at the same time, accentuate sounds at 40 c/s, thereby giving an increase in bass response at that frequency.

This course might not be very advisable, however, since, in many cases it is not always worth while using the closed labyrinth to remove resonances in the speaker, it being better to have it "flatly tuned" to, say, 30 c/s or so, whereupon it could usefully expand the bass response.



C496

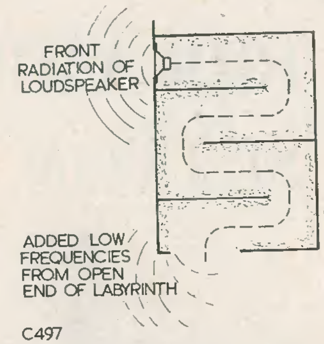
Fig. 10: Illustrating the resonant behaviour of an open pipe.

When the resonant properties of the pipe are being calculated, it must be remembered that the effective length of the pipe, when lagged, is equal to the length of the free air inside the lagging, and not the length of the pipe itself. Care must be taken to ensure that the lagging is carried out well, as the resonances would otherwise be too strong. A certain amount of experimenting could possibly be carried out at the end remote from the speaker by using different materials for reflection, although most of the sound energy will be lost in the inside lagging. It must also be remembered that the length of the air column is only capable of giving an approximate idea of the resonance frequency.

The Open Labyrinth

In Fig. 10 is shown a pipe which has the end remote from the speaker open to the air. Let us assume that its length is equal to one quarter wavelength, *i.e.* $\frac{y}{4}$. In this case, when the pressure wave from the back of the speaker diaphragm reaches the end of the pipe it escapes into the air, thus causing a *rarefaction* wave to travel back up the pipe. When the rarefaction wave reaches the speaker the latter will be generating a rarefaction wave itself; in other words, it will have completed half a cycle since the pressure wave was originally formed. The rarefaction wave from the open end of the pipe will then be reflected from the speaker at the same time as the speaker itself is generating a similar wave, and the pipe will therefore become resonant.

Now let us assume that the speaker is generating a sound whose frequency is twice the previous one. In this case the pressure wave formed by the speaker will return, as a rarefaction wave, not when the speaker has completed half a cycle, but when it has completed a full cycle (*i.e.* when it is forming a pressure wave again). The pipe will therefore tend to attenuate that frequency.



C497

Fig. 11: How an open labyrinth may be used to provide a secondary source of bass. Such a cabinet should be stood on feet (or some similar mounting) to enable the added bass to reach the listener.

Once again, as with the closed pipe, we can reach a series of conclusions for the open pipe. Firstly, the pipe accentuates sounds whose wavelength is four times its length, and attenuates sounds whose wavelength is twice its length.

This is an extremely interesting result and it will be noticed that the open pipe has an opposite effect to the closed one. The closed pipe attenuated a frequency equal to half of that it accentuated, whereas the open pipe attenuates frequencies equal to *twice* the frequency of those it accentuates.

In practice, one sometimes meets loudspeakers which are resonant at about 60 c/s or so. The open pipe could then be used to attenuate such a resonance, whilst at the same time accentuating the frequencies around 30 c/s; thus increasing the bass response of the reproducer.

The open pipe has other advantages which make it useful for the experimenter. First of all it only needs to have half the length of the closed pipe to enable it to resonate at a certain wavelength, and it may therefore be made more compact. Secondly, the open end of the pipe may be used to provide a secondary source of low frequency sound, remote from the loudspeaker itself. Fig. 11 shows a suggested example. The dotted line in this diagram gives an approximate idea of the effective length of the labyrinth should it be opened out into a straight pipe.

(*To be continued*)

PRE-AMPLIFIER FOR SUTTON COLDFIELD

by L. A. BARKER

MANY readers living in areas of low signal strength will find that they can put to good use the compact item described below, particularly those who are using R1355 and superhet receivers from which trouble arises due to powerful short-wave stations breaking through at IF. With a modest gain of from 4 to 6 times from the pre-amplifier, the gain control of the receiver can be proportionately reduced—when breakthrough at IF is most unlikely, except, perhaps, in areas swamped by the interfering transmitter.

While he has not been able to measure its gain, the writer believes that a gain of 10 could be obtained with this pre-amplifier by narrowing the bandwidth to pass the vision channel only.

The Chassis utilised is an American HT distributor unit measuring 4″ square by 1¼″ deep complete with base plate, and containing one tubular (metal) and eight mica capacitors and W socket, costing 1/6d. All of the capacitors, W socket and two of the metal screens were removed, but a central screen was left intact as it supports five feed-through solder tags which are used to feed the HT, heater supply and output. Output is taken via a sufficient length of coax cable to a pye plug for attachment to the receiver, and the HT, heater and common leads are connected to an old valve base, which plugs into a suitable valveholder fixed to the receiver chassis. Input is via the pye plug in the side of the chassis.

Readers who cannot obtain a distributor unit as described above should have little difficulty in making up a small chassis of similar dimensions, preferably from tinplated steel for easy soldering, and for the latter reason a piece of tinplate should be used as a screen and soldered firmly across pins numbered 5 and 8 of the B9G valveholder. As far as possible all earth return leads should be taken to the same point, unless this means an unnecessarily long lead, when it may be soldered directly to the chassis. Fig. 1 makes the layout clear.

It is advisable to use resistors of more than just sufficient wattage rating with a view to keeping noise at a low level, providing their bulk is reasonable. Mica capacitors are best, and four originally in the unit have been utilised.

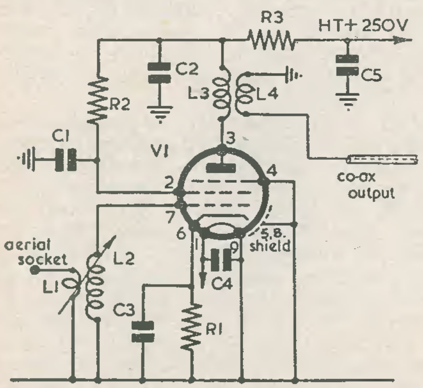


FIG.2. Valve pins 4,5,8,9 and centre clip connected to earth.

C305

COMPONENT LIST

C1, 2, 3, 4, 5, 0.001 µF
R1, 220 Ω ½W
R2, 10 kΩ½W
R3, 3.9 kΩ 1W
L1, 4, 1½ turns 26 swg DCC
L2, 3, 6½-7 turns 26 swg DCC
2, ¼″ Aladdin formers, with slugs
1, Pye socket
1, Pye plug
1, B9G holder, paxolin or ceramic
V1, EF50

The coupling windings L1 and L4 are wound at the chassis end of the formers between turns 1 and 3 of L2 and L3. L2 and L3 are wound, spaced by one wire diameter between turns, towards the end of the former which is furthermost from the chassis, in order to allow the maximum of influence of the tuning slugs. In the circuit of Fig. 2 one side of the heater is earthed, and care must be taken to ascertain that the receiver with which it is to be used is also connected in the same manner, also that the common HT/Heater lead from the pre-amp goes to the chassis of the receiver, otherwise there is risk of shorting the heater supply of the whole receiver through the coax braid. Some modifications to the circuit of Fig. 2 will also be necessary if the receiver concerned is designed for use with balanced feeder input.

Adjustment of the pre-amp is simple, but varies with the type of receiver. If it is used for the vision channel only, then it should be first peaked for maximum signal, when the cores should be about midway in the formers, and then detuned for best definition by screwing in the slug of L3/L4 about half a turn at a time, but only so far as is required for full definition obtainable with the receiver.

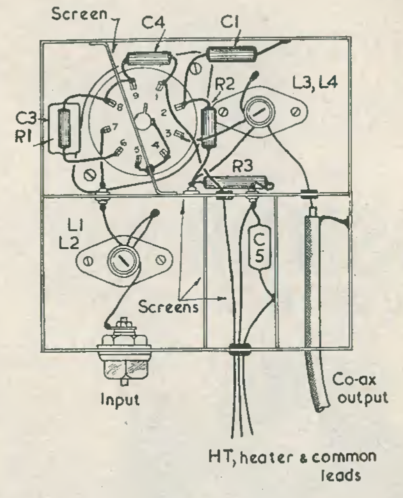


FIG.1 C1 fits right over the valveholder but is not shown in that position for clarity.

C304

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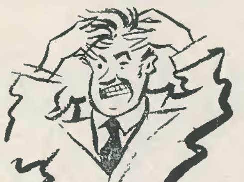

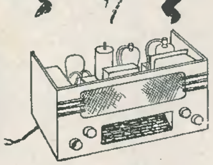

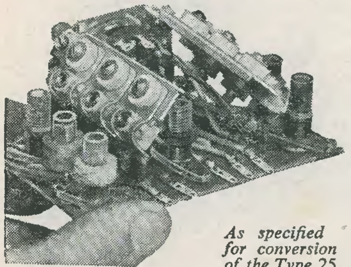

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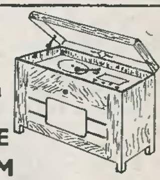

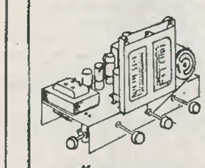

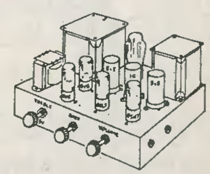

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