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The RADIO CONSTRUCTOR

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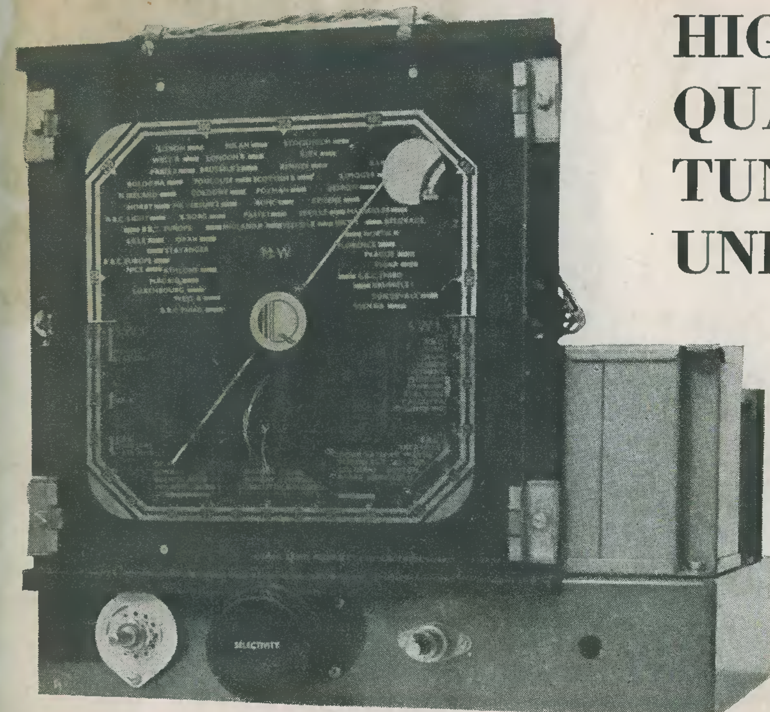
for the Radio and Television Enthusiast



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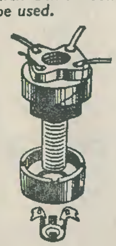

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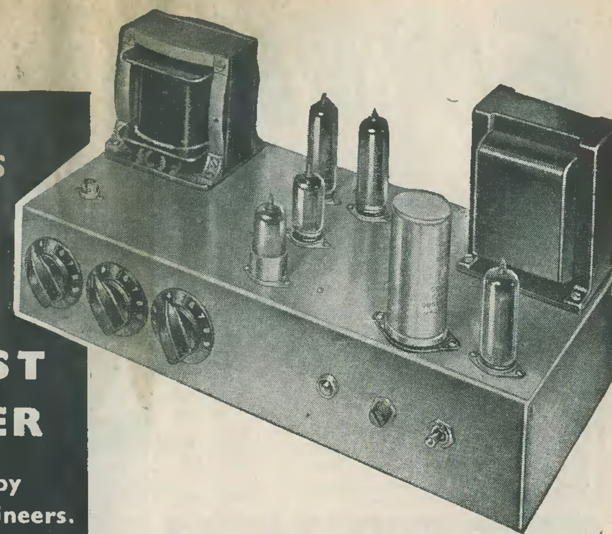

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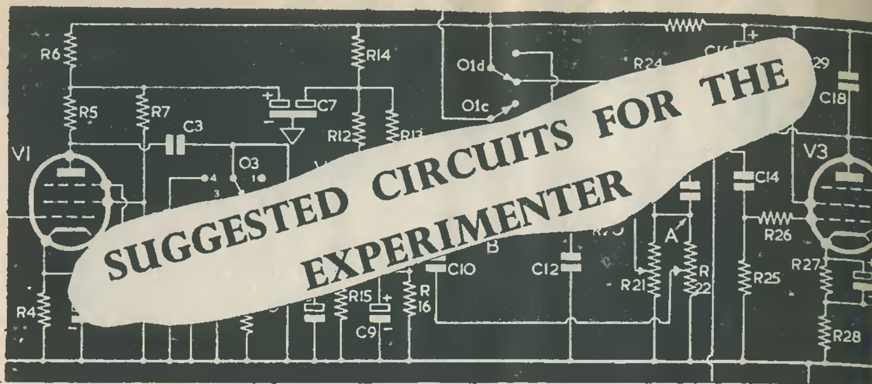

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No. 55 AN ALIGNMENT METER FOR F.M. RECEIVERS

By the time this article appears in print, f.m. transmissions on a full scale will have commenced in this country. In consequence, it is fairly certain that the first few f.m. repair jobs will have been presented to the serviceman. In quite a few cases, the repair of an f.m. receiver necessitates its re-alignment; a process which normally entails the use of a signal generator and a valve voltmeter. The latter instrument is needed to test for accurate alignment of the discriminator transformer secondary.

"Suggested Circuits," this month, presents the circuit of a very simple "alignment meter" which carries out the same function as would be given by a valve voltmeter. This alignment meter will function satisfactorily with any conventional ratio discriminator, whether balanced or unbalanced; and it can be constructed at quite low cost, since few of the small number of components required are at all critical in their values.

