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for the Radio and Television Enthusiast

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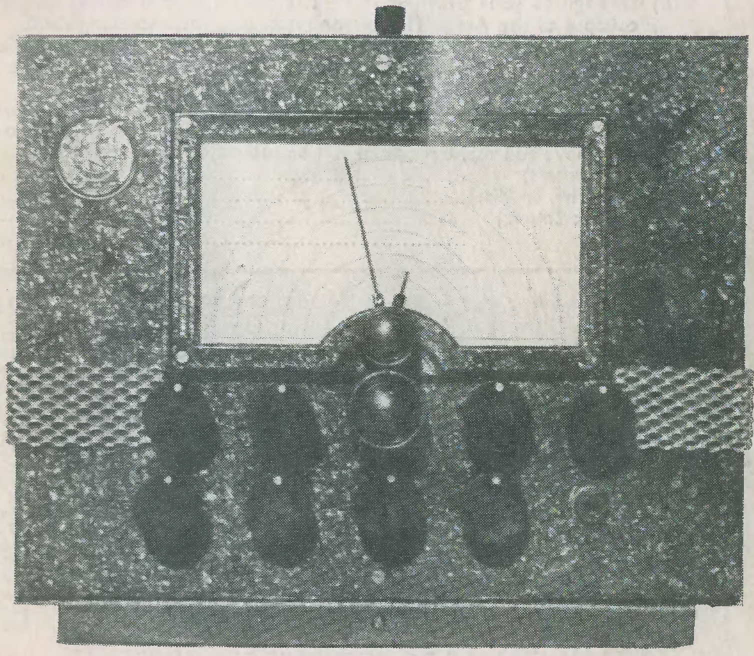

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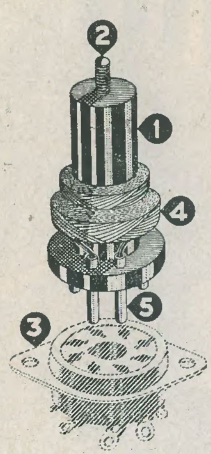

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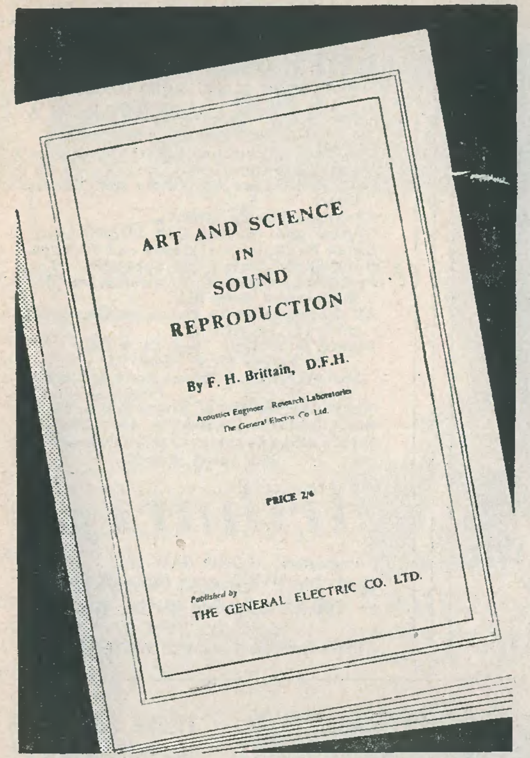

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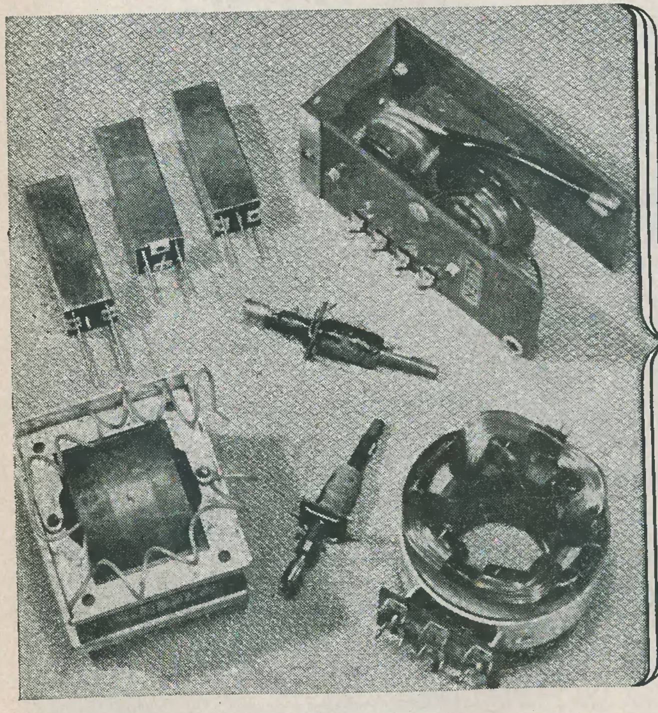

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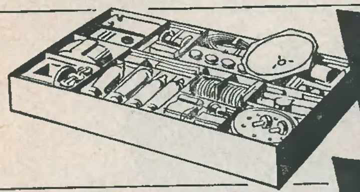

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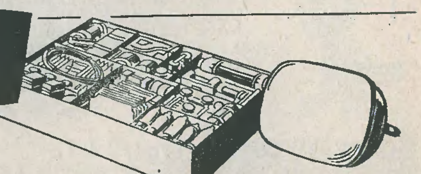

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THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

All Mss must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

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

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR, 57 Maida Vale, Paddington, London W.9. *Telephone* CUN. 6518.

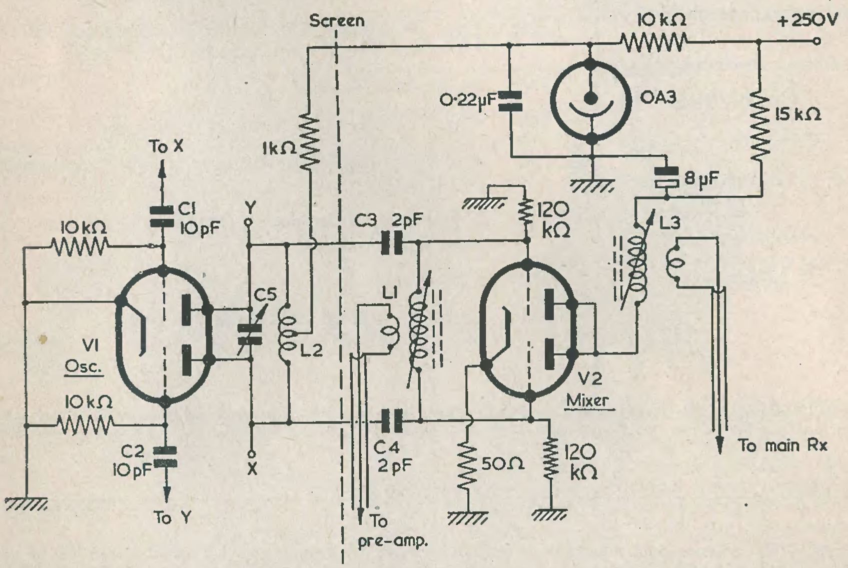
A HIGH STABILITY T9 VHF MIXER/OSCILLATOR UNIT

By H. E. SMITH, G6UH

NOTHING REVOLUTIONARY IS CLAIMED in the design of this unit, but it will be found ideal for the operator who likes to experiment with pre-amplifier stages. The low impedance co-axial input may be coupled to any type of pre-amplifier.

The oscillator is extremely stable, and in operation compares very favourably with any crystal controlled oscillator (after the initial warm-up period of about 10 minutes). Two 6J6/ECC91 valves are used, the first being a push-pull oscillator of the Colpitts type, the second being a push-push mixer structing this unit. First, the oscillator valve and coil must both be well screened from the mixer stage. The amount of oscillator injection via the two coupling condensers is just about right for efficient and noise-free mixing, and if any random coupling is allowed to exist between the two circuits, the weak-signal performance will be spoiled.

Secondly, the feed resistor to L2 should be soldered at the exact centre of the coil, and all components associated with the oscillator should be distributed symmetrically around the valveholder. This same rule applies to



A high stability VHF mixer-oscillator.

FIG.1. THE CIRCUIT.

with anode (IF) coil well decoupled, which eliminates the last traces of modulation hum.

There are several important but simple points which must be observed when con- the leads from the mixer coil to the valve-holder. In other words, keep everything balanced. The two oscillator coupling condensers should have exactly the same

length of lead on each, and both should be mounted the same distance away from the chassis.

Oscillator Coil Assembly

4 turns of No. 16 swg tinned or silver-plated wire, 3/8" diameter, turns spaced 1/16", self-supporting and soldered directly to the tuning condenser, will provide for an IF of between 10 and 30 Mc/s when trimmed by a 3-30 pF Philips trimmer (or equivalent). The tuning condenser C5 was an air-spaced Polar trimmer with 1/4" spindle, with all taken, via a short length of low impedance co-axial cable, to a socket on the chassis (input from the pre-amplifier). Once this circuit has been peaked for maximum hiss at approximately 145 Mc/s, there is no need for any further adjustment.

IF Coil

The number of turns on this coil are dependent on the IF chosen. For an IF of 30 Mc/s we used a 3/8" former wound with 12 turns of No. 24 enamelled wire (close-

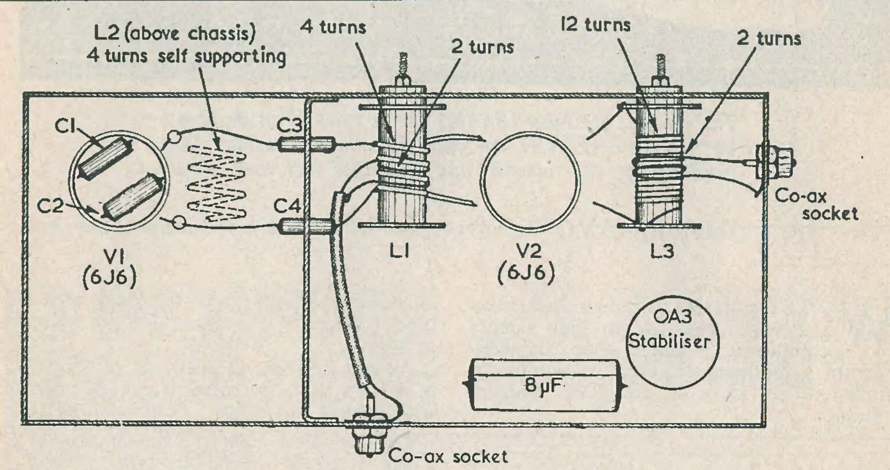


FIG. 2. UNDER CHASSIS LAYOUT OF MAIN COMPONENTS

plates, except one fixed and one moving, removed. The two remaining plates are arranged to have double spacing between them, i.e., approx. 1/16". This resulted in a variable capacity of approximately 1.5 to 3.5pF, and, with a 0-100 degrees dial, the 2 metre band is spread out over 10 to 90 degrees. (Note: It would probably be better to use a split-stator type of condenser for this job, with the rotating vanes earthed. There would then be no necessity to use insulated couplings to bring the spindle out to the front panel, as we had to do in this instance).

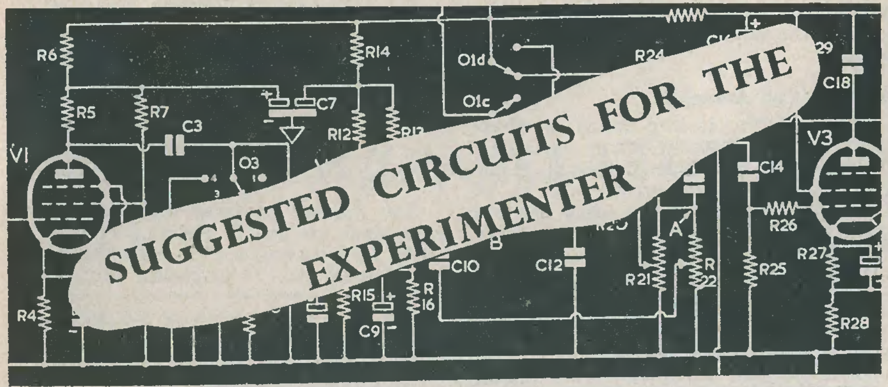
Mixer Coil

This is once again No. 16 swg wire, 4 turns spaced 1/16" apart on a 3/8" former tuned with a dust-iron plunger. 2 turns of the same gauge wire, insulated with systoflex, are wound over the centre of L1, and are wound) tuned with a dust-iron plunger. The coupling coil, wound with the same gauge wire, insulated with sleeving, consisted of two turns overwound at the HT feed end of the coil. This is connected to another short length of co-ax, which feeds the main receiver. The decoupling circuit is most important, and with an HT voltage of 250, the 15kΩ resistor provides just about the right amount of voltage on the mixer anode for minimum mixer noise.

Trimming

Unless you are blessed with a signal generator, there is no easy road to "finding the band." This will need some little patience, but if you have followed the instructions regarding coil sizes, etc., you will at least know that the band is obtainable. Trim the IF first. Set the main receiver to the IF you have chosen to work with, and trim

[*continued on page 355*



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

No. 38: Obtaining AVC Bias from an Infinite Impedance Detector

WHILST THE INFINITE IMPEDANCE detector is of great use in high fidelity equipment, it suffers from the considerable disadvantage that it cannot be employed to provide an AVC control voltage.

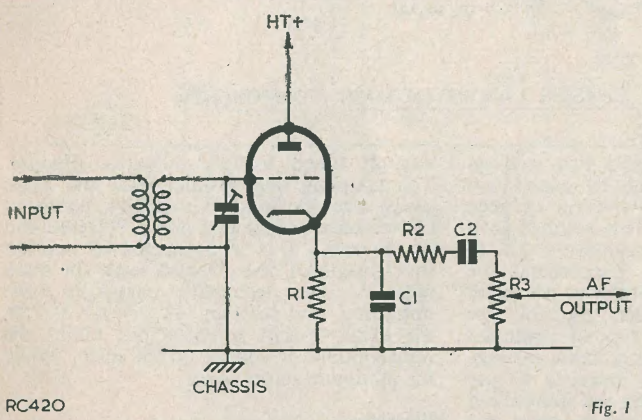


Fig. 1

A typical infinite impedance detector is shown in Fig. 1. It functions by reason of the fact that pulses of anode current corresponding to the positive peaks of grid voltage are passed by the valve. The AF voltage built up across the RC circuit, R1-C1, consequently follows the modulation envelope of the impressed signal. Since the grid does not draw current, the input impedance approaches infinity; with the result that the tuned circuit feeding the grid is not damped or loaded.

As will be seen, the cathode of the valve is always at a potential which is positive with respect to chassis. This potential rises according to the amplitude of the received carrier. The voltage at the cathode is, therefore, diametrically opposed to that which would be needed for AVC control.

An Additional Diode

It is possible to obtain AVC bias from the tuned circuit feeding the detector by fitting an additional diode. This could be connected either to the tuned circuit itself or, assuming an IF transformer, to the previous anode. Unfortunately, the diode would at once cause a load to be placed upon the tuned circuit or transformer, and one of the advantages of the detector — its infinite input impedance — would be cancelled.

In this month's Suggested Circuit, which is illustrated in Fig. 2, the additional diode is fitted, instead, in the cathode circuit of the detector. This is done by connecting the primary of an additional IF transformer between the cathode load resistor and its by-pass capacitor. Whilst the transformer primary will not interfere with the AF characteristic of the RC circuit, it will at the same time have built up across it most of the RF appearing at the cathode. In addition, it will not cause the grid circuit of the detector to be loaded in any way at all.

The secondary of the additional IF transformer is connected to a diode rectifier which provides AVC bias in the conventional manner.

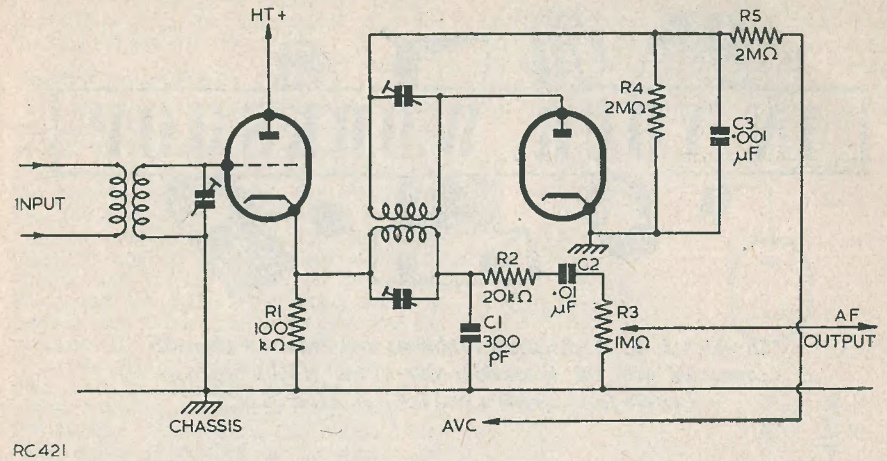


Fig. 2

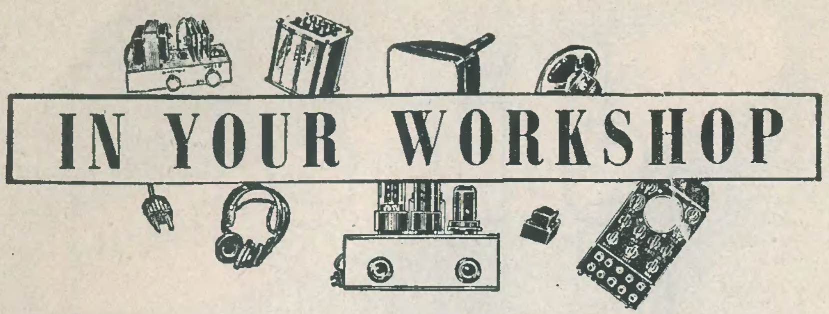
Practical Points

The circuit of Fig. 2 should not prove difficult to apply in practice. It is possible that the performance of the circuit may be improved if a further capacitor of some 50pF is connected across R1; although this might, of course, cause a drop in AVC voltage. The point is experimental. The additional capacitor will cause detuning of the IF transformer primary.

Due to the fact that the RF appearing at the detector cathode consists of pulses of current, it may be found that a higher AVC voltage is obtained when the IF transformer secondary feeding the diode is connected one particular way round. This point should be checked by temporarily reversing the connections from the transformer secondary.

It will be noted that the values of R1 and R3 are in the ratio of 10:1. This ratio will prevent negative peak-clipping for modulation depths of up to approximately 90 per cent.

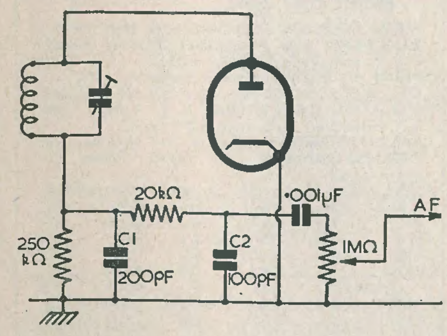
It should be pointed out finally that, in its practical form, care should be taken to ensure that the cathode and grid tuned circuits are adequately screened from each other, and that all connecting leads are kept short.



IN YOUR WORKSHOP

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

OVER THE LAST FEW MONTHS I have been receiving letters from many readers concerning the question of detectors for high-fidelity receivers. As these readers point out, the BBC is now transmitting on Medium and Long waves up to a modulation depth of 80 per cent and more, with the result that it is difficult to be certain whether any distortion introduced by such heavy modulation is introduced in the receiver or in the transmitter. At the time of writing, the question of distortionless detection of BBC transmissions is the subject of a series of letters in the correspondence columns of a contemporary. It can be seen, therefore, that the BBC's policy of allowing heavy modulation is causing quite a little unhappiness amongst those listeners who are interested in really faithful reproduction.



RC422

Fig. 1. A conventional diode detector

Transmitter or Receiver?

The first thing to consider when tackling the problem of high modulation depth transmission and reception is whether the distortion lies in the transmitter, the receiver, or both.

So far as I can see, increasing the modulation depth at the transmitter is almost certain to increase distortion, even if only by a very small amount. However, BBC engineers are notoriously painstaking and persevering, and I think we can be fairly certain that they would keep the distortion introduced by high modulation to as low a limit as possible. They have, furthermore, the moral advantage of right on their side. Modulation depth, they say, has been increased to counteract interference from powerful Continental stations.

So, really, we are faced with the alternatives of high modulation, with possible attendant distortion, and lower modulation with almost certain interference. Of the two, I think it is fairly safe to say that the first is the more preferable.

Having (albeit a little grudgingly!) exonerated the BBC, and having assumed that the programmes transmitted are as free from distortion as is possible, let us now examine our receivers. It is here that we may get something of a shock.

Fig. 1 shows the circuit of a conventional diode detector; one, indeed, that has been looked upon as an "Old Faithful" for many, many years. Such a circuit will not give a great deal of distortion at, say, 40 per cent modulation. When we step the modulation up to 80 per cent, however, distortion may not become just merely noticeable; it may become downright unpleasant. Such distortion will be particularly evident on high notes and transients, and it will almost always be caused by negative peak-clipping in the CR circuit used for filtering the detected AF.

Negative Peak-Clipping

To appreciate how negative peak-clipping may occur, let us examine the circuit shown in Fig. 2. This represents a diode detector stripped down to its essentials. To facilitate the process of explanation, the diode load has, this time, been connected between the diode cathode and chassis. The modulated signal is applied by the tuned circuit to chassis and to the anode of the diode. When the top end of the tuned circuit is positive the diode conducts, charging the capacitor **C**. When the top end of the tuned circuit is negative the diode does not conduct, and the capacitor discharges into **R**.

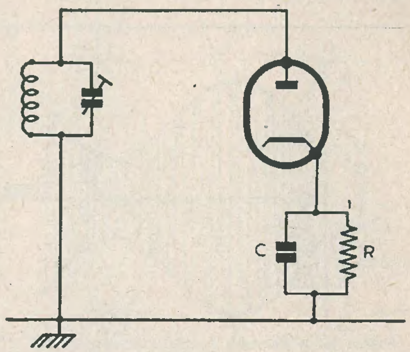
Fig. 3 shows the process graphically. In this familiar diagram, the modulated waveform at (a) is rectified by the diode; the resultant signal, illustrated in (b), appearing across the diode load. Note that, between positive half-cylces of RF the capacitor discharges into the resistor, (as happens, for example, between points **A** and **B** in the diagram), until the next positive RF half-cycle appears and charges the capacitor up to peak value again. (The irregular outline of Fig. 3 (b) is due to the fact that, for purposes of illustration, the carrier frequency is shown as being much lower than it would be in practice).

Now, what happens if the values of **C** and **R** are made such that the capacitor can only discharge slowly between successive half-cycles? This will not worry us between points **C** and **D** in Fig. 3 (b), because the capacitor is being charged up by the diode to a higher voltage at each half-cycle. Between points **E** and **F**, however, the voltage at the cathode of the diode is falling, and, if **C** cannot discharge into **R** quickly enough to "follow" the cathode voltage, there will be distortion. An approximate idea of the distorted waveform is given in Fig. 3 (c). It will be seen that the distorted part of the curve appears when the diode cathode voltage is falling. Hence the term "negative peak-clipping."

Critical Values

It may be seen from the above that the values of **C** and **R** are of considerable importance if we are to achieve distortionless reproduction from a diode detector. I have been carrying out a little investigation of my own into this matter and, by making several assumptions that can be fairly comfortably met in high-quality receivers, am able to show that there is a limiting value of **CR** in the circuit of Fig. 2 above which distortion is almost inevitable.

Fig. 4 shows the AF voltage appearing across the cathode load of a diode using the circuit of Fig. 2. The waveform of this voltage is, of course, practically identical with that of Fig. 3 (b), with the exception that the RF half-cycles are not shown.



RC423

Fig. 2. Equivalent circuit of the detector, illustrating the importance of **C** *and* **R**

The peak voltage of the waveform is v_1 volts, and its average voltage (measured from the point where the AC voltage is zero) is v_2 volts. The waveform is that of a sine wave and there is no distortion. Its frequency is f cycles per second.

We will need to assume that the resistive value of the diode load is very much higher than the internal resistance of the diode, and that the resistance offered by the diode remains constant over the half-cycle during which it conducts. We can satisfy the first assumption by giving the load resistance a value of some 250 kΩ or more, and the second by applying the RF to the diode at a fairly high voltage. We will have to assume also that the impedance of the RF source, in this case the tuned circuit, is negligible so far as AF and DC are concerned. This latter assumption is readily met if our tuned circuit is the secondary of a conventional IF transformer.

Having proceeded so far, let us examine Fig. 4. As it stands, the values of **C** and **R** are such that **C** can discharge sufficiently quickly into **R** at all points of the cycle, thereby allowing the voltage waveform across **R** to follow that of the modulation envelope.

Let us now gradually increase the value of **C** until it is just on the threshold of being too large to allow the capacitor to discharge into R quickly enough at the steepest part of the AF cycle. It can be seen that this state of affairs will be encountered at the point where the sine wave voltage is *falling* at its greatest speed. In Fig. 4, the point at which the sine wave voltage is falling at its greatest speed is at P, on the line AB; that is, at the point where the AC voltage is equal to zero.

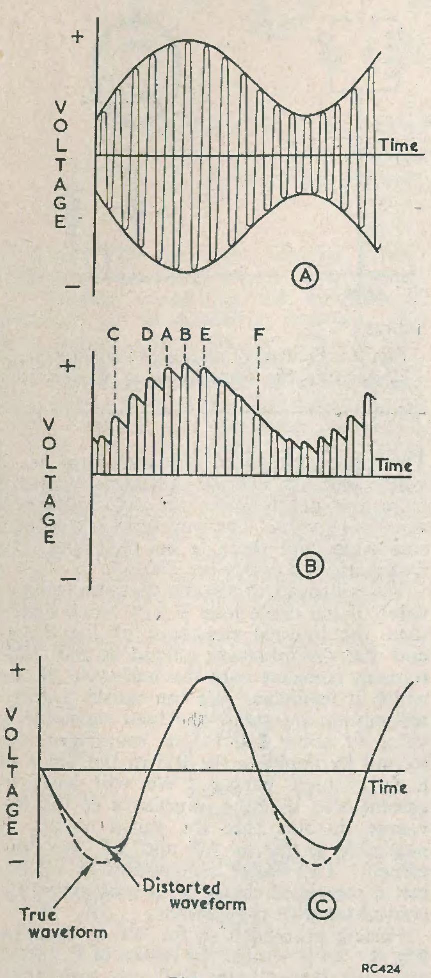


FIG. 3.

Fig. 3 (a) *An amplitude-modulated signal*
(b) *The signal after detection*
(c) *Distortion introduced in the signal by too high a value of CR.*

Equal Rates

At this juncture it would be advisable to use more concrete terms. So let us re-word the conclusions of the last paragraph to state that we are considering the case where the rate of change of voltage of the sine wave at point P is equal to the *initial* rate of change of voltage across C when it discharges into R. We refer to the *initial* rate of change of voltage across C because this is the only time during the whole cycle when the capacitor has been expected to discharge into the resistor at a rate dependent solely upon the values of C and R. Previously, the voltage was "held up," as it were, by the diode cathode. If we evaluate these two rates of change, we will be able to find the limiting values of C and R.

Our reference books tell us that the rate of change of voltage of a sine wave at zero voltage is given by

$$R_1 = 2\pi fV \text{ volts per second,}$$

where R_1 is the rate of change, V is the peak voltage, and f the frequency. Therefore, in the case of Fig. 4, the rate of change will be given by

$$R_1 = 2\pi fv_1 \text{ volts per second.}$$

The initial rate of change of voltage across a capacitor discharging into a resistor is given by

$$R_2 = \frac{E}{CR} \text{ volts per second,}$$

where R_2 is the rate of change, E is the initial voltage, and C and R are measured in farads and ohms respectively. In Fig. 4, E will be equal to v_2; and so we obtain:

$$R_2 = \frac{v_2}{CR} \text{ volts per second.}$$

As we are considering the case where R_1 is equal to R_2, we may now reach the following:

$$2\pi fv_1 = \frac{v_2}{CR}$$

This may be rewritten:

$$CR = \frac{v_2}{2\pi fv_1}$$

However, $\frac{v_1}{v_2}$ is equal to the modulation depth (see Fig. 4). If, therefore, we represent the modulation depth (as a fraction, not as a percentage) by the letter K we may further rewrite the equation as follows:

$$CR = \frac{1}{2\pi fK}$$

A Practical Example

It would be interesting now to see what values of C and R we can obtain under practical conditions of reception.

Let us start off, therefore, with a stringent but, nevertheless, representative set of requirements. We wish to produce a detector circuit which will not introduce negative peak-clipping for all frequencies up to 10 kc/s. The modulation depth will be four-fifths (i.e., 80 per cent).

Using these figures, we obtain:

$$CR = \frac{1}{2\pi fK}$$
$$= \frac{1 \times 5}{2\pi \times 10{,}000 \times 4}$$
$$= \frac{1}{16{,}000\pi}$$

If we decide to use the conventional value of 250kΩ for the diode load resistor, we then obtain:

$$C = \frac{1}{16{,}000\pi \times 250{,}000} \text{ farads}$$
$$= 80\text{pF (approx).}$$

Some Solutions

80pF is not a large capacitance by any means, and it will at once be realised how the apparently harmless circuit of Fig. 1 is capable of causing a considerable amount of distortion; this being especially true of high notes at high levels of modulation. It must be remembered that, in Fig. 1, both C1 and C2 are effectively in parallel across the diode resistor so far as AF is concerned; and that the total capacitance is nearly equal to 300pF. Which is a lot more than 80pF!

At the same time, it is essential to have a reasonable amount of capacitance across the diode load, or we will not be able to filter RF away from the succeeding AF stages. We must remember also that there are residual capacitances to consider, including the input capacitance of the subsequent valve.

One way of increasing the permissible parallel capacitance consists of reducing the resistive load. Thus, if R is halved, C may be doubled. This will still maintain the same limiting value of CR.

This is not a very useful solution, however, because if we reduce R to too low a value, we will be introducing distortion from other causes. If, in the case just quoted, we were to reduce R to 150kΩ (probably as far as we could go with safety), this would allow us to increase C to a value of approximately 130pF.

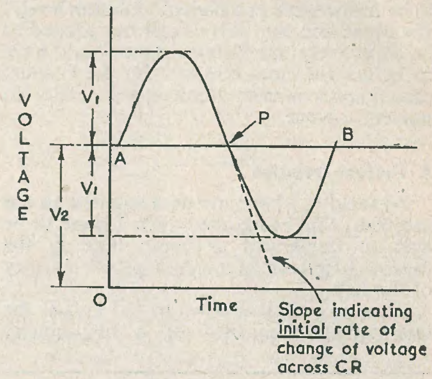
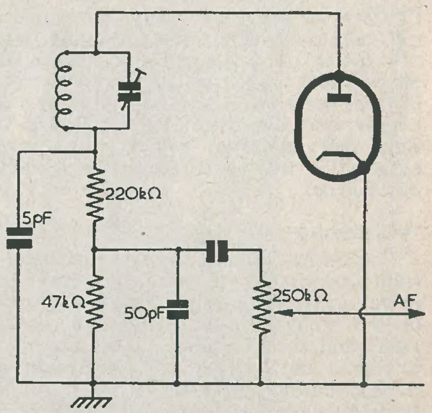


FIG. 4.

Fig. 4. Illustrating a condition in which the initial rate of change of voltage of CR is equal to the fastest rate of change of voltage of the sine wave

Another method of attack would be to increase the value of the series resistor in the RF decoupling circuit. The circuit shown in Fig. 5 is due to J. D. Herring and appeared in *Wireless World* for September,



RC426

Fig. 5. A high-fidelity diode detector circuit (see text)

and it will be seen that it uses a very low value of C. To prevent confusing the issue, I have not referred to AC/DC diode load ratios in this article, but I would like to mention that Mr. Herring estimates that this circuit gives an AC/DC load ratio "of 95 per cent, at the highest frequency likely to be transmitted at a high modulation level." He states also that this circuit has proved to be completely satisfactory. One would have to be careful, however, to keep the residual capacitances in the circuit low in order to prevent top-cut.

A Perfect Solution ?

Personally, I have my own solution to the problem; this being one which I hope to be able to implement at some time in the future. It consists of increasing the frequency of the IF's.

If we tie ourselves down to 465 kc/s as the intermediate frequency of a high-quality receiver, we will always have trouble at the detector stage. But, by the simple process of increasing the frequency, we can at once reduce the value of the necessary by-pass capacitors across the diode load. Furthermore, increasing the IF has the result that the impedance of the series resistor in the diode filter circuit increases also.

It must be admitted that, apart from local-station listening, working at a high IF will definitely introduce problems of selectivity, especially in our present crowded broadcast bands. The answer to that particular problem could consist of constructing a receiver which employed the conventional number of stages of IF amplification at 465 kc/s; and which then employed a second frequency-changer to alter the frequency to, say, 3 or 4 Mc/s for final application to the detector.

The VOYAGER

By **FRANK A. BALDWIN,** A.M.I.P.R.E.

A 5-valve Communications Type TRF receiver using Eddystone plug-in coils, Mullard B8A valves, and incorporating a Noise Limiter and Audio Filter.

THIS RECEIVER HAS BEEN DESIGNED AND constructed for those enthusiasts who prefer using modern miniature components and plug-in coils. The advantages of these components are too well known to require discussion here; be it sufficient to state that maximum efficiency has been achieved in this design mainly as a result of their use.

Preliminaries

The completed receiver is shown on the front cover, and the various illustrations in this article adequately explain the physical lay-out both above and below the chassis. Panel and chassis drilling details are given in Figs. 1 and 2 respectively. Before operations commence, however, various modifications to the steel cabinet (supplied by Kendall and Mousley), are required in order to obtain a lift-up top — which is required in order to change coils. The cabinet sides, top and bottom are inter-changeable merely by removing the fastening screws and re-assembling. The bottom of the cabinet should first of all be removed, reversed (i.e., inner surface to become the outer so that the cabinet now stands on two runners), and the perforated rear panel should be inter-changed with the top. What has now become the top panel should be affixed to the rear panel by means of two small hinges (available from the local hardware store). Fitment of these hinges is a simple matter and should present no difficulty to the average home constructor. A small knob is then fitted to the lid (see illustration) to facilitate easy accessibility when coil changing. Once the aluminium panel and chassis have been drilled, etc., both sides of the former and the top and sides of the latter should be painted with "Panl" (see small advertisements), in order to impart that professional look to the receiver and as an added protection to the metalwork.

Circuit

This uses the following valves — RF Stage, EF41; Detector, EF41; First Audio Stage, EF40; Output Stage, EL42 and Rectifier, EZ41. The Noise Limiter incorporated in the Audio stages utilises two Mullard OA60 Germanium Crystal Diodes which, although primarily designed for use as a Video Detector with a maximum continuous inverse voltage of 25 volts, work extremely well in the circuit as shown.

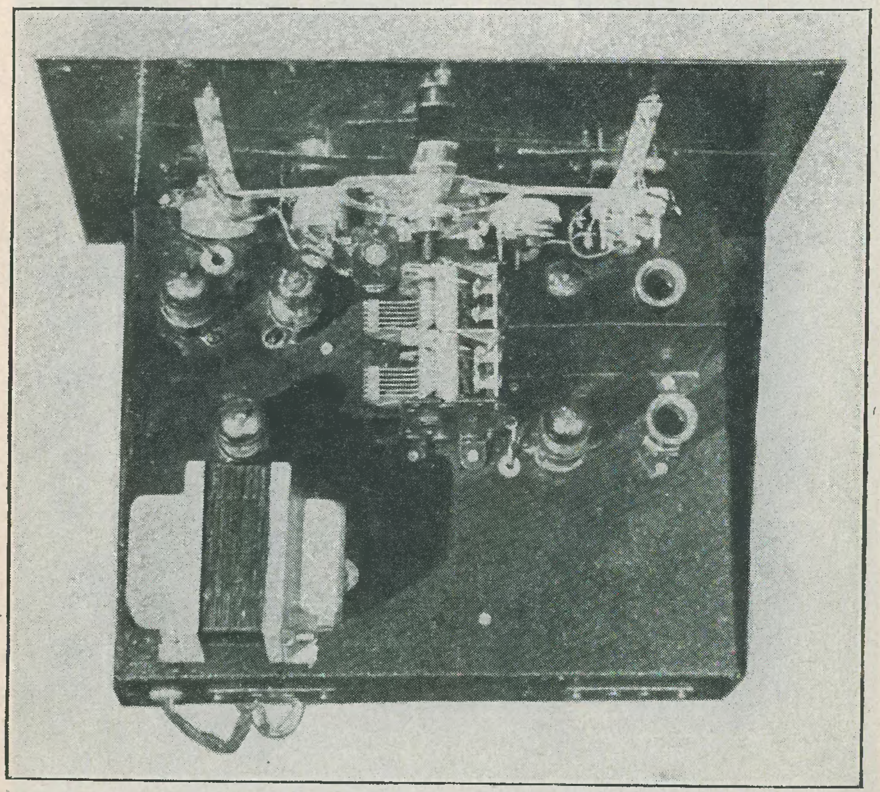
The Audio Filter choke is an Osmor type QC1 RF Choke. The use of this type of choke has definite advantages in that it works very efficiently, is physically small and thus occupies very little space and, in addition, is much cheaper than the usual inter-valve transformer used for this purpose.

RF Stage

The aerial input is via C1 — a 25pF split stator — and this effectively matches the impedance of the aerial to the receiver over the entire frequency coverage. In operation, this is adjusted to give the best signal-to-noise ratio on the particular frequency in question. C3 is the RF trim control. RF gain is by means of the variable resistor R5 in the cathode circuit. The valve is a Mullard EF41 — a variable-mu RF pentode in which the entire electrode system is internally enclosed in a metal shield, thus obviating the need for a metal screen. As an RF amplifying valve, the EF41 is particularly suited to sets designed to include short wave bands. The RF choke, an Osmor type QC1, mounts vertically on to the chassis by means of a single fixing bolt. The RF output is fed via C6 into the coil primary of the Detector stage. Note the under-chassis screening between the RF and Detector stages — this effectively prevents any interaction between the two RF chokes.

Detector Stage

This stage incorporates a further EF41 RF pentode, which has been found to work extremely well as a leaky grid detector. Owing to the fact that the Eddystone miniature plug-in coils have their windings all internally connected to an earth pin, reaction is obtained by varying the screen grid



The "Voyager" — Above-chassis View

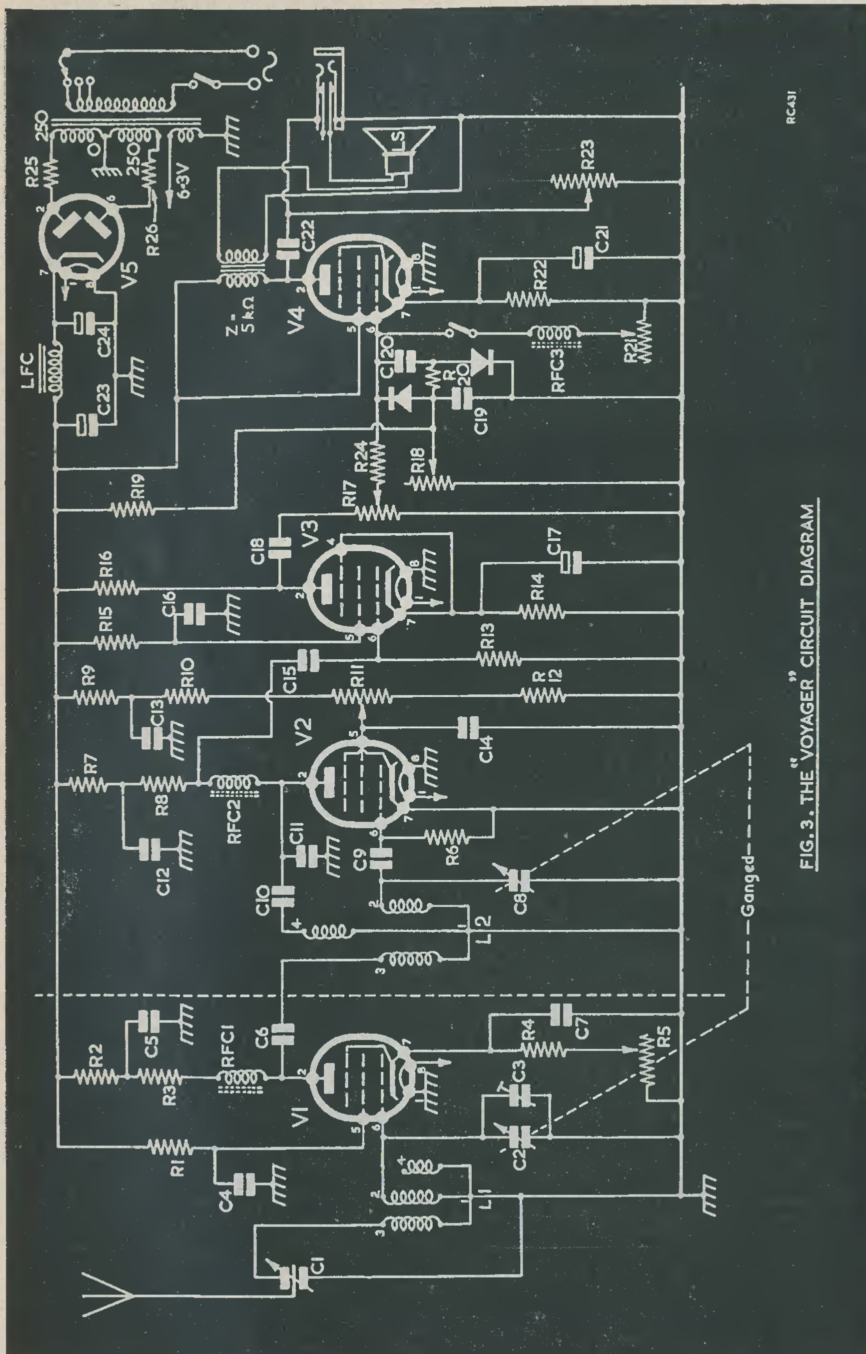


FIG. 3. THE "VOYAGER" CIRCUIT DIAGRAM

voltage. The values of R9, 10, 11 and 12 have been carefully chosen to ensure that smooth reaction is present throughout the receiver coverage. The values of C10 and C11 are also important in this respect. Using the values shown in the component list, the Detector will be found to be completely stable, and careful operation of R11 will allow the circuit to slide gently into oscillation at will. The output of the Detector stage is fed via C15 into the grid of V3.

First Audio Stage

In this stage the EF40 AF pentode has been specially selected as it was designed for use in high sensitivity amplifiers; hum, microphony and valve noise are reduced to a very low level. It has a straight characteristic and a slope of 1.85 mA/V. Component values have again been chosen for best performance, and LF instability is conspicuous by its absence. The suppressor grid is connected externally to the cathode.

Output Stage

The input to this stage is via the audio gain control R17. The remaining components in the grid circuit are the Noise Limiter and Audio Filter respectively. Dealing first with the former, R18 is the manual control, and adjustment of this towards the maximum setting provides a high degree of audio pulse limitation. In the prototype receiver, distortion at the maximum setting is extremely small, C19 and C20 being the critical values in this respect — some variation of values by constructors is therefore admissible here.

Component List

R1	100kΩ ½W ±20%, Dubilier
R2	15kΩ 1W ±20%, Dubilier
R3	10kΩ ½W ±20%, Dubilier
R4	300Ω ½W ±20%, Dubilier
R5	5kΩ pot., Dubilier
R6	3MΩ ½W ±20%, Dubilier
R7	50kΩ ½W ±20%, Dubilier
R8	10kΩ ½W ±20%, Dubilier
R9	50kΩ ½W ±20%, Dubilier
R10	50kΩ ½W ±20%, Dubilier
R11	50kΩ pot., Dubilier
R12	10kΩ, ½W ±20%, Dubilier
R13	1MΩ ½W ±20%, Dubilier
R14	2.2kΩ ½W ±20%, Dubilier
R15	1.5MΩ ½W ±20%, Dubilier
R16	330kΩ ½W ±20%, Dubilier
R17	250kΩ pot with switch, Dubilier
R18	50kΩ pot., Dubilier
R19	10MΩ ½W ±20%, Dubilier
R20	150kΩ ½W ±20%, Dubilier
R21	250kΩ pot. with switch, Dubilier
R22	400Ω ½W ±20%, Dubilier
R23	50kΩ pot., Dubilier
R24	10kΩ ½W ±20%, Dubilier
R25	150Ω 1W ±20%, Dubilier
R26	150Ω 1W ±20%, Dubilier
C1	25pF Split-Stator, Eddystone. Cat. No. 719
C2, 8	160pF Two-Gang Variable. Premier Radio
C3	25pF Variable. Eddystone. Cat. No. 588.
C4	0.05μF, TCC
C5	0.05μF, TCC
C6	100pF Mica, TCC
C7	0.001μF Mica, TCC
C9	100pF Mica, TCC
C10	100pF Mica, TCC
C11	200pF Mica, TCC
C12	1μF Tubular, TCC
C13	0.05μF Tubular, TCC
C14	0.05μF Tubular, TCC
C15	0.01μF Tubular, TCC
C16	0.05μF Tubular, TCC
C17	25μF, 25 volts wkg, Electrolytic, TCC
C18	0.01μF Tubular, TCC
C19	0.1μF Tubular, TCC
C20	0.1μF Tubular, TCC
C21	25μF, 25 volts wkg, Electrolytic, TCC
C22	0.1μF, 350 volts wkg, Tubular, TCC
C23	16μF, 350 volts wkg, Electrolytic, TCC
C24	8μF, 350volts wkg, Electrolytic, TCC
V1	EF41 Mullard
V2	EF41, Mullard
V3	EF40, Mullard
V4	EL42, Mullard
V5	EZ41, Mullard

Germanium Diodes — OA60, Mullard
RFC1, 2 and 3 — Osmor, Type QC1
Eddystone Miniature Plug-in Coils, 2 each type — 706/LB, 706/Y, 706/R, etc.
Coil Bases — Eddystone. Cat. No. 707
Coil Stands — Eddystone. Cat. No. 775
B8A Bases — McMurdo
Cabinet, Chassis and Panel — Kendall and Mousley
Phone Jack — Igranic
Speaker Transformer — Goodmans type 74/243
Speaker — Goodmans type R/4/306/3, 3½"
Mains Transformer — Ellison type MT162 — Solidas Ltd.
Dial Drive and Assembly — Jackson Bros., "Caliband."

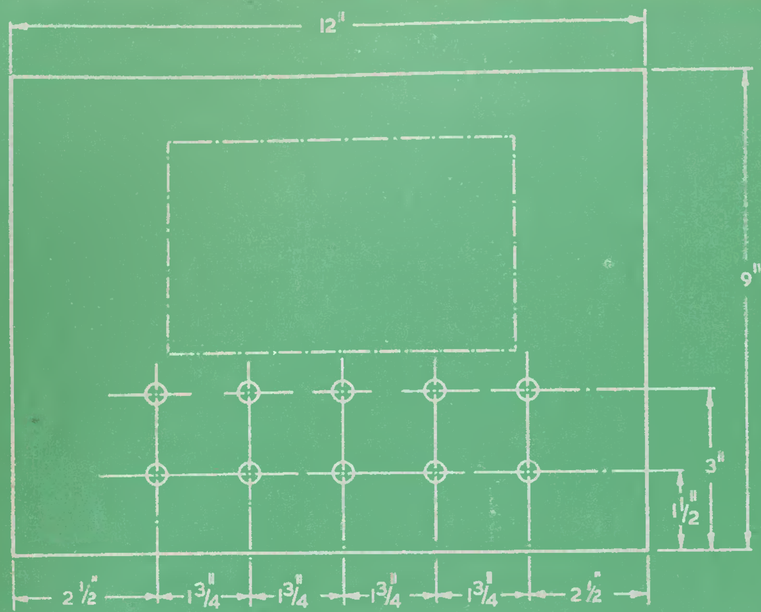


FIG. 1. PANEL DRILLING DETAILS.

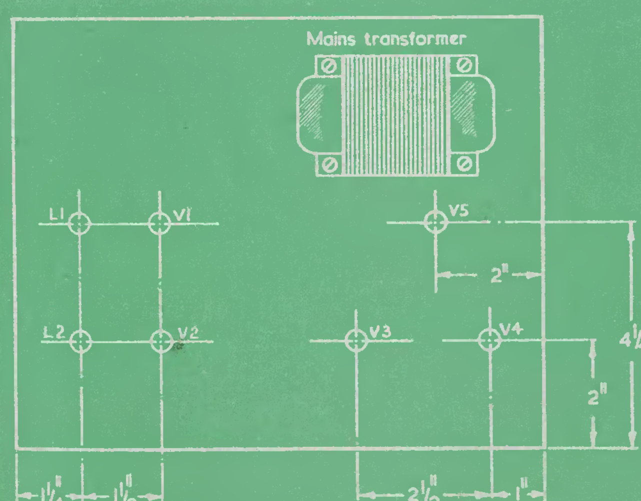
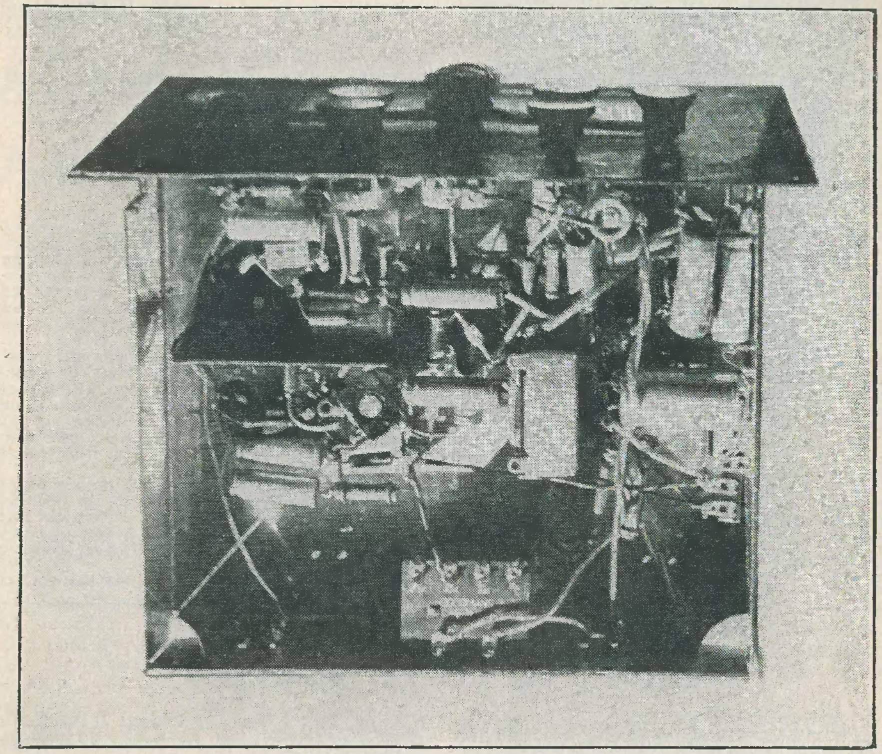


FIG. 2. CHASSIS DETAILS.

RC430

The Audio Filter follows normal practice except that an RF choke is utilised, and this component is mounted above the chassis and directly behind its control — R21. This circuit works extremely well, the effect being most marked on CW signals and particularly where several such signals are received at the same time. With the Filter in circuit, it is a comparatively easy matter to read the required transmission.

In the anode circuit, the output transformer is of particular importance in that a correct matching must be made to the EL42 (see component list). This valve is a low consumption output pentode, the heater current being only 200 mA. The maximum output of 2.8 watts has been achieved in the circuit shown. Insertion of the headphones into circuit automatically mutes the speaker, which is separate from the receiver, the output being brought through the chassis back-drop (see illustrations).



The "Voyager" — Under-chassis View

Power Pack

The EZ41 full-wave rectifier is specified here. The heater current of this rectifier is only some 0.4A, and it is capable of delivering up to 60 mA HT current. The heater voltage is obtained from the common valve heater supply. The 1 watt resistors R25 and R26 have been included to avoid momentary flashover between anode and cathode.

It was considered wise to incorporate these resistors in view of the fact that many intending constructors may choose to utilise a mains transformer other than that specified. Should the specified transformer be included, these resistors may be omitted.

General Remarks

Fig. 1 showing the panel drilling details is complete except for the dial and drive assembly. This has been omitted for the reason that this assembly is adjustable with respect to height from the chassis deck in order to accommodate various sizes of tuning condensers.

Fig. 3 shows the complete circuit diagram which, together with the component list and illustrations, provides complete data on the construction of this receiver.

The gold coloured decoration shown on the front panel and cabinet sides consists of two strips of metal speaker mesh, suitably cut to size, and bolted to the cabinet itself.

Conclusion

On completion, *The Voyager* will be found a pleasure to handle with a performance in keeping with its looks. Provided the circuitry is closely followed and a sound mechanical design adopted, no trouble will be experienced by the intending constructor.

NOTE: Some of the valve base pins are internally connected although not shown in the circuit diagram. It is important, therefore, that no valve holder tags be used for anchoring purposes.

BOOK REVIEW

TELEVISION RECEIVER DESIGN — FLYWHEEL SYNCHRONIZATION OF SAW-TOOTH GENERATORS. By P. A. Neeteson. 153 pages, 118 diagrams. Price 21s. Distributed in England by Cleaver-Hume Press Ltd., 42a South Audley Street, London, W.1.

This volume is Book VIII.B of the Philips Technical Library, and is a companion work to the Monograph dealing with the design of television receiver IF stages reviewed in the June 1953 issue of this journal. The production of the book itself, and its contents, are fully in keeping with the high standard of the series.

The principles of simple capacitive and inductive saw-tooth generators are briefly described in the opening chapter, and some complications that can arise with the inductive circuit are given notice. Some practical saw-tooth generator circuits are considered next and deal with blocking oscillators and multivibrators.

The greater part of the book is devoted to mathematical treatments of flywheel action resonant circuits and automatic phase control. In order to show how these principles can be applied to various types of saw-tooth generator, it is inevitable that the author has to describe in detail the operation of blocking oscillators, and multivibrators that work in the symmetrical and asymmetrical modes. Herein can be found a considerable amount of design data that can be most useful in other applications, especially in the case of multivibrator circuits.

Like other books in this series, this one will appeal to the design engineer of degree standard. The mathematics are rather too involved for those who do not possess a good knowledge of the Calculus. Those who can appreciate the author's treatments of his subjects will find that he deals at great length with various circuits and reaches his conclusions by logical argument from basic principles.

There is a chapter devoted to the description of special valves which are applicable to the practical circuits given in the book, and it is to be noted that even though the emphasis is on developments by Philips of Eindhoven, these same valves are available in the British Mullard range.

NORMAN CASTLE

Can Anyone Help?

Dear Sir,....Could you please oblige me with some information regarding the ex-WD transformer marked Power Unit No. T484990—VA 14.6—PHI PER 50—Style 201053.—**G. Robinson, 23 Ullswater Road, Ferryhill, Co. Durham.**

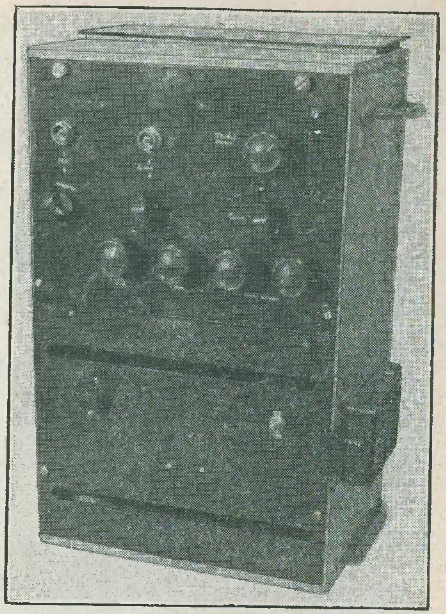
Dear Sir, Could anyone oblige me with the address in the U.S.A. of the makers of the Halford receivers. I would also like to buy or borrow the circuit, and any other particulars, of the Admiralty (Marconi) "F.H.B." receiver and associated power pack.—**E. W. Hillier, 60 Randolph Avenue, London, W.9.**

Dear Sir, I wonder whether any of your readers can supply me with the circuit or any other gen of the Marconi receiver type RG34C—9 valves (KTW63's and KTZ63's), frequency range 1.2—22 Mc/s in five switched bands. The trouble is that the aerial input circuit has been modified for Direction Finding, and I want to change it back for normal reception.—**W. Buchanan, 12 Carrick Park, Ayr, Scotland.**

Dear Sir, I am writing to see if you can give me any information with regard to the RAF R1116 receiver. I should like to know the front panel layout with regard to the controls, and also the valve line-up.—**R. E. Bowgen, 83 Hall Place, London, W.2.**

Dear Sir, Would you be so kind as to spare half an inch of space to print a vote of thanks to all those readers who replied to my S.O.S. for details of the R3170A, which you published in the May issue. I have not yet been able to reply to all those who kindly sent me assistance. Incidentally, details of the U.S.N. Radar Chassis CPR-46AAT—made by Philco—would be very much appreciated.—**E. Decottignies, 58 Leighcliff Road, Leigh-on-Sea, Essex.**

General Purpose PUBLIC ADDRESS AMPLIFIER



By **T. HATTON**

THE AUTHOR DECIDED to construct an amplifier capable of supplying all the normal requirements of PA work with reasonable quality. Most of the amplifier circuits available provided for maximums of about 25 watts, which was deemed to be insufficient for the purpose, while at the other end of the scale an American magazine gave details of an enormous audio frequency modulator to give 500 watts. The latter was rather too powerful to be harnessed to a loudspeaker, and the only alternative was to start from scratch, and design an amplifier to a suitable specification.

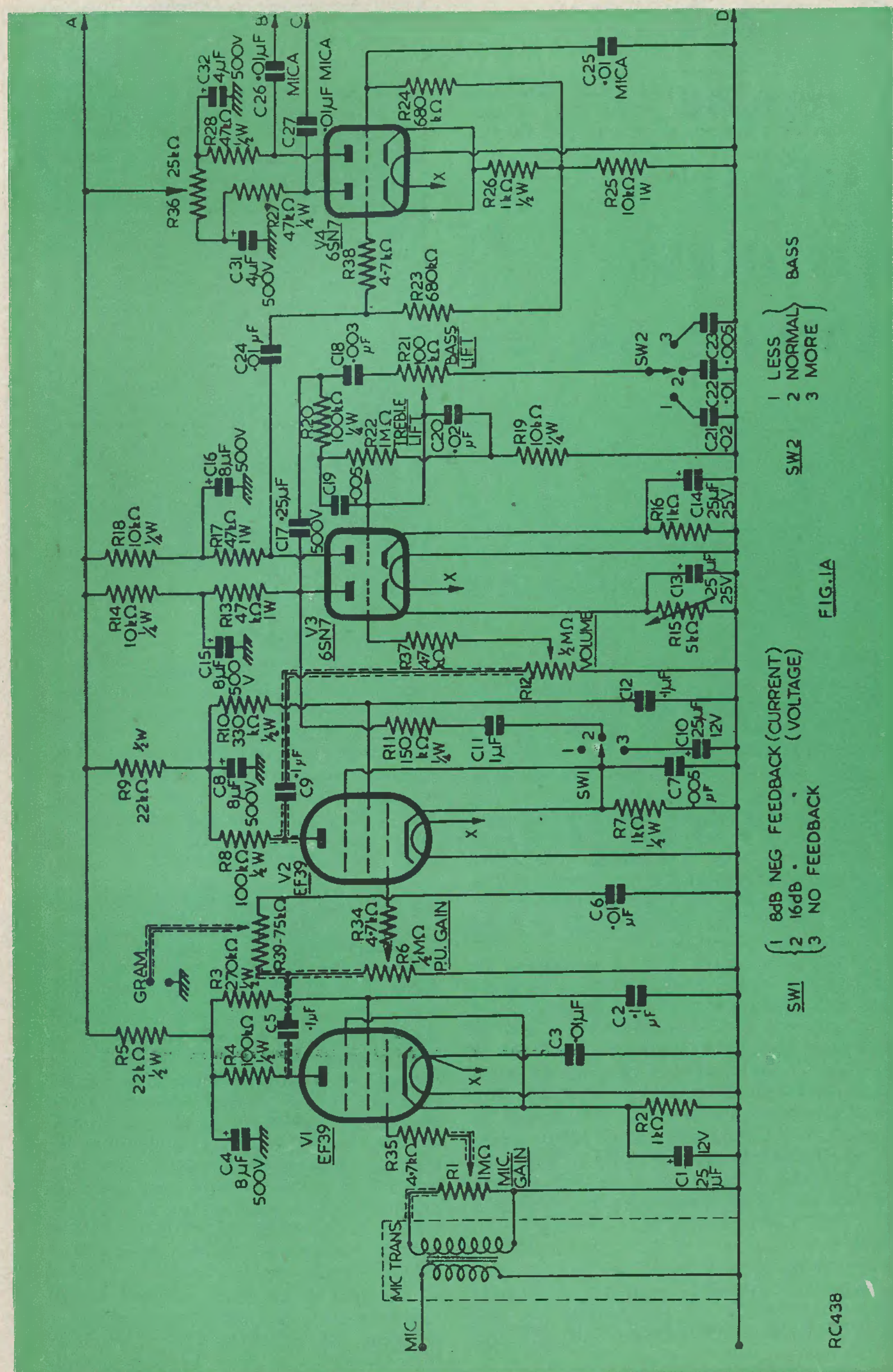
A pair of Mullard EL37's seemed to be ideal for the output stage, and these were the only two valves which had to be specifically purchased for the amplifier. They will be seen from the valve tables to be capable of 69 watts under fixed grid bias, or 45 watts when used with cathode bias. The amplifier was to incorporate as many refinements as possible, with microphone or gram input. These refinements included negative feedback, and a fairly complex tone control, and so the circuit of Figs. 1a and b was developed.

Circuit

It will be seen that the first stage is a microphone amplifier, and the pick-up is fed, via a circuit to compensate for the drop in bass of the records, into the grid of the next stage.

Negative feedback is applied to V2, and may be either voltage feedback, from the anode of the following valve, or current feedback, which is achieved by omitting the bias decoupling condenser C10. A third position of the switch Sw1 decouples the cathode, and gives no negative feedback at all. The degrees of feedback obtained are approximately 8 and 16dB, with the switch in positions 1 and 2 respectively.

V3 is a twin triode, amplifying in cascade, the coupling between the two halves comprising an ambitious tone control circuit. The second half of the double valve feeds a paraphase amplifier, V4, which in turn feeds the two EL37's, operated in class AB1. The EL37 is a most attractive valve to use for high powers on account of its high efficiency, and relatively small physical dimensions. Unfortunately, like most high efficiency valves, it is rather prone to parasitic oscillation, and demands accurate matching of the anode load for maximum power output. With reasonable care, however, it is possible to make the final stage quite stable, and provided the loudspeaker load is matched with a transformer which will transfer the correct impedance, at least nominally, the output should be very near its maximum. If the final stage does oscillate, it will be noticed as a great reduction in power, and, if within the audible range, will be heard in the speaker. It may be argued that a



"reduction" in output would scarcely be detected by ear, when a total of 50 or so watts is available, and one cannot be expected to tell the difference between full power and three-quarter power when one has never heard what full power is like. Therefore a surer method of detecting parasitics will be suggested later.

of 100, which is not very difficult to attain with a high gain pentode, the signal input to V2 for full output will be 0.12 volts. As the average gramophone pick-up output is in the neighbourhood of a volt or more, this gives plenty of margin for offsetting the attenuation of R21 when used for bass characteristic compensation. And since

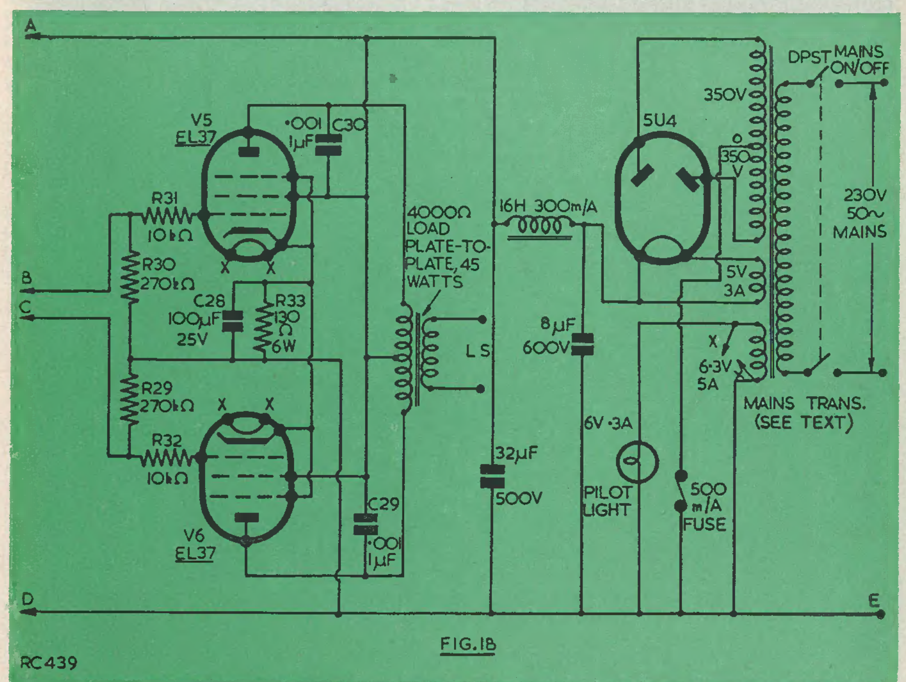


FIG.1B

Design

The input to the EL37's for full output under the conditions shown is about 60 volts signal from grid to grid. When used with fixed bias, this becomes about 70 volts. The gain of the phase splitter, V4, may be assumed to be about 1.8 times, so the required input to V4 under conditions of maximum output will be 40 volts. Since R25 is 10kΩ, only 1/11 of this voltage will appear across R23, and so V4 will not be overloaded. The voltage gain of the second half of V3 will be about 15 times, so the input to its grid must be 3 volts. It is necessary to allow for about 18dB attenuation in the tone control circuit, so the input to the first half of V3 must be about 1½ volts. It is also necessary to allow about 16dB loss for the negative feedback, and therefore the output from V2 will have to be about 12 volts. Hence, assuming V2 provides a gain the input from a microphone is of the order of 0.01 volts, the gain of V1 is considerably more than is necessary, and advantage could be taken of this by applying, as with V2, about 8dB of negative feedback by omitting C1.

Construction

The original amplifier was built into the cabinet of the TR9 transmitter-receiver, which is fairly easily available on the surplus market. It was decided that the normal operating position would be upright, with the sliding metal drawer at the top. This drawer should be cut off about 2″ down the sides, so as to leave only the top; then the sides may be bolted to the sides of the case, so that the drawer appears to be about ¼″ open. This forms an effective ventilator, as both the EL37's and the 5U4 rectifier produce a good deal of heat.

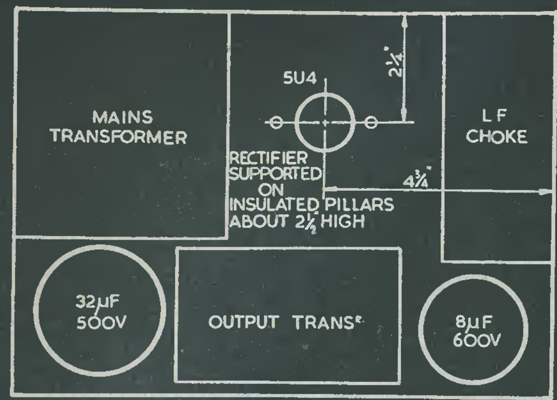


FIG.2

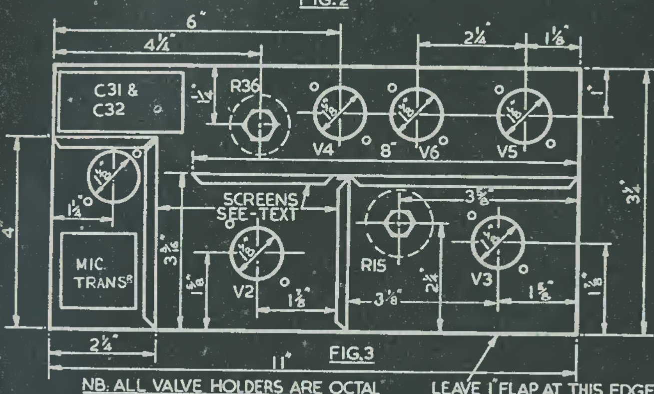


FIG.3

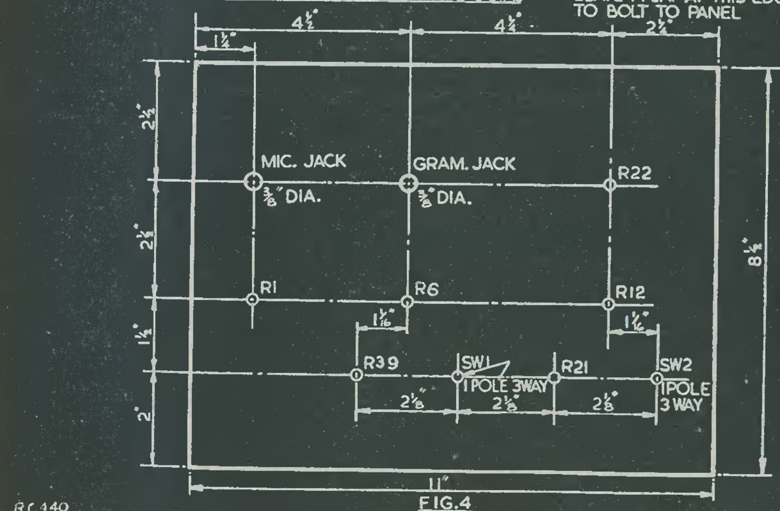


FIG.4

The amplifier was built into the top half of the case, and the power pack and output transformer were put at the bottom. Two separate panels were used, the upper one being bolted to the amplifier chassis, and the lower one merely bolted to tapped brackets at the side of the case, as the power pack was built directly into the bottom of the case without using a chassis. It is as well to put all the power pack components roughly in their positions before bolting any down, as the larger components may vary considerably in shape and size.

The original layout is shown in Fig. 2, and may be used as a rough guide. It should be noted that the 5U4 is supported on insulating pillars, about 2½″ high.

More care must be taken with the upper deck, of course, and considerable thought went into determining the best possible layout, which is shown from the top in Fig. 3. The view from the underneath of this chassis corresponds with the top view, and has screens which follow those on top, but are only 2″ deep, plus a ⅜″ flange for bolting down. The screens above the chassis are all 5″ deep. Space is very scarce, and the layout should be followed carefully. The chassis should be made of 18 swg aluminium, and the screens of 20 or 22 gauge aluminium, or better still of copper. It is then very convenient for use as a sort of continuous earthing strip. The rear edge of the chassis rests on the edge of the metal bar which runs across the TR9 case. This bar is best covered in felt to avoid stray rattles. Both the upper and lower panels were made of 18 gauge mild steel, but unless the constructor possesses an electric drill, it is easier to use aluminium. A drilling diagram is shown for the upper panel in Fig. 4.

A pilot light and mains switch were mounted on the original lower panel, with the mains plug and fuses at the side of the case, under a hinged metal cover. It is also desirable to cut a pair of ¼″ slots horizontally across the panel, to help with the ventilation.

It should be noticed that all the electrolytic decoupling condensers used were rated at 500 volts working.

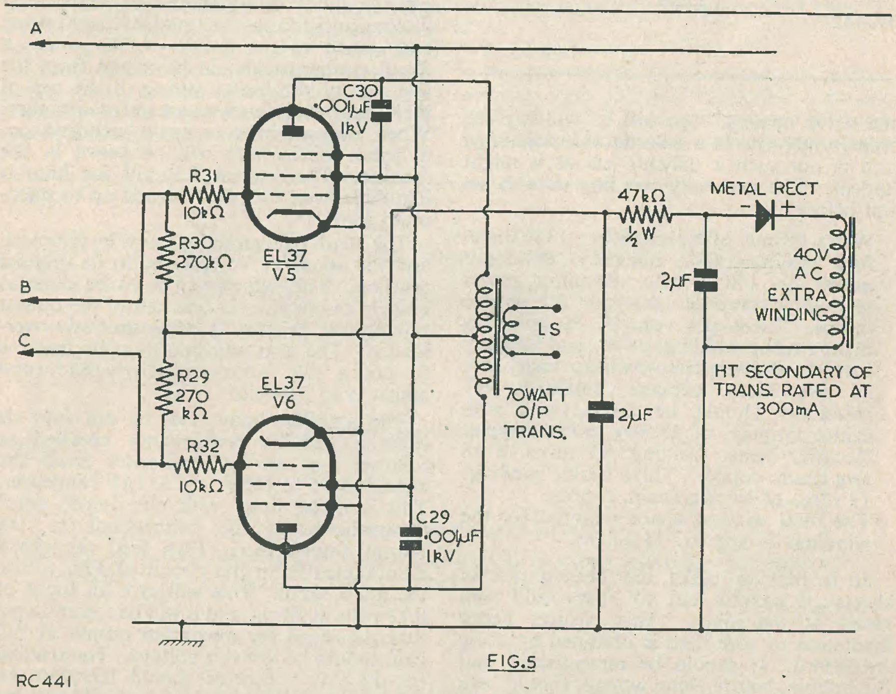


FIG.5

If the constructor feels that the full output of 69 watts is desirable, it is necessary to run the output stage with fixed bias. The modification necessary is shown in Fig. 5. A larger output transformer will also be needed, and a further winding giving 40 volts at about 15 mA will be needed on the mains transformer.

The mains transformer may either be bought, or wound at home. If bought, it should be rated at 350-0-350 volts at 250 mA (or, if it is proposed to run the EL37's under fixed bias, at 300 mA), also 5V 3A for the rectifier heater, and 6.3 volts 5A for

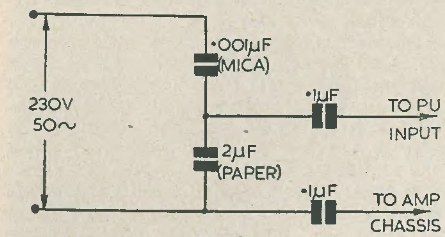


FIG.6

RC442

the valve heaters. The job of winding the transformer effects a considerable economy, and is not such a difficult job as it might appear. The necessary winding data is set out below:

Watts output of transformer: 134, therefore assuming 85% efficiency, the input power is 158 watts. Required cross section of core is therefore 2.7 square inches. Turns per volt=3. So primary turns (mains winding)=690, and primary current=0.7 Amperes, so wind primary with 24 swg enam. copper. Similarly, HT secondary should be 2,100 turns with centre tapping, of 28 swg enam. copper. Rectifier heater winding: 15 turns of 18 swg enam. copper. Valve heater winding: 19 turns of 16 swg enam. copper.
The total window space required for the windings is approx. 1½ *sq ins.*

It is best to make the bobbin out of sheets of paxolin cut to shape and well glued at the joints. This ensures better insulation to core than is obtained by using cardboard. It should be remembered that the bobbin, before being wound, should be a fairly loose fit on the laminations, as the weight of the wire will reduce the inside measurements considerably. The primary should be wound on first, then covered with either several layers of new greaseproof paper, or better still, a thin sheet of paxolin. A similar procedure should be adopted after the HT winding has been completed.

Testing

When finished, the power pack leads should be long enough to allow the amplifier to be tested outside its case. With no input to gram or mic., the amplifier should be switched on, and all the volume controls turned to maximum. Some hum will be audible, but at this output level a little hum is not normally noticed. It may be found that as the volume controls approach maximum, the amplifier becomes unstable. This indicates that either C4, 8, 15, or 16 is faulty, and should be replaced. Since these are expensive items, the instability may possibly be disregarded, as the amplifier will not normally be used at such a high level of gain, even though full power may be used. It is best to replace them if possible, though, as signals may tend to shock the amplifier into instability. However, assuming the amplifier gives every mute indication of being satisfactory, the push-pull stage may now be balanced. With the amplifier switched off, the anode of V5 should be temporarily disconnected from the output transformer, and joined to the anode of V6. Also, a .01μF condenser should be joined from the live side of the heater wiring to the top of R11. Both modifications are only temporary. When the amplifier is again switched on, a heavy mains hum will be heard in the speaker. Then adjust R36 till the hum is inaudible even with R11 turned up to maximum gain.

The .01μF condenser may now be removed, and the anode of V5 restored to its original position. This adjustment must be done as quickly as possible, as one half of the output transformer primary is being seriously overloaded. The next adjustment to be made is to put a DC voltmeter across R15, and adjust it to 3½ volts.

The amplifier may now be put into its cabinet, and its performance checked as follows: put an AC voltmeter from the anode of V5 to HT+, via a .1μF condenser. This can be done with the lower panel removed, using the connections to the output transformer. Then feed the signal as obtained from the circuit of Fig. 6 into the gram input. This will give an input of 0.12 volts at 50 c/s, and it will be remembered that the input for maximum output at full gain should be just this voltage. The reading on the AC voltmeter should therefore be about 210 volts. If it is not possible to get full power with this input, replace the 2μF condenser by a 1μF. The input will then be 0.24 volts. If this will not give full output, the conclusion is that the output stage is not working properly, and is probably oscillating. All being well, however, the amplifier is now ready for use.

The "UNIVERSAL" RADIOGRAM

A description by A. S. TORRANCE *of the second of the two units, each complete in themselves, which make up the complete TV-Radio-Gramophone home entertainment*

THE MOST DIFFICULT SITUATION that arose during the design of this instrument was the choice of a suitable record-changer.

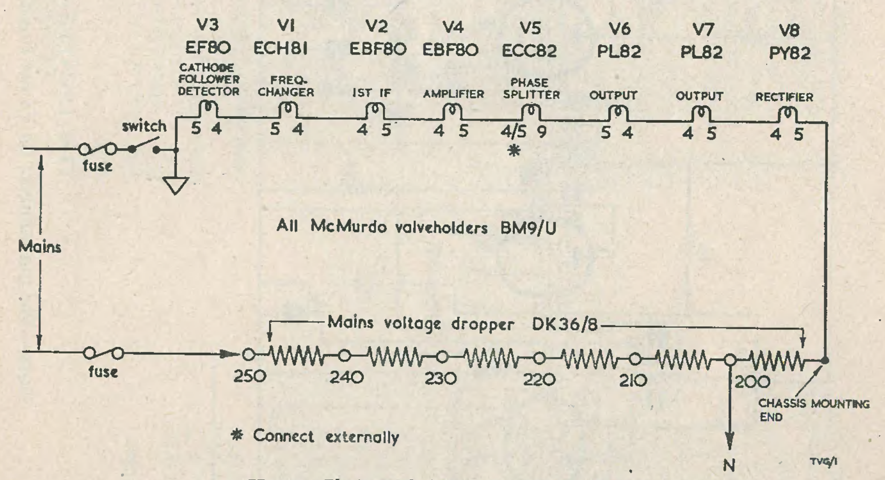
There are, of course, direct current types, but it is quite certain that the alternating current machines are more likely to have better regularity; and, too, the "Universal," the cabinets for which are essentially contemporary in their style of unit furniture, was planned for modern ideas embodying three speeds and efficient record-changing.

After careful consideration it was, therefore, decided to instal a pure AC type which would fulfil the above requirements.

The B.R.S. "Monarch" record player was the final choice. For those on DC mains, an oscillator/converter specially designed for this changer is obtainable at a moderate price. This instrument, besides having three speeds, will change records of inter-mixed sizes.

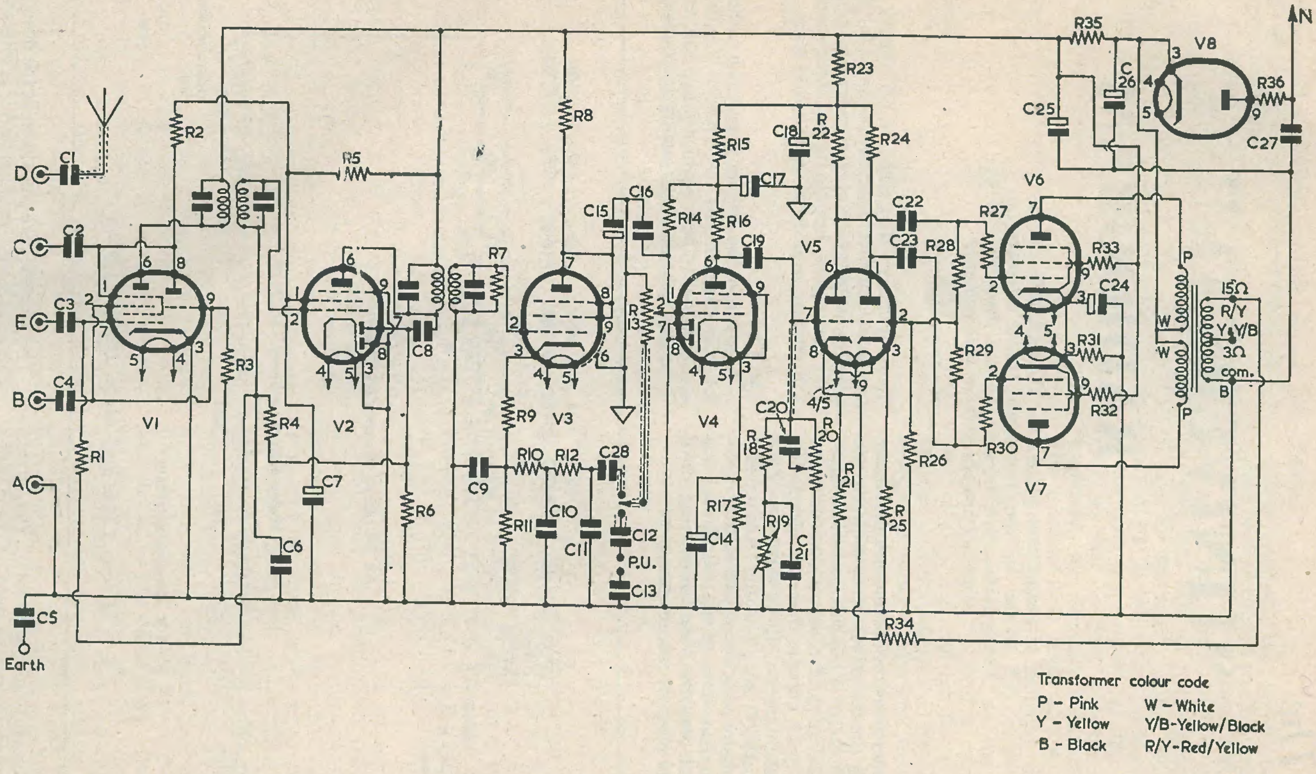
The Circuit

Apart from the infinite impedance cathode follower stage, this AC/DC receiver is entirely conventional. The stage mentioned will readily be seen as being a high quality arrangement.



Heater Chain and Mains Dropper Circuit

The greatest care was taken in the design to achieve accurate phasing, and it is interesting to note that the Goodmans 10″ elliptical speaker may be driven to its limits without



THE UNIVERSAL RADIOGRAM CIRCUIT

NOTE—The pin numbers on V1 are slightly incorrect; pin numbers 2 and 7 should be reversed.

COMPONENT LIST

Resistors. All Dubilier

R 1	1 MΩ, type BTS
R 2	10 kΩ, type BTS
R 3	47 kΩ, type BTS
R 4	1 MΩ, type BTS
R 5	22 kΩ 2W
R 6	3.3 MΩ, type BTS
R 7	220 kΩ, type BTS
R 8	47 kΩ, type BTS
R 9	22 kΩ, type BTS
R10	10 kΩ, type BTS
R11	10 kΩ, type BTS
R12	10 kΩ, type BTS
R13	2 MΩ with SP sw, type CP volume
R14	2.2 MΩ, type BTS
R15	47 kΩ, type BTS
R16	470 kΩ, type BTS
R17	4.7 kΩ, type BTS
R18	100kΩ, type BTS
R19	2 MΩ pot, tone, type CP
R20	2 MΩ pot, tone, type CP
R21	2.2 kΩ, type BTS
R22	100 kΩ, type BTS
R23	10 kΩ, type BTS
R24	100 kΩ, type BTS
R25	2.3 kΩ, type BTS
R26	220 kΩ, type BTS
R27	1 kΩ, type BTS
R28	220 kΩ ±2%, type R627
R29	270 kΩ ±2%, type R627
R30	1kΩ, type BTS
R31	100 Ω 1W, type BWF
R32	47 Ω 1W, type BWF
R33	47 Ω 1W, type BWF
R34	39kΩ, type BTS
R35	1 kΩ 2W, type R850
R36	20Ω 1W, type BWF

Condensers. All T.C.C.

C 1	250 pF, type SMWN
C 2	100 pF, type SMWN
C 3	100 pF, type SMWN
C 4	100 pF, type SMWN
C 5	0.01 μF 750VW, type 743
C 6	0.05 μF 350VW, type 343
C 7	8 μF } same can, type CE34PE
C15	8 μF } same can, type CE34PE
C 8	5 pF, ceramic
C 9	82 pF, ceramic
C10	82 pF, ceramic
C11	82 pF, ceramic
C12	0.1 μF 500VW, type 543
C13	0.1 μF 500VW, type 543
C14	100 μF, 6VW, type CE32A
C16	0.1 μF 500VW, type 543
C17	8μF } same can, type CE34PE
C18	8μF } same can, type CE34PE
C19	0.02 μF 500VW, type 543
C20	0.002 μF 500VW, type 543
C21	0.005 μF 500VW, type 543
C22	0.02 μF 500VW, type 543
C23	0.02 μF 500VW, type 543
C24	50 μF 25VW, type CE81C
C25	32 μF 350VW } same can, type CE27LE
C26	32 μF 350VW } same can, type CE27LE
C27	0.01 μF 750VW, type 743
C28	0.1 μF type 37N

Valves. All Mullard—see heater chain circuit

Speaker. Goodmans T32/61001/3

Output Transformer. Electrovoice 113D (H. L. Smith & Co. Ltd.)

Coil Turret. Type CT6U, Denco (Clacton) Ltd.

Chassis. Denco (Clacton) Ltd.

Heater Dropper. Goldsman DK36/8 distributed by Amplion Ltd.

Cabinet. Lasky's (Harrow Road) Ltd.

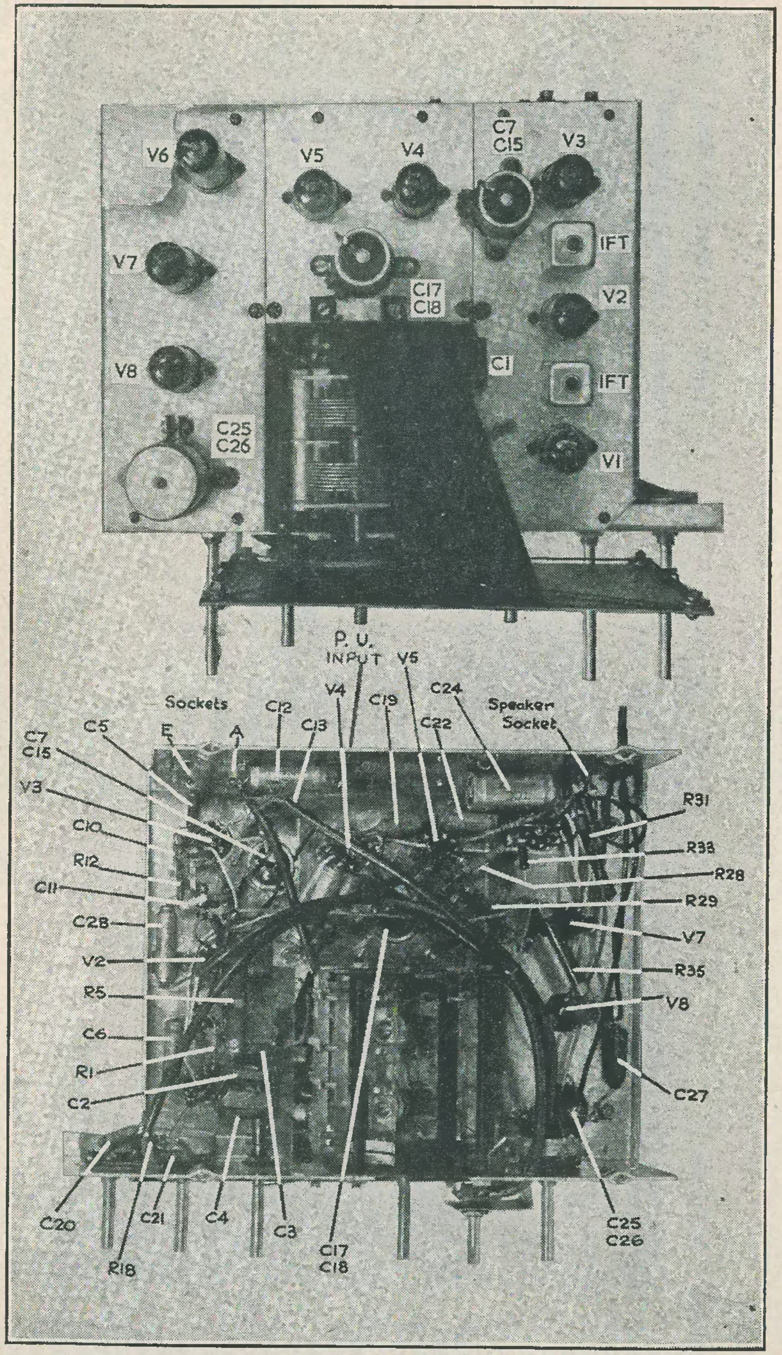
Knobs. Lasky's (Harrow Road) Ltd.

IF Transformers. 2, IFT11, Denco (Clacton) Ltd.

Oscillator/Converter. For use on DC, Fidelity Radio, London, W.11.

Radio/Gram Switch. Single-pole two-way rotary

Insulated Aerial plug and socket.
Insulated Earth plug and socket.
Insulated PU 2-pin plug and socket.
Insulated Speaker 4-pin plug and socket.
Grommets, solder tags, wire, sleeving, nuts,



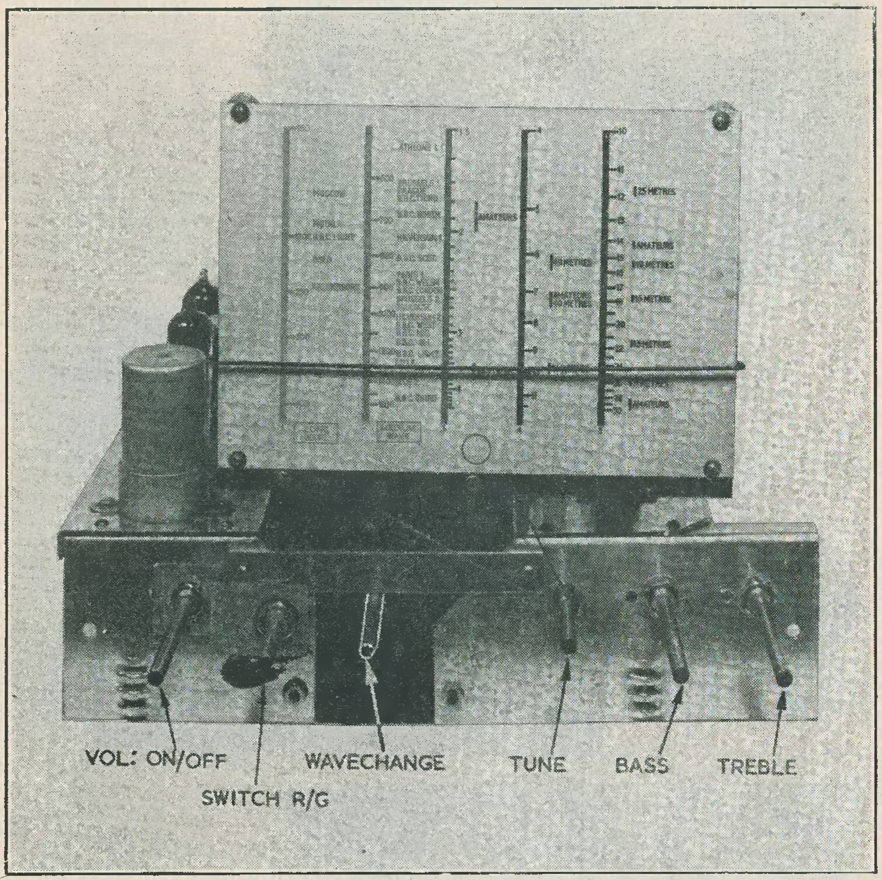
distortion, and with a degree of quality which has surprised many technicians.

Construction

The chassis is composed of five plates

General Wiring

This is best achieved by wiring up one stage at a time; the placement of components is helped by the illustrations, in which a great many resistors and condensers have been



Front view of chassis showing arrangement of the controls. On opposite page, two views showing location of main components

which are assembled around the turret (see photos.) This should occasion no difficulty and is, in fact, an obvious way of doing it.

When installing the valveholders, study the photograph of the underside and the circuit for their orientation. Thus, V1 will have pin 2 close to C3, and so on.

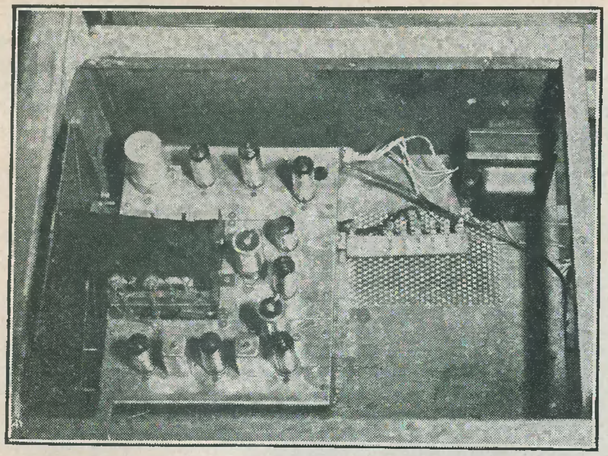
Heater Chain Wiring

This is completed as given in the circuit, and in the same order.

identified by their circuit numbers. The five screened connections may be put in last of all; standard TV co-ax is very suitable here.

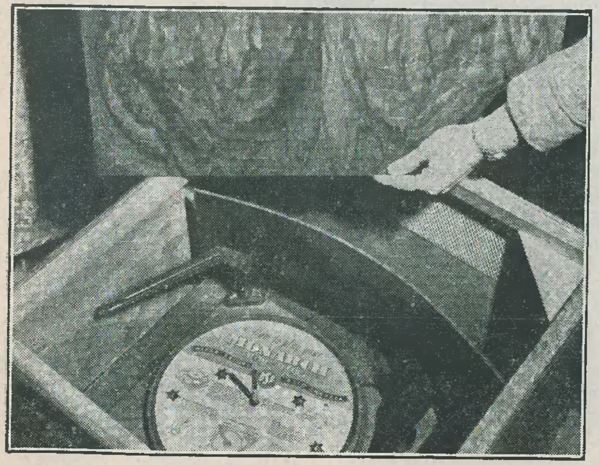
Mains Switching

Note that this is single-pole, and that it is the chassis side which is switched. This greatly assists in hum reduction. There may still be hum present if the mains plug is inserted incorrectly into its socket.



Chassis installed—showing disposition of the heater dropper and output transformer

Record Player installation, showing the woodwork which has to be removed. Note that this is effected from the top



The installation completed and the cabinet top about to be replaced

Radio/Gram Switching

A standard single-pole two-way rotary switch is attached to a small bracket on the chassis front (see photograph), and this is held into position by the bush nut on the volume control.

The leads from the switch enter the chassis via the usual grommet.

The Heater Dropper

This component will be seen mounted at the rear of the chassis. This is convenient during testing, but it develops a great deal of heat, and readers are advised to finally mount this component at the rear on an extension bracket, so removing the heat further from the chassis and at the same time enabling it to dissipate more rapidly.

Incidentally, there is plenty of room at the back of the cabinet for the oscillator/converter, if the latter is required.

Output Transformer

This can be seen in the illustration showing the chassis installation. A standard 5-pin connector is required for it; should any 'howling' be experienced, either the primary or the secondary connections should be reversed. This condition is known as "out of phase." Note that both the chassis and the output transformer require fixing bolts having countersunk heads.

Alignment

The coil turret and the IF transformers (465 kc/s) are pre-aligned before leaving the factory, but if any serious defect in tracking or response is experienced it would be advisable to have the receiver properly lined-up. Full alignment data is given in the literature supplied with each coil turret.

Installation into the Cabinet

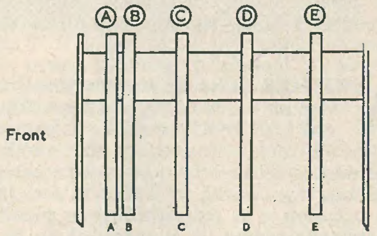
This procedure is illustrated by three photographs, and the sections to be removed may be clearly seen.

Remove the top, and then the four screws holding down the wooden support for the record player. Lay the cabinet on its side, and fix the speaker (with flexible leads attached) into position. Restore the upright position of the cabinet, and place the chassis in location with the spindle holes. Cut the spindles to the correct length, using the knobs as guides.

Fit the glass dial protection, and fix down the chassis using bolts as mentioned above.

On the underside of the record changer connect colour-coded leads to the PU solder tags and to the mains connecting wires (white), The latter should be heavily insulated. Check that the mains selector is correct.

Recesses are provided in the wooden top for the springs, which when fitted considerably lessen any "rumble" effects. The springs are held in position by nuts and large washers; one nut is threaded on first, then a washer, and then another nut used for locking. Two additional screw holes are provided, but these should be ignored. Adequate information for



Turret contacts. Note lettering of the contacts in sequence from front of turret

COIL TURRET TYPE C.T.6. TVG/3

its installation and operation is provided with each changer.

Rumble

If this effect is observed, a 500kΩ resistor should be soldered directly across the pick-up connecting tag strip on the underside of the record player.

No pilot lights have been incorporated in the circuit, but miniature mains bulbs are obtainable and may be added if required. On no account should bulbs be tapped into the circuit.

It is recommended that all literature appertaining to the "Universal" be placed into an envelope and pinned to the cabinet, so that it is available for any future servicing requirements.

Precautions

The remarks given in the TV section on safety measures are equally applicable to the radiogram unit, and should be observed at all times.

Remember that the "Monarch" record changer is designed for AC inputs only, and must not be directly connected to a DC supply.

Aerial

The aerial input is completely isolated from direct connection with the receiver. In some areas satisfactory results may be obtained from the TV co-ax braiding, but a proper and separate aerial is best for optimum results.

Radio Miscellany

ANOTHER R.S.G.B. EXHIBITION — the seventh — has come, and gone. There was little which could be categorised as "new", and a number of the standard lines and established favourites were absent. This was regrettable, as I like to feel that this occasion is as representative as possible of amateur radio. It is intended to be a public one, and at no time of the year is the hobby more in the public eye.

As always it was a great occasion for amateurs from widely separated regions to get together, and many must have found the visit worth while for this alone. David Godwin (? a newcomer to the amateur market) exhibited a range of separately available foundation units which can be assembled as a TVI-proof table-top transmitter. Unfortunately they kept the bottoms screwed on, so visitors were not able to see much of the "works." Panda Radio also had their "Table-Topper" on show, and also a new low-power rig, the "Panda Cub." This table-top emphasis is markedly symptomatic of the trend in recent years. In amateur design the formerly popular 6-foot-odd rack-and-panel seems to be increasingly falling out of favour. Also in the fashion were our old friends, E. J. Philpotts Ltd., who had a couple of 3-tier table-top racks on show, one fully enclosed. Now the housing situation is getting a little easier, it is curious that amateurs are anxious to squeeze their stations onto a corner of the dining-room instead of spreading it around a spare-room shack.

Home-made

The Amateur Constructors Section was of great interest, and some very elaborate apparatus was on view. Many visitors must have wondered whether all of it worked as well as it looked.

The standard of finish was extremely high and the marking of controls was of a high order. Modern transfers are most effective if carefully used. It wasn't many years ago that this column felt it necessary to urgently appeal for someone to market such transfers to fill a crying need! Despite the ambitious design and workmanlike construction, much of the gear was made "on the kitchen table." One or two of the cases had admittedly been to professional finishers for cellulosing, etc. The winning entries in the Ann Cup and Trophy Competition, held at Norwood a week earlier, were on show. I am told that they were then photographed, and it is hoped the pictures will appear in a future *Bulletin.*

Talking of Society affairs, most readers will already know that the resolution to increase the subscription rate has at last been approved. A north-westerly member insisted on telling me that there was some resentment in that area — not at the increase, of course, but at "dictatorial methods" and "suppression of divergent views." He blamed apathy among the general membership, and wanted to bet me that less than a thousand members would trouble to vote in the coming Council election. The result will be known soon after this appears in print. I didn't take him on. After all, in less controversial years, the percentage who have voted has always been small.

The Other Half

The problem of radio and TV pirates is always with us. Apparently it always will be. Hence I make no apology for returning to the subject again so soon, but why do they do it?

During the recent Lords debate the possibility of raising the licence fee up to a fiver was again mentioned. I guess it must have resolved many a pirate not to get his name on the books. Once you take out a licence you have to make a false statement in writing, or move, when it comes to renewal time.

What an enormous number they must still tot up to. During a recent detector van purge in the Brighton area, nearly 1,500 licences were taken out in four days. The normal *weekly* average for the district was only fifty licences.

Six hundred of them were for TV— much easier to "detect" than steam radio. Locating a TV is comparatively a simple matter — when the set is working. The magnetic field from the line scan can be picked up nearly a hundred feet away on the second harmonic — 20.25 kc/s. Even so, the ordinary radio pirates were still in the majority.

Centre Tap *talks about* R.S.G.B. Exhibition — More About Pirates—Ruggedization

Readers, like myself, who have come to regard sound broadcasting as old-fashioned (I have done practically no broadcast listening for four years now) must find it hard to believe that more ordinary radios than TV receivers are still being sold. This is proved by statistics; not culled from one of those Strange-But-True columns.

Is further proof needed that one half of the world knows next to nothing about how the other half lives?

Programmes

In the recent discussions on alternative TV programmes, a lot of people unqualified to publicly express any view did most of the talking. Much was made of the Horrible Example of American TV. Perhaps they haven't yet realised that many of the most popular programmes are American in origin and copyright. "What's my Line" is but one example.

Has anyone examined the question in reverse? What do the Americans think of *our* programmes? Those who I have asked think they are very dull, and a few were positively embarrassed by the patronising earnestness of our documentaries. They had, at least, seen both the best and the worst of both systems. On every 'bus you can meet people who will tell you all about American TV— and they have never left British shores! B.B.C. TV can be rank bad. Fancy asking our American friends to judge it by the recent serial "Place of Execution." One critic said it was gruesome, slapdash and imaginatively impoverished. He was being generous. It must have made every intelligent viewer squirm. And that was a Saturday night high-spot!

No one reasonably expects sparkle all the time. Nor is TV like a tap, ready to be switched on at any hour of the day or night. Programmes should be radiated at certain hours only — not continuously — and during those hours there should be one programme free from meddlesome busybodies. Like me, they don't know how the other half lives, and yet they would order other peoples' lives and plan their entertainment for them.

When one considers it, it is amazing that if even only one half of the population want an alternative TV source, an interfering minority still feel themselves entitled to prevent them from having it. One might almost image that viewers are going to be compelled to look in. As the soap-box orator said, "The day is at hand when everybody will be able to do as they like. And those who don't will be made to."

The Weak Spot

Readers of American periodicals will remember that some years ago much was made of new techniques in the ruggedization of valves. American terms are often expressive, but I never felt quite sure what was meant by "ruggedization." It might mean mechanical strength, new design reducing the amount of electrode welding or more rigid electrode construction. Expressive terms are not always self-explanatory. I remember a "W" Amateur, then a G.I., writing to tell me he had been alerted for rotation as soon as he was de-hospitalised. I put my own interpretation on it, just as I did with ruggedization.

Recently I have had the glass of no less than three B7G valves fracture within a month, making a total of five in all in the last year. Numerous other readers and friends have met with similar misfortune. The trouble seems to arise from contraction following cooling after switching off. At first I blamed the rigidity of the porcelain holders, until the trouble also occurred with the replacement paxolin-type holders.

Since then I have decided that it must be due to faults in the glass. It seems that only a small stress on tiny surface scratches or crevices is enough to result in a fracture after the valve has run hot. As the blame does not appear to rest on the holders, the weakness would seem to lie in the differential contraction of the envelope and the internal glass "pinch." The glass support and the envelope are, of course, welded together. A similar weakness in the glass-to-metal seals would also be a source of trouble. I have often heard the holders blamed for breaks of this nature, but in my own case, and no doubt in many more than commonly supposed, they can be absolved from responsibility.

The question has been of some concern to me as I have been gradually converting to the all-glass miniatures in recent years. Oddly enough, despite the vaunted ruggedization, the valves of American manufacture have been far more troublesome, both in my own case and in those in which I have been able to personally investigate. I am wondering how many other readers have kept a note of the makes of B7G-ers that have "feet of clay," and whether their experience matches up with mine.

Query Corner

A Radio Constructor Service for Readers

Art of Soldering

As a newcomer to the hobby of radio construction, I find difficulty in obtaining first-class soldered joints. Can you give me a few hints, please?

D. J. P., Slough

On a number of occasions we have received pleas from readers requesting us not to make the magazine too technical. This month, therefore, our selections from the postbag have been made with a view to helping those who are just starting.

Soldering is, itself, an art which has to be mastered if any degree of success is to be expected from a piece of newly-made equipment. There must be many constructors who, in their eagerness to complete and test the job, have paid insufficient attention to the soldering, only to be frustrated by a long and tedious fault-finding procedure. Dry joints are notoriously difficult to locate in a completely assembled receiver. First, then, let us consider the choice of the soldering iron. Its size, shape and weight will depend largely on the size of the parts to be joined, and, as most of the joints will be between a thin wire and, say, a valveholder tag, an iron having a pencil bit is most suitable. These are available from several manufacturers, and provision is made for the bit to be renewed after a long period of use. For the heavier jobs, however, these small irons do not provide sufficient heat, and if it is desired to solder leads or small screens directly to a chassis an appreciably larger iron will be needed. Thus the well-equipped workshop will have at least two held in readiness to meet most demands.

Before use an iron must be tinned; that is, the working surface of the bit must be coated with solder. This is essential if the required transfer of heat from the bit to the work is to be efficiently achieved. If the bit is dirty, or the iron new, tinning is done by switching on the iron and allowing it to reach its working temperature, then running a file a number of times over the working surface of the bit so that the bright copper is revealed. At this stage a resin-cored solder is applied quickly to the bit before it has had time to oxidise; if necessary, the blob of solder can be spread by wiping it with a cloth. Once an iron has been tinned it should not require further attention for a considerable period of time.

Now let us turn our attention to the work in hand and proceed to make a few solder joints. The first is to connect a piece of tinned copper wire to a tag on a valveholder. Providing the tag is clean and bright and perfectly free from grease, the copper wire may be passed through the hole and pinched back with a pair of pliers. This ensures a good mechanical anchorage and prevents the parts moving whilst being soldered. Next, hold the end of a length of flux-cored solder on the joint and apply the iron, removing the solder immediately sufficient has melted. The iron is held in position long enough to ensure that the solder runs freely over the joint. The wire should not be moved until the solder has completely solidified, otherwise a dry joint will occur.

The success of soldering depends mainly upon having the parts clean, and if either the wire or the tags of the valveholder were tarnished, or greasy, a doubtful connection would have been made. Grease may be removed by wiping away with a cloth dipped in methylated spirits. Dirt is removed from wire with the aid of a piece of emery cloth. Tags are best cleaned by scraping with a sharp tool; it is not sufficient merely to produce a few scratches on the metal — the whole area to be covered with solder must be cleaned. If the solder behaves rather like a spot of water on a greasy plate, it is a sure indication that the surface needs cleaning. Remember that on a good joint the solder will have flowed freely into all the crevices, and will solidify with a smooth surface.

The foregoing procedure applies when an electric iron is used with a flux-cored solder; if a flame-heated iron is employed the procedure differs only in one respect. As the iron is removed from the flame it is touched in a tin of resin or other suitable flux before being applied to the work. This removes any oxidisation which may have formed.

Cabinet Resonance

My recently-constructed radiogram is giving good results but for a rather annoying distortion which occurs on some of the lower notes. I have had the speaker examined, and I now believe the trouble is due to cabinet resonance. What can I do to prevent this effect?

D. Connolly, Leeds

Cabinet resonance can produce a form of blurring on certain notes, usually in the lower register. When designing a cabinet the trouble can be minimised by employing a wide but shallow form. When applying corrective measures, however, steps must be taken to damp out the resonance. Some improvement can usually be obtained by lining the inside walls of the cabinet with an accoustically dead material, such as ½" thick felt or Celotex board. If further improvement is required, as much of the bottom of the cabinet should be cut away as possible and a number of holes cut in the sides. These holes should be covered with material of a fine gauge to prevent the ingress of dust.

Locating Faulty Valves

When servicing a receiver which had low sensitivity, I suspected that one of the valves had low emission. Is there a quick check which can be made to ascertain whether or not the valves are functioning correctly?

F. W. Williams, Catford

Yes, the operating cathode current of each valve is a guide to its efficiency, and it may be measured without breaking the circuit if the following procedure is adopted. First take the universal test meter and measure the resistance between the valve cathode and chassis (cathode bias resistor), then switch on the receiver and, after it has warmed up, measure the voltage between cathode and chassis. These two readings will enable the cathode current in milliamperes to be calculated by Ohms Law, by dividing the voltage by the current and multiplying by 1000. If, now, the data on the valve in question is referred to, it will be possible to find out whether it be passing the calculated current at the measured bias. Providing the results are within 20 per cent it can be assumed that the valve is functioning correctly; if, however, a wider deviation is found the remainder of the electrode voltages (screen and anode) should be checked, and if found in order the valve must be suspected of being faulty. In this case it should be tested and replaced.

This checking procedure is a simple one and can be quickly applied to each stage in turn. It is, of course, of great assistance if a circuit diagram of the receiver is available, as it provides a ready check for bias and screen resistor values.

If a valve is operated in a resistance/capacity coupled stage its cathode current will be low, most probably in the region of 1 mA. This is a useful figure to bear in mind, as R-C amplifier operating conditions are seldom included in the valve-maker's abridged published data sheets.

Query Corner

RULES

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

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

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

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

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

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

TRADE REVIEW

The Teletron Co., of 266 Nightingale Road, London, N.9., have favoured us with a sample of their Crystal Transformer Coil type HAX, designed for Medium Wave coverage with a crystal detector.

This very fine and compact transformer has been specially designed for use with a Germanium diode. Being triple wound, it provides a high signal output together with maximum selectivity and minimum damping of the tuned circuit. The Q of this transformer is 100, with a gain of 33. A standard Aladdin type former is used, complete with dust-iron core, and it is fitted with a paxolin tag panel—altogether a very fine job which performed extremely well in a prototype receiver constructed by us. The price is 3/–, and it may be obtained direct from the manufacturer at the above address.

The

ORPHEUS

TAPE RECORDER

PART 2

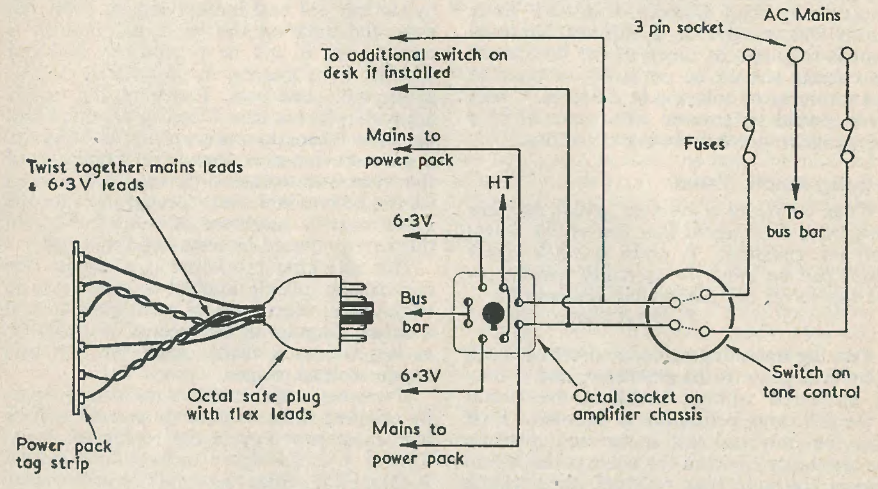
Described by A. S. TORRANCE

TOGETHER WITH THE PHOTOGRAPHS seen last month, the diagrams in this issue will give readers a clear understanding of the general layout.

As has been previously stated, simplicity is the keynote of this design, but the performance will still please most people. There is nothing, of course, to prevent the more advanced constructor from elaborating according to his taste and his pocket.

The tone control will be seen to be really an attenuator of the upper frequencies. in the February 1953 issue of this magazine, a limited number of copies of which are still available.

Many readers will already possess high fidelity amplifiers. In their case a switch could be added to the junction of C3 and C6, and the playback signal taken from the radio/gram input socket direct to the external amplifier. The design of a new and suitable external amplifier has been made available to us by The General Electric Co. Ltd., and it is hoped to publish this at an early date.



Octal plug & socket McMurdo C8/USP — L8/USS

SCHEMATIC ARRANGEMENT OF POWER CONNECTIONS

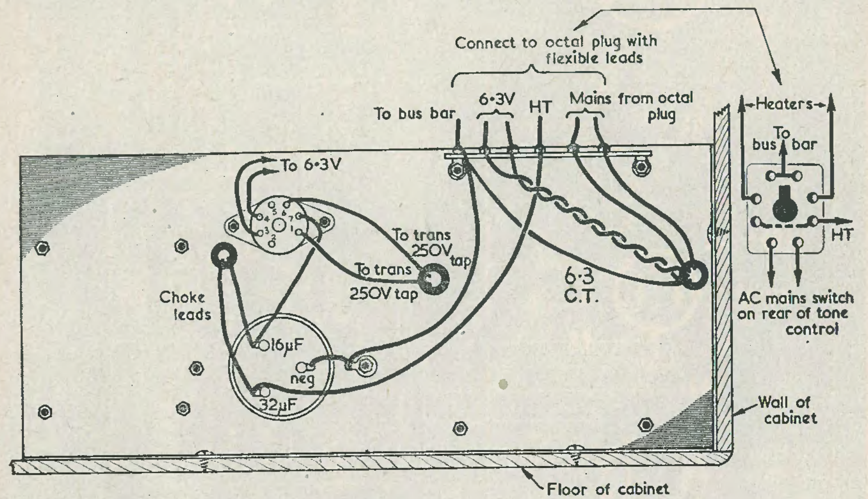
Should something more ambitious here be required, the reader is referred to the book *Tape and Wire Recording*; a really comprehensive tone control system was published

The Circuit

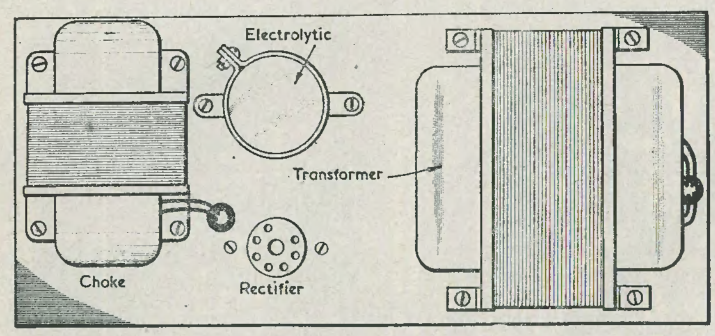
Both the recording head and microphone are used with V1 and so make use of the additional gain obtainable from this stage.

C3 couples the anode of V1 to the tone and volume controls. Condenser C7 with a fixed grid leak was added to prevent undue loss of high frequencies. All the grid resistors are soldered directly to their respective grid pins, to avoid self-oscillation.

feedback, as such, has been incorporated, although a measure of such feedback is obtained by omitting the cathode bypass condenser in the output stage. However, under some circumstances additional gain may be required, hence the inclusion of this



UNDERSIDE



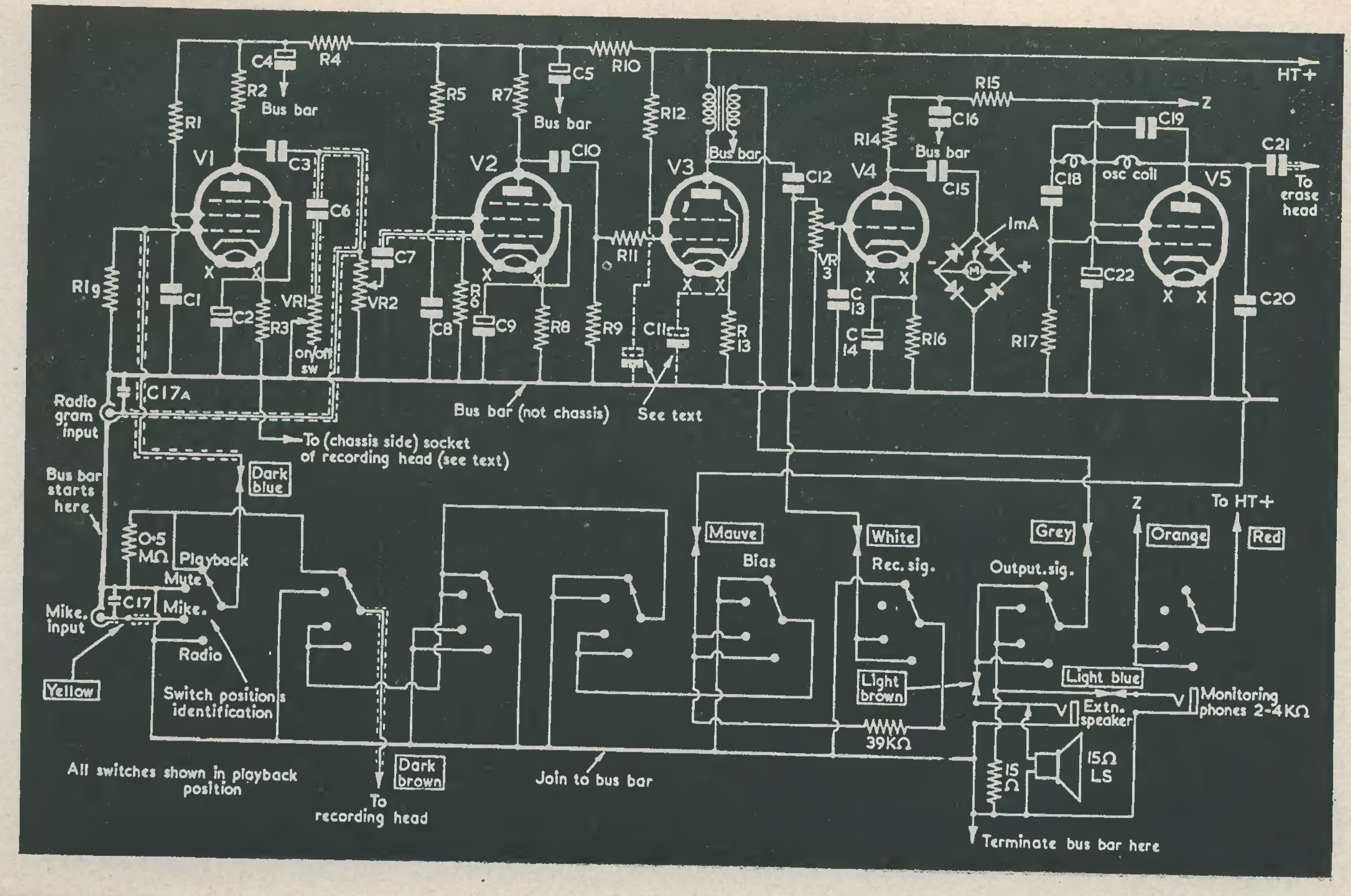
TOP VIEW

POWER PACK DETAILS

Radio and gram inputs, which are normally of an adequate strength, are fed into the grid of V2. A radio input utilising a germanium diode, such as that described in *Tape and Wire Recording*, may be plugged into V1.

V2 feeds into the output stage. No negative condenser is left as a matter of personal choice, and it is shown dotted in the circuit diagram.

The screen decoupling condenser (8 μF) is also optional, but its inclusion was found to give slightly improved results.



The speaker transformer output is taken to the switch where various listening requirements may be obtained, such as headphone monitoring. In the "mute" position, a dummy load (15Ω) effectively protects V3 from damage should no normal load be present.

From the junction of C12 and the switch, the feedline for the level meter circuit is taken to V4. Correct polarity of the meter and the rectifier must be observed.

V5 is the bias oscillator, and has an output in the region of 37 kc/s. C20 couples the bias to the recording head, and the 39 kΩ resistor on the switch provides as constant a load as possible for the output valve.

C17 and C17a greatly reduce unwanted effects at the input sockets when in the "playback" position, and are attached at these points.

Switching

The wiring of complicated switches is always a confusing task. Fortunately, this switch is obtainable assembled and ready-wired with colour coded leads, and the resistors (shown with values marked) are included. The switch positions read, from left to right: Radio/Gram; Mic; Mute; and Playback.

The use of a high quality external speaker is recommended where possible, and the

COMPONENT LIST

Condensers. All T.C.C.

C 1	0.25μF, type CP48N
C 2	50μF, type CE32B
C 3	0.1μF, type CP37N
C 4, 5	16-16μF, type CE35PE
C 6	0.005μF, type SMWN
C 7	0.1μF, type CP37N
C 8	0.25μF, type CP48N
C 9	50μF, type CE32B
C10	0.1μF, type CP37N
C11	50μF, type CE32B (see text)
C12	0.25μF, type CP48N
C13	2000pF, type CTH310
C14	50μF, type CE32B
C15	0.1μF, type CP37N
C16	0.1μF, type CP37N
C17	1000pF, type CTH310
C17a	1000pF, type CTH310
C18, 19, 20	Each 0.002μF silver mica matched, supplied by Trusound with osc. coil
C21	0.1μF, type CP37N
C22	16μF, type CE91LE
Power Pack, 32-16μF, type CE27PE	

Resistors. All Dubilier.

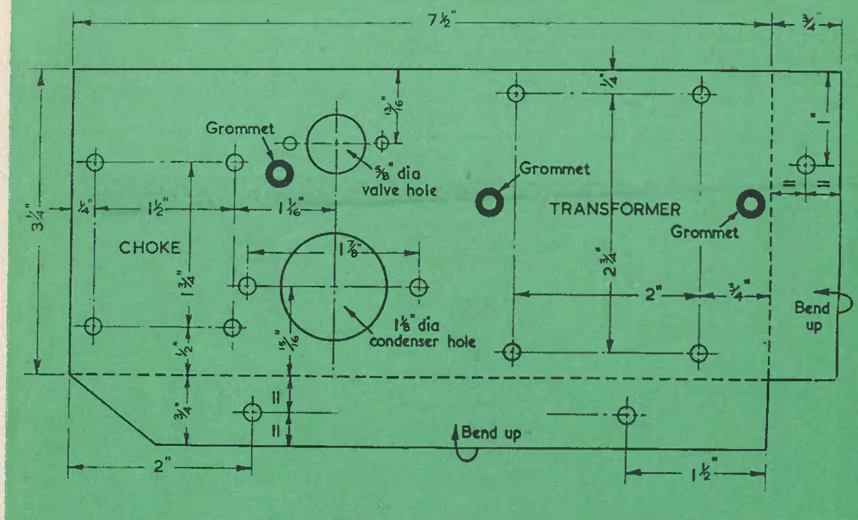
R 1	1MΩ, type BTS
R1g	1MΩ, type BTS
R 2	220kΩ, type BTS
R 3	2.2kΩ, type BTS
R 4	47kΩ, type BTS
R 5	1MΩ, type BTS
R 6	470kΩ, type BTS
R 7	220kΩ, type BTS
R 8	2.2kΩ, type BTS
R 9	470kΩ, type BTS
R10	22kΩ, type BTS
R11	22kΩ, type BTS
R12	1kΩ, type BTS
R13	120Ω, type BTS
R14	47kΩ, type BTS
R15	47kΩ, type BTS
R16	2.2kΩ, type BTS
R17	100kΩ, type BTS
VR1	1MΩ with D/P switch, Tone
VR2	500kΩ, Volume
VR3	1MΩ Meter Balance

Resistors on switch supplied by makers of switch (Trusound Ltd.)

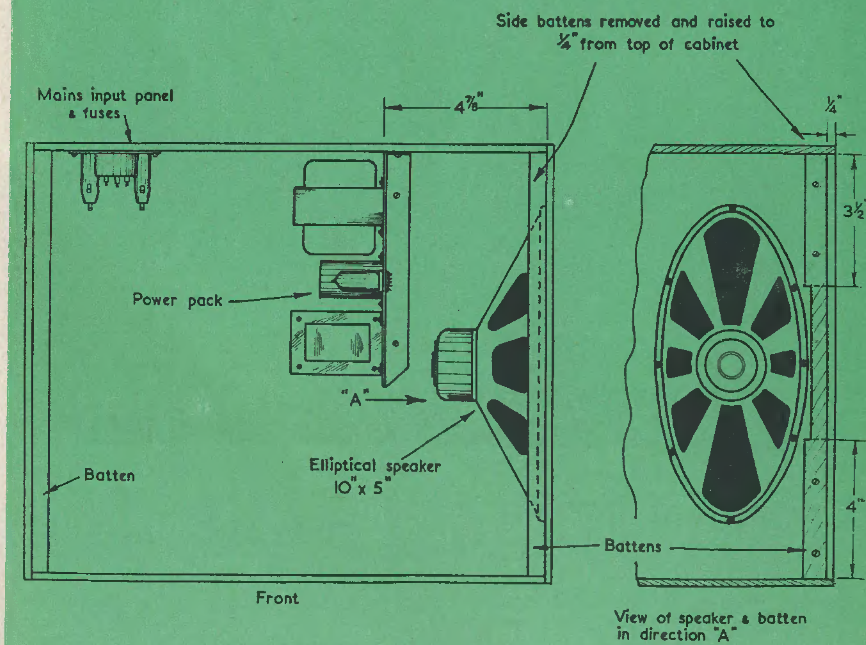
Valves. All Osram		**Valveholders** All Mc'Murdo
V1	Z729	XM9/UG1 with No. 7 can
V2	Z729	
V3	N727	BM7/UB1
V4	L77	BM7/UB1
V5	N727	BM7/UB1
Rect.	U78	BM7U

Miscellaneous

1 mA Meter Rectifier, Westinghouse
Speaker, Goodmans T47/61001/15
Output Transformer, Goodmans T74/7000/15
Microphone, Goodmans Z33 high impedance
Meter, 0-1mA, 2" with square face
Mains Transformer, Electro-Voice 104A
Smoothing Choke, Electro-Voice 101C
Fuseholders, 2, Bulgin F55
Tape Deck, Trusound Ltd.
Cabinet, Trusound Ltd.
Oscillator Coil, Trusound Ltd.
Oscillator Condensers, Trusound Ltd.
Selector Switch, Trusound Ltd.
Octal Plug & Socket, Mc'Murdo
Co-ax Plugs and Sockets, 2
Jacks and Plugs, Igranic, 2
Chassis, Aluminium for.
Pilot Lamp Holder and 6.3V Bulb
14swg Tinned Copper Wire and Co-ax Cable
3-pin Mains Socket
Grilles for speaker and vent holes
Paxolin for mains input panel
Tag Strips and Panels



POWER PACK CHASSIS DIMENSIONS



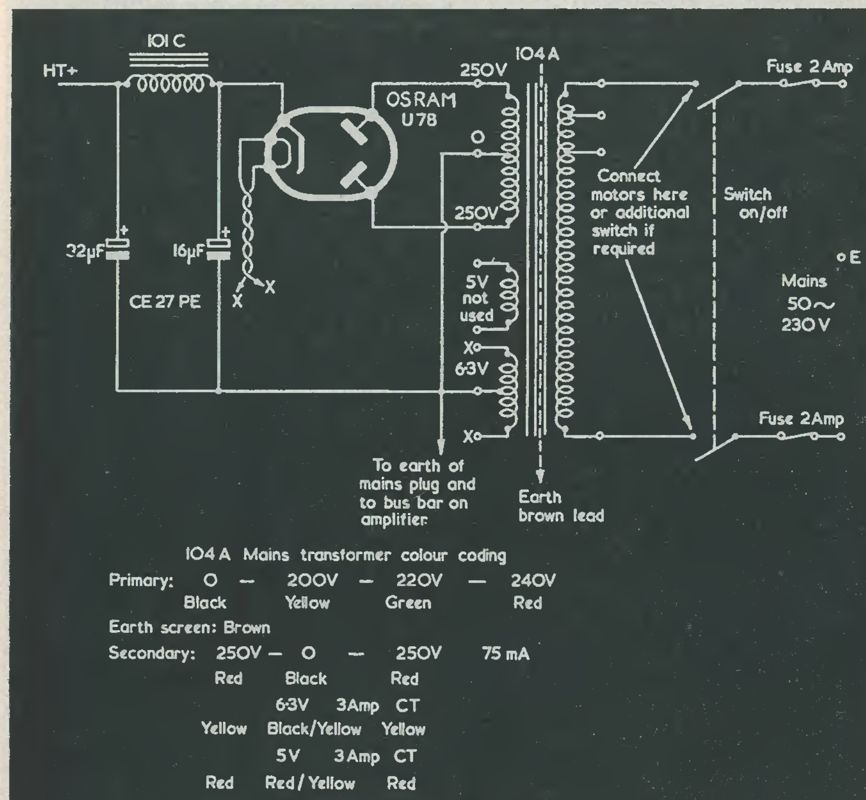
INTERIOR LAYOUT OF CABINET

insertion of the Igranic jack-plug will automatically cut out the internal speaker.

The Power Pack

The sketches and wiring details are comprehensive and provide complete construction details. Note in the circuit diagram that the HT supply to both the bias oscillator and directly to the switch on the amplifier chassis, the earth lead to the bus-bar.

From here the mains are fed to the octal socket for supply to the power pack, and if required (strongly recommended) an additional toggle switch for isolating the motors. In this way a most useful amplifier



POWER—PACK CIRCUIT.

the level meter valve is switched out in the "playback" position.

Mains Connections

The order of mains connection is as shown in the sketch. The input is brought in to a panel at the back of the cabinet. From the fuses and the earth pin of the 3-pin mains socket, 3-way flex (rubber or PVC) is taken is available for other purposes than recording if required.

There is, of course, a "stop" position on the tape deck, but this control works by applying a DC potential to the motors, and must not be left "on" for an indefinite period; it should be used merely for braking purposes.

[*To be continued*]

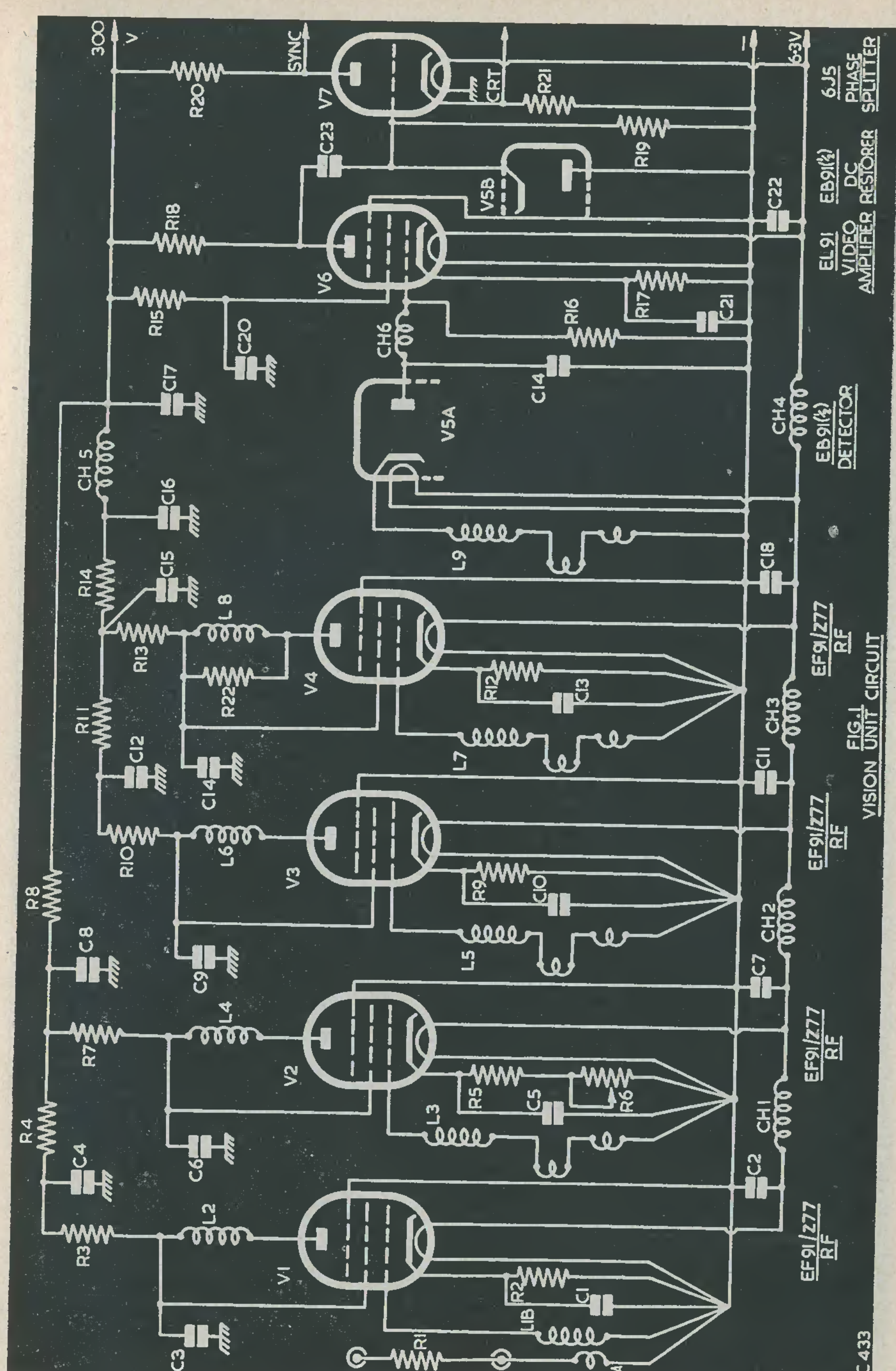


FIG. 1 VISION UNIT CIRCUIT

FRINGE AREA TELEVISION

By **J. GLAZER**

PART 1: THE VISION UNIT

When dealing with the problem of fringe area television, the constructor is always up against the battle between gain and quality. One way to increase the gain of a vision unit is to peak all the coils. Unfortunately, this causes the bandwidth to narrow, and the picture definition consequently suffers. Another way to increase the gain is to use more valves, but there is a limit to this because of the undesirable increase in valve "noise" which produces a background "mush." A superhet undoubtedly gives better gain than a TRF unit, but there are extra construction and alignment difficulties. However, by using four tuned-anode, tuned-grid stages a TRF vision unit gives excellent gain without impairing the picture definition to any noticeable degree.

Component List

R1	68Ω
R2, 5, 9, 12, 17	220Ω
R3, 10, 16	4.7kΩ
R4, 11	1kΩ
R8, 14	3.3kΩ
R7, 13, 21	5.6kΩ
R6	10kΩ wire-wound variable (contrast)
R15	15kΩ
R18	6.8kΩ 1 watt
R19	1MΩ
R20, 22	10kΩ

All resistors ¼watt except where stated.

C1, 3, 5, 6, 9, 10, 13, 14	0.001μF ceramic or mica
C2, 4, 7, 8, 11, 12, 15, 16, 17, 18	500pF mica discs
C19	15pF ceramic cup
C20, 21	0.002μF ceramic or mica
C23	0.1μF non-inductive paper tubular 350V wkg.
V1, 2, 3, 4	EF91 or Z77
V5	EB91 or D77
V6	EL91
V7	6J5GT all metal valve

Reference to the circuit diagram shows the four RF stages with the tuned-anode, tuned-grid arrangement, employing nine tuned coils. The earthy ends of the grid coils are tightly coupled to the HT ends of the previous anode coils. The tight coupling, and the damping of L8, ensures sufficient bandwidth for good definition. The four RF valves are EF91's, and although Z77's work quite as well, the coils have to be altered to suit, as their inter-electrode capacitances are slightly higher than that of the EF91 valves.

The screen grids and anodes of all four RF valves are decoupled with 0.001μF capacitors. These can be obtained in the ceramic tubular type (not paper) as these save more space than the mica variety. The HT lines of the first two RF stages are fed separately from the last two, so as to miminise the risk of instability. The HT lines are decoupled at regular intervals with 500pF mica disc capacitors, as are the valve heaters. The cathode bias resistors are 200Ω, and are decoupled with 0.001μF capacitors; the contrast control being a 10kΩ variable resistor in the cathode of the second RF valve.

The diode detector, which is half of an EB91, is the last tuned stage. As the input capacitance is only 3pF, as compared with the 7pF of the EF91's, this tuned coil (L9) needs more turns than the usual grid coil. The negative signal is fed to the grid of the video amplifier via a suitable RF filter. The use of a 3 Mc/s boost choke at this point was found to give much better results than as a part of the anode load of the video amplifier. An EL91 miniature output valve gives excellent results as a video amplifier because it can handle a large grid voltage swing and gives quite an appreciable output. The grid leak of this valve, 4.7kΩ, and the anode load, 6.8kΩ, were found to be the best values for giving a good balance between definition and gain. The 220Ω cathode resistor and the 15kΩ screen resistor are decoupled by 0.002μF capacitors which give

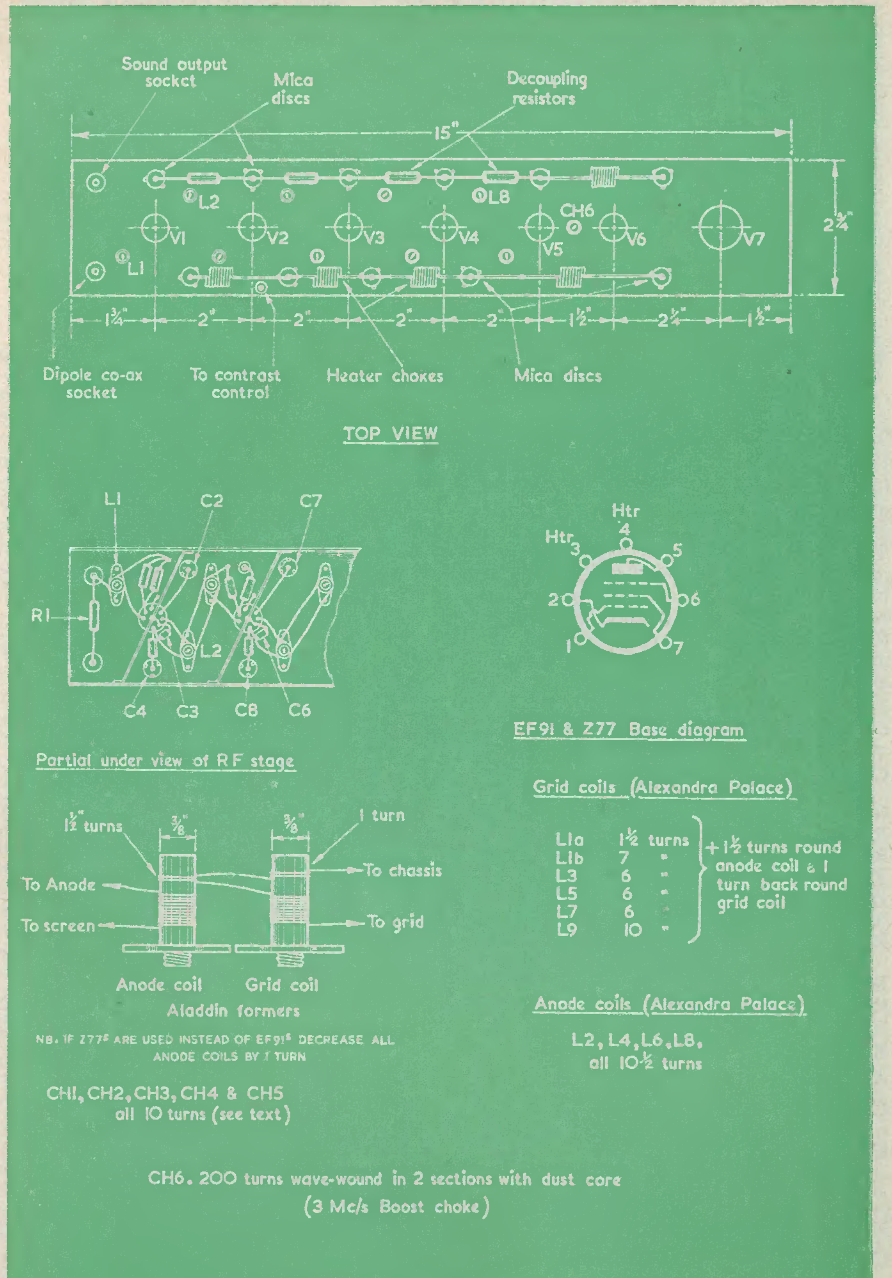


FIG. 2. VISION UNIT – CONSTRUCTIONAL DETAILS

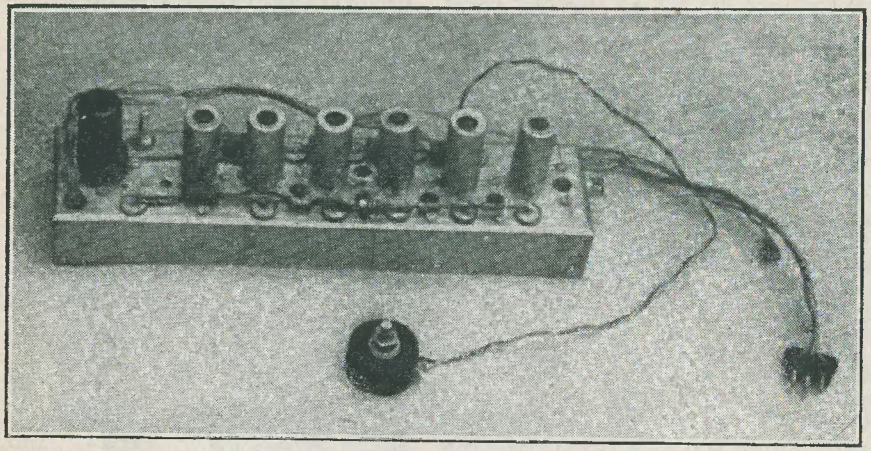
boost to the frequencies around 2.5 Mc/s.

Although the grid of the video amplifier is driven negative, it is not advisable to decrease the cathode resistor below 220Ω; as, although this will increase the gain, the anode current will also increase considerably, as the signal ceases. This extra current is liable to burn out the anode load resistor, which is already of the 1 watt variety. The video signal is passed on to the phase-splitting stage, via a 0.1μF capacitor, to be separated for feeding the CRT and syncronising separator. Because of the 0.1μF coupling capacitor, the DC content of the picture is lost (the video signal must not be amplified or applied to the CRT if it has lost its DC content, or the definition will be seriously affected). The DC content of the signal is restored by the other half of the EB91. The phase-splitting valve is a 6J5, the only international octal valve in the unit, all the others being B7G glass-button miniatures. The CRT is fed with a positive pulse from the cathode of the 6J5, and the sync separator from the anode. The total anode current of the vision unit is between 55 and 65 mA, with an HT voltage of 250-300 volts.

The sound unit is fed directly from the dipole television aerial (the writer's television aerial was a folded dipole, with director and reflector), rather than from a stage in the vision unit, so that none of the vision coils have to cover the 41.5 Mc/s sound channel, and this makes unnecessary the use of sound rejectors. The writer's vision unit was found to be exceptionally clear from car ignition interference, and the use of an interference suppressor on the vision unit was thought unnecessary.

Construction

The vision unit chassis is made of tinplate (aluminium being next to useless because of bad connections through not being able to solder directly on to an aluminium chassis).



The Vision Unit described in this article

The chassis is 15" long by 2¾" wide, and 1½" deep. The four RF B7G valveholders have a diameter of ⅝" and are spaced 2" apart along the chassis centre line. Mica disc capacitors are soldered through ⅜" holes up each side of the chassis: six on the HT decoupling side, and five on the heater decoupling side. The decoupling resistors and chokes are mounted outside, on top of the chassis. This gives more room for components inside, and less chance of feedback. The position of the coil tuning holes, which are ⅜" in diameter, are as in the diagram, diagonally in line with the valveholders. Four tinplate screens are soldered diagonally across each of the four RF valveholders, and one across the double diode valveholder.

The coils are wound on *Aladdin* formers of ⅜" diameter with 34 gauge cotton-covered copper wire. The anode coils are wound first in a clock-wise direction, looking from the flange end, and the turns are fixed into position with *Durofix*. These coils are fastened into the chassis with self-tapping screws which make their removal (if necessary) quite easy. The ends of the anode coils are soldered direct to the screen and anode tags of the B7G valveholders. The grid coils are then wound, leaving 3-4 inches of wire at the top — earthy end. These coils are then placed into position and the grid end is soldered to its respective grid tag. The spare wire is then wound round the top — HT — end of the preceding anode coil for 1½ turns, then back again around the grid coil for another 1 turn as in the diagram. This end is then earthed at the same point as the cathode decoupling capacitor and bias resistor. The one HT and the four heater decoupling chokes are wound on ¼" diameter rod (standard pencil) with 21 gauge, plastic-covered copper wire, and consist of 10 turns and made self-supporting. The writer found that single-point earthing was not necessary, but connected grid and cathode decoupling components on one side of the valveholder and screen, to the chassis, and the anode and screen decoupling components on the other side of the screen to the chassis. There was no sign of instability, even when all the coils were peaked and the contrast control was at maximum gain.

Alignment

As most constructors do not possess an accurate signal generator, capable of reaching 45 Mc/s, the best method of alignment is by the BBC transmission. The vision unit is disconnected from the timebase chassis, the sound unit and the CRT. The aerial is then connected, and a pair of high resistance headphones in series with a 0.1μF capacitor is placed between the anode of the 6J5 valve and chassis. With the contrast-control turned to maximum gain, car ignition interference should be heard in the phones. Adjustment of the iron dust cores will bring in the vision signal, which sounds somewhat like mains hum. The iron dust cores should then be adjusted for maximum sound. The headphones should then be removed and the vision unit connected to the rest of the television receiver. A fair picture should present itself on the CRT screen. The iron-dust cores should be adjusted for maximum brilliance (i.e., peaked) using the contrast control so as not to overload the video stage. It might be necessary to adjust the turns on some of the coils, but it must be remembered that half a turn makes quite a lot of difference at 45 Mc/s. If a coil needs a turn added, it is advisable to rewind the complete coil, rather than attempt to add a piece more wire, as this last can seriously reduce the "Q" of the coil.

Having peaked all the coils, unscrew all the dust cores of the anode coils L2, L4, L6, and L8 about one turn. This increases the bandwidth and boosts the higher frequency response, which in turn gives sharpness to the picture. If the constructor finds he has plenty of gain, damping the anode coils with 10kΩ resistors will help to increase the bandwidth. Finally, the 3 Mc/s boost choke should be adjusted for maximum picture definition.

The most common fault with this type of receiver is instability, which can be caused by dry or bad joints in the RF section, especially at the earthing points. Open circuit or leaky capacitors will also cause the receiver to go unstable, which shows itself as dark bands about ½" wide travelling vertically down the CRT screen. Another fault is a negative picture; this is due to the diode detector and/or video amplifier being overloaded. If this occurs and the picture, when it is positive, is weak, the fault will probably be found after the diode detector.

[To be continued

LEICESTER RADIO SOCIETY

At the Annual General Meeting of the Leicester Radio Society, held in the Club Room, Holly Bush Hotel, Belgrave Gate, Leicester on 7th December, the following officers were elected to serve the society during the coming year.

President, L. Ridgeway (G2RI); Chairman, R. Frisby (G2CFC); Hon. Secretary, N. Wibberley, Hon. Treasurer, D. Hoff (G3AVM).

Committee Messrs. MacQueen (G3DVP), Chapman (3AFZ) Tranmere, Baker (8HA) and Pennistone (G3GVK).

The Contests Officer, and Publicity Officer, Mr. M. Storey (G4BB) and C. L. Wright (G3CCA) respectively were automatically returned to serve the society again.

Three entries from the listener members of the society for the "Thomas Trophy" (presented by Capt. Thomas (G2CUR) are being examined by a special committee.

The Hon. Treasurer reported that the society's finances were in a very good "solvent" state, in spite of the fact that a large sum had been paid out to cover RSGB Field Day activities.

After the official business had been completed a talk was given to the members on the "Radio Amateur Emergency Network."

Meetings are now held every alternate Monday commencing at 7.30 p.m., during January the dates are 4th and 18th, and during February 1st and 15th.

Important Event An all Transistor transmitter has been built by the Society's Publicity Officer, and lectures will be given entitled "Transistors and the Amateur Transmitter." Part one will deal with the basic theory and part two with practical applications. During part two, demonstrations of transistor applications will be given.

CHESTER AND DISTRICT AMATEUR RADIO SOCIETY

Hon. Secretary N. RICHARDSON

Club Report for January 1954 *by* G3ITY

We begin the new year with activities on top band and on 80m, with our new low power TX. The HQ Station call is G3GIZ, which for the information of visitors has its QTH at the Tarron Hut, Y.M.C.A., Chester. Meetings of the C&DARS are held every Tuesday of each week at the latter address, with Morse practice and lectures of general interest to all in radio.

The Club and its members took an active part in many of the Contests through the year of 1953, improving its score all round, and is hoping to do better this new year.

Would-be members are reminded that R.A.E. lectures are held at the club on the first and third Tuesdays of every month, and are free to all. These lectures will continue till the eve of the R.A.E. this year.

Let's Get Started

8: AMPLIFIERS, AGAIN!

By A. BLACKBURN

MANY readers, particularly the newcomers to radio, may have wondered just why particular values of components are chosen for specific purposes. They may have wondered why, for example, the anode load of an LF amplifier is normally 20 kΩ or more, when the anode load of a television video valve is seldom greater than 5 kΩ. Most of the theory underlying the operation of any circuit has been expressed mathematically, but in many cases the maths involved are of a formidable nature. Few people to whom radio is a hobby would be inclined to tackle the subject from this angle. However, it is possible to predict with a fair degree of accuracy the performance of an amplifier without too much mental somersaulting.

The major requirements of an AF amplifier can be listed as: sufficient gain for the purpose in mind; sufficient power output; as little harmonic distortion as possible; and a bandwidth capable of dealing with all frequencies present in the signal. With battery operated amplifiers a further important consideration is high efficiency.

Gain and Distortion

When designing an amplifier, the best plan is to start from the output valve and work back to the input. First, choose an output valve which will deliver the power required. Do not confuse anode dissipation with power output — they are different quantities which will be explained later. Having decided which valve to use, you will now need to know the input voltage required to drive the valve for full power output. One way is to use the load line. This is a graphical method of determining the correct operating conditions, based on the anode-voltage/anode-current curves for the valve.

An elementary valve circuit is shown in Fig. 1b. The *anode* voltage (*not* the HT voltage) depends upon (1) the current flowing through the valve and (2) the value of the load resistor. For example, if the HT were 250 volts, $R_L = 20\,k\Omega$, and $I_a = 5$ mA, the voltage developed across R_L would be

$$V = I_a R_L = \frac{5}{1000} \times \frac{20{,}000}{1} = 100 \text{ volts.}$$

If this voltage is lost across the anode load, then the voltage at the anode will be the HT voltage less 100V, which in this case is 250 – 100 = 150 volts. Furthermore, because the current flowing through the valve depends upon the bias voltage V_g, the anode voltage fluctuates with the signal applied to the grid.

In Fig. 1a we have a family of graphs which relate the three quantities in which we are interested, i.e. I_a, V_a and V_g.

Suppose we have a valve which we wish to use in an AF amplifier. In order to avoid distortion the valve must be operated under the correct conditions. First fix the HT voltage, making sure that it is not greater than the maximum value recommended by the manufacturer. The voltage decided upon is marked at point A on the graph in Fig. 2. If the valve is of the power type, the optimum anode load will probably be supplied in the manufacturer's data, and this should be used to calculate the second point on the graph. This is calculated on the assumption that, under the influence of the grid, the valve continues to pass increasing current until the anode falls to earth potential. Such a thing is, of course, a practical impossibility, but surprisingly enough it does not affect the ultimate result!

If the anode is at earth potential, the whole HT voltage must be across R_L and the current through it will be $I_a = \frac{V_a}{R_L}$. This point is plotted at **B** on the graph. **A** and **B** are connected as shown, and the resultant line is called the load line. It will be noticed that it cuts all the anode-current/anode-voltage lines, each of which represents a definite grid voltage. If the grid were biased to –4V and a signal of 8V peak-to-peak value were applied to the grid, the total signal excursion would be from –8V to 0 volts, swinging, as it were, about the bias voltage. This excursion is represented on the load line by that part of the line lying between the points C and D. The signal, drawn dotted, shows the full 8V excursion. It can now be seen exactly what the anode voltage swing for the grid swing will be by reading off the voltages at the extremes of the signal. In this case the voltages are 200 and 100. The anode swing is therefore 100V, and the

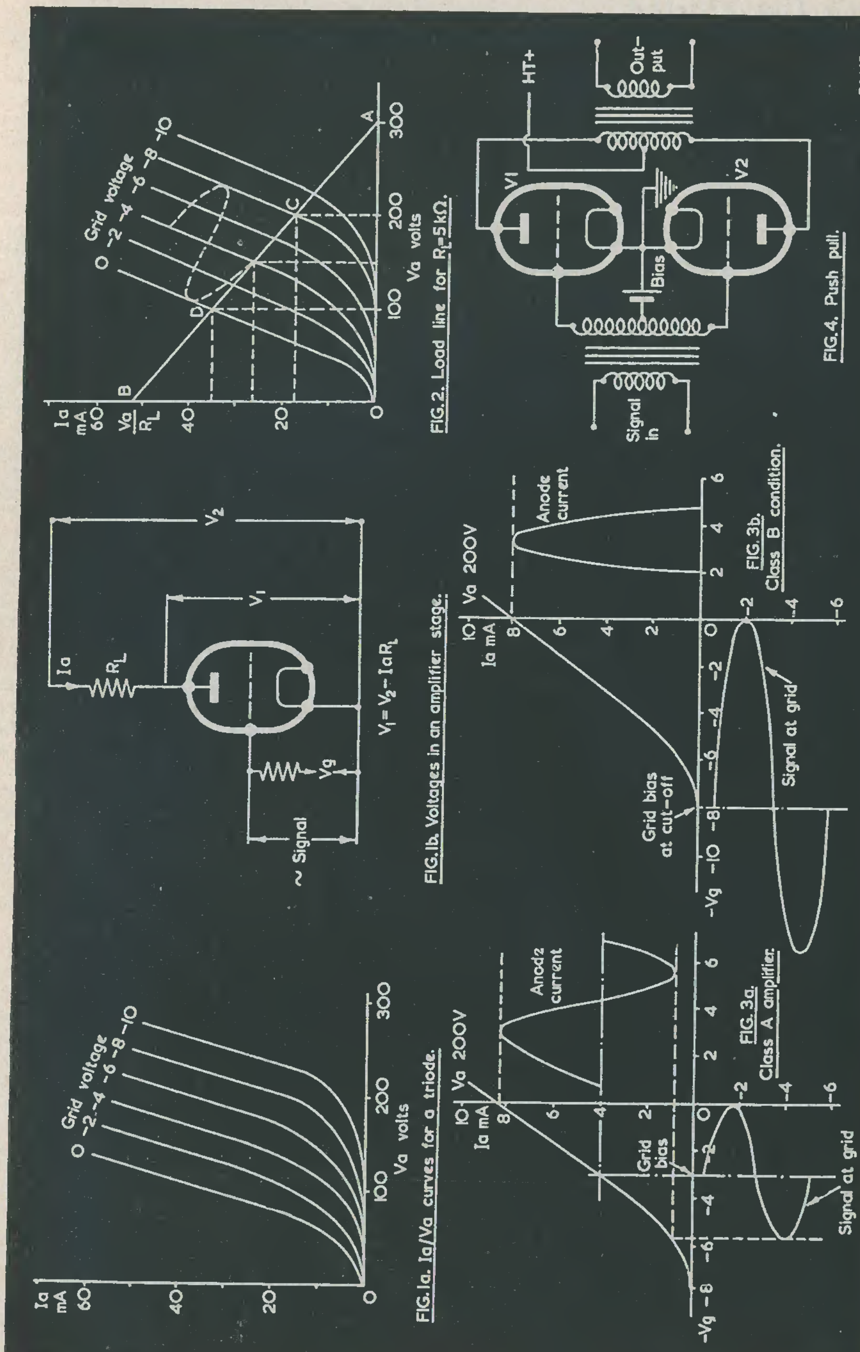


FIG.1a. Ia/Va curves for a triode.

FIG.1b. Voltages in an amplifier stage.

FIG.2. Load line for R_L=5kΩ.

FIG.3a. Class A amplifier.

FIG.3b. Class B condition.

FIG.4. Push pull.

grid swing 8V, which gives the gain as $\frac{100}{8}=12.5$. The power output can be computed from the anode voltage swing and the current swing. The latter is 35 – 16=19 mA. The power output is calculated from the expression:

$$\text{Power in watts} = \frac{(\text{voltage swing})\times(\text{current swing in mA})}{8000}$$

$$=\frac{100\times19}{8000}$$

$$=.25 \text{ watts approx.}$$

The plate load is, of course,

$$\frac{V_a}{I_a}=\frac{250\times1000}{50}=5000\,\Omega$$

Often the HT voltage is known and it is required to calculate the anode load to give a definite gain. To do this, the point A is fixed as before and with a ruler pivoted on this point a number of trial lines drawn until the required gain is achieved. Point B, obtained from the intersection of the load line and the I_a axis of the graph, gives the load resistance.

Providing that the peak-to-peak signal at the grid never exceeds the two I_a/E_a curves chosen (D and C), the amplifier will be working under the correct conditions. The grid bias is always chosen, of course, to be the middle value, in this case –4V; i.e. half-way between 0 and –8 volts.

Excess of signal voltage over the determined value results in distortion. The grid will be driven positive over part of the cycle and part of the input waveform will be clipped. This is because the grid acts as a diode when it becomes positive with respect to the cathode. Consequently, the grid conducts, or passes current, and the waveform is distorted. On the other hand, if the signal drives the grid too negative over part of the cycle, the valve will be cut off, that is, there will be no current flowing. Under these circumstances, the anode waveform can bear no relation to the input waveform because the grid has no control over the anode.

Operation of the valve under the correct conditions, obtained from the load line, is called 'class A' operation. It can be shown that the maximum efficiency obtainable under this condition is 50%. Efficiency is defined as the audio power output divided by the DC power input. For 50% efficiency, therefore, the DC power provided by the power supply must be twice the power output. In practice, efficiencies of 25–30% are normal. The question of efficiency is particularly important when battery operation is considered. It is obviously an advantage to get as much out of the amplifier as possible for the longest battery life. Considerable improvement can be obtained by the use of 'class B' operation.

Class B and Push-Pull

The theoretical maximum efficiency of a class B stage is nearly 80%, which is a worthwhile improvement over the 50% for class A. Unfortunately, other problems are involved which tend to offset this advantage.

Basically, class B operation is obtained by using a grid bias voltage large enough to cut off the valve. From what I have said about class A operation, it will be clear that distortion will occur because any part of the signal waveform attempting to drive the grid more negative than the bias will not be reproduced at the anode.

Fig. 3a shows how a signal appears at the anode in a comparatively undistorted form under class A conditions. Fig. 3b shows how biasing the valve to cut-off distorts the waveform.

Reproduction would be almost unintelligible from a stage of this sort, but the circuit shown in Fig. 4 gives good quality reproduction. This arrangement is called 'push-pull'.

At any instant the signal at one end of the input transformer is going positive as the other end is going negative. The grids connected to the transformer are, of course, following these potentials. Supposing that V_1 in Fig. 4 is going positive, and V_2 negative, the positive-going grid of V_1 will produce an output at its anode similar to that shown in Fig. 3b. However, the negative-going grid of V_2 can produce no output at its anode because the grid is being driven far beyond cut-off. Half a cycle later the conditions will reverse and V_2 will begin to go positive and V_1 negative. There will now be no output from V_1, but V_2 will produce an output similar to that of V_1 half a cycle before. The two outputs are combined in the output transformer and the signal at the secondary will be relatively undistorted.

Push-pull output stages are not necessarily used under class B conditions. When class A push-pull stages are used, the output from the two valves is somewhat greater than twice the output from each valve alone, and the quality of reproduction can be very good.

Frequency Response

Ideally, an audio amplifier should reproduce every frequency in the audio spectrum with the same amplitude. That is to say, the gain of the amplifier should be the same at all frequencies. This presents one of the greatest problems to designers, and many ways have been devised to improve the frequency response of amplifiers.

Generally speaking, the problem is split into two separate parts. One is obtaining good response to high frequency, and the other obtaining good response at low frequencies. Let us consider high frequencies first. The circuit shown in Fig. 5a is a typical resistance-capacity-coupled voltage amplifier. The dotted capacitors represent the inter-electrode capacities of the valves. These 'invisible components' are unavoidable, as all the electrodes in the valve must have some capacity to all the others.

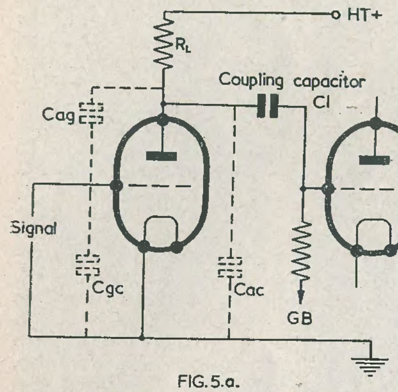


FIG. 5.a.
R.C. coupled stage with stray capacities.

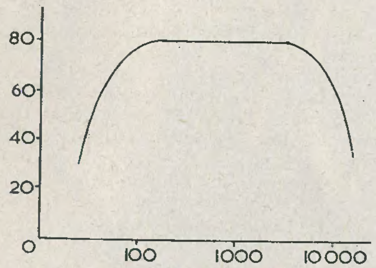


FIG. 5b.
Frequency response of A.F amplifier.

RC446

You may remember that in an earlier article it was shown that as far as the signal is concerned, the HT line and earth are at the same potential; the HT and earth are so connected together in Fig. 5a. Clearly then, the anode to cathode capacity C_{ac} is in parallel with R_L, the anode load. If we ignore the coupling capacitor C_1 for a moment, the grid to cathode capacity of V_2 is also in parallel with R_L. The total capacity is therefore $C_{ac}+C_{gc}$. The reactance, or apparent resistance to an alternating current, varies with the frequency. The reactance is calculated from the simple formula

$$\text{Reactance in ohms} = \frac{10^{12}}{2\pi fc}$$

where f = frequency in c/s
c = capacity in pF.

This expression shows that as the frequency *increases* the reactance *decreases*. The resultant anode load will therefore tend to decrease with increasing frequency because the anode load consists of the resistor R_L and the capacities in parallel.

The gain will also decrease because its value is dependent upon the value of the anode load. Normally at 1 kc/s the capacities have a reactance that is at least five times the value of R_L. At 10 kc/s, however, they will equal R_L and the anode load will be halved. For example, if R_L is 200 kΩ, the reactance of $C_{ac}+C_{gc}$ will be 2 MΩ at 1 kc/s, and the resultant anode load is 180 kΩ, but at 10 kc/s the reactance of $C_{ac}+C_{gc}$ will be 200 kΩ, and the resultant anode load 100 kΩ. The gain of the stage will therefore be at 10 kc/s one half its value at 1 kc/s. High notes in the signal will therefore suffer.

At the low frequency end, C_1 is the troublesome component. The same reasons apply as before, but now the capacitor is in series with the signal, so to speak, and not in parallel. Remembering that the reactance of a capacitor does the opposite to the frequency, the reactance of C_1 will rise as the frequency falls. The effective coupling of the signal from the anode of V_1 to the grid of V_2 will decrease with the frequency, and the signal passed to the grid of V_2 will also be less.

From this you can see that bass notes and high notes are likely to get lost in the amplifier. Improvement of the bass, i.e. the lower frequencies, is brought about by making C_1 as large as possible. High frequency response is not so easily dealt with, because the capacities are inherent in the valves themselves. An important point to watch in this respect is that the wiring between stages also adds to the capacity alarmingly, and should therefore be kept as short as possible and well away from the chassis.

The problem of extending the high frequency response of an amplifier becomes particularly acute in television. The vision signal contains frequencies up to 3 Mc/s, and the video amplifier must therefore be capable of reproducing such frequencies reasonably accurately. We have already seen that the reactance of the shunt capacities of the stage (C_{gc} and C_{ac}) becomes less as the frequency rises, until eventually the reactance and anode load have the same value. Increasing the frequency further will make the reactances less than the plate load, of course, and the gain of the stage will drop accordingly. If the plate load were made a low value, say 5 kΩ, then the frequency at which the reactances would become equal to 5 kΩ, would be higher than for a plate load of, say, 100 kΩ. For example, if R_L were 100 kΩ and the gain of the stage dropped to one half its maximum value at 15 kc/s, making R_L 5 kΩ would make the gain drop to half its maximum value at $15\times\frac{100}{5}=300$ kc/s, i.e. 15 kc/s multiplied by the ratio of the two values of R_L. The inevitable snag is, of course, that if the maximum gain with $R_L=100$ kΩ were 200 times, with $R_L=5$ kΩ it would only be approximately 10 times. In other words, band width can only be obtained at the expense of gain.

Choice of Valves

The choice of valves in amplifiers is conditioned by a number of factors. Pentodes can generally produce higher gains than triodes, but it is usually considered that their harmonic distortion is higher than triodes. Pentodes or beam tetrodes are almost invariably used for output stages. Voltage amplifying stages generally consist of pentodes also, because of their high gain feature. An effect known as 'Miller effect' is particularly noticeable in triodes. You may have noticed that in Fig. 5a no mention has been made of C_{ag}. This capacity can be very troublesome because the input capacity C_{gc} is increased by C_{ag} multiplied by the gain of the valve. For example, in a triode with capacities $C_{gc}=2.5$ pF, $C_{ag}=2$ pF, and gain 100, the total grid-to-cathode capacity is $2.5\text{ pF}+100\times2\text{ pF}$, which is 202.5 pF. In a pentode, C_{ag} is seldom more than .01 pF; the input capacity here, with everything else as before, would be $2.5\text{ pF}+100\times.01\text{ pF}=3.5$ pF. Better bandwidth and higher gains are therefore available with pentodes, but the harmonic distortion may be greater.

Design

Briefly, to summarise what has gone before, the method of designing an audio amplifier consists of a number of steps, as follows:

First choose an output valve to deliver the required power output or, for push-pull, half the required output. The manufacturer's data will tell you the grid bias, HT voltage, and optimum load. The output transformer ratio is calculated from the expression:

$$\text{Ratio} = \sqrt{\frac{\text{Optimum load}}{\text{Speaker speech-coil impedance}}}$$

Doubling the value of the grid bias value gives the approximate peak-to-peak signal voltage to produce maximum power. This voltage must be produced at the anode of the previous stage, so that, having chosen a valve, it can be designed from the load line. Another stage to drive this one can then be designed, and so on, until the point is reached where the required input voltage corresponds to the maximum output of the pick-up or microphone to be used with the amplifier.

Often the limiting factor in amplifier design, a poor output transformer can have a ruinous effect — no matter how good the amplifier. A transformer having a large core and the secondary interwound with the primary gives the best frequency response.

Other Improvements

Another means of improving the performance in modern amplifiers is to use negative feedback. Briefly this consists of feeding part of the output signal back to the input. The phase of the fed-back signal is arranged to be out of phase with the input signal. Negative feedback can be applied over the whole amplifier or merely to individual stages. The gain of the stage is reduced when feedback is employed, but considerable improvement in quality can be obtained. Space does not admit of a complete explanation here, which must be deferred to a later date when the subject can be covered in more detail.

HIGH STABILITY VHF MIXER/OSCILLATOR—*cont. from p.* 309

L3 for maximum hiss on the receiver. Now trim the oscillator trimmer with the tuning condenser set at half mesh. (This *must* be done with an insulated trimming tool). These oscillator trimming adjustments must, of course, be done with an aerial connected, either via a pre-amp or coupled direct to the mixer input. Once the band has been located it is only a matter of patience and slight adjustments to the trimmer to obtain coverage of the complete band on the tuner. Use a good slow-motion dial with no backlash.

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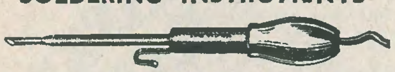

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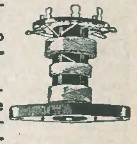

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[continued on page 363

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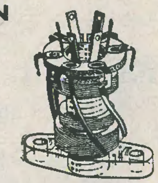

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continued from page 361]

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