The Circuit

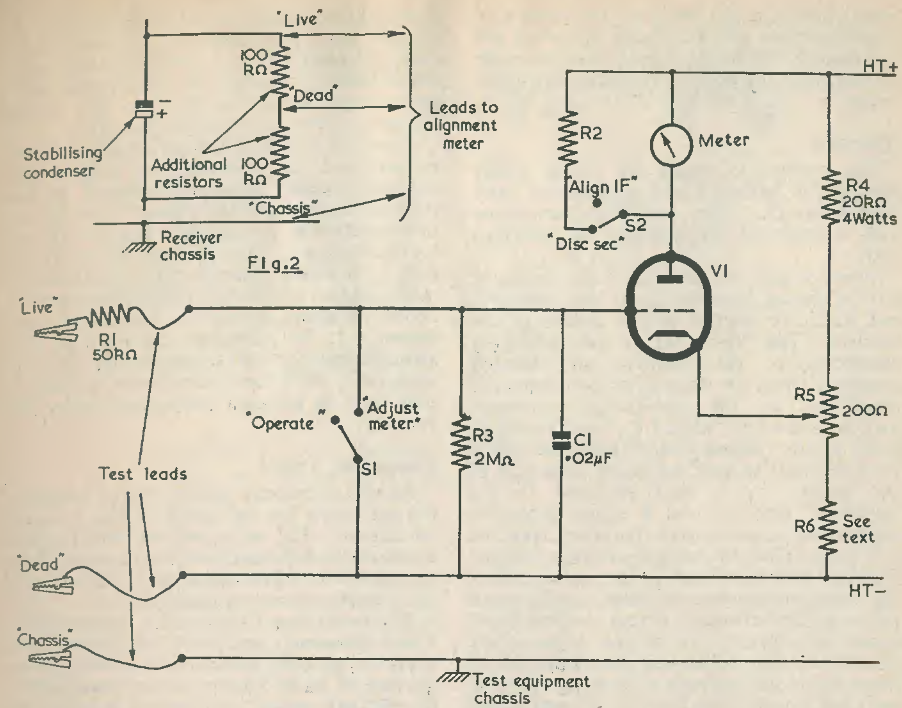
The circuit of the alignment meter is shown in Fig. 1. This does not include the power pack, which will be discussed later.

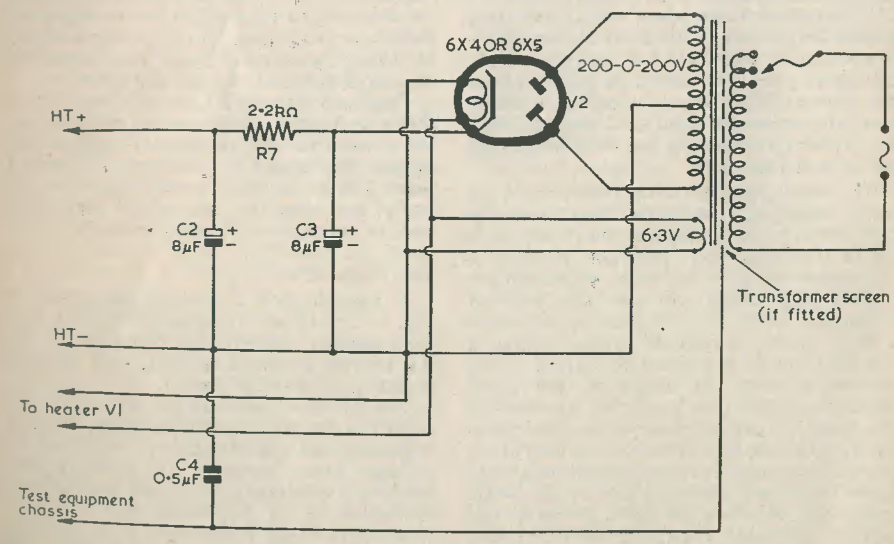
As may be seen, the instrument comprises a triode valve, in the anode circuit of which is connected a milliameter. The cathode of the triode is connected to the slider of R_5, this latter component being part of a resistive potentiometer connected across the h.t. supply and consisting, *in toto*, of R_4, R_5 and R_6.

Three test leads are provided with the gear; one of these (marked "chassis") being connected to the chassis of the instrument, the second (marked "dead") to its h.t. negative line, and the third (marked "live") to the grid of the triode. It will be noted that a resistor, R_1, is inserted at the termination of the third test lead. Part of the procedure employed in the alignment of an f.m. receiver consists of connecting the "live" test lead to the audio take-off point of the discriminator, and the resistor R_1 prevents any r.f. which may be present at this point from being radiated by the test lead and causing instability or unreliable readings. It is advisable to fit this resistor as near to the test prod, or test clip, as possible.

Two switches, S_1 and S_2, are fitted to the test gear. The purpose of S_1 is to short-circuit the grid of the triode to the h.t. negative line in order to set up the meter. Setting up is then effected by adjusting R_5. A reading of full-scale deflection should be given when S_2 is in the "align I.F." position; and a half-scale reading when S_2 is in the "disc. sec." position. As will be gathered, the shunt resistor R_2, switched in by S_2, provides this half-scale reading.

A final point is given by the presence of the 2MΩ resistor, R_3. The sole purpose of this resistor is to ensure that the triode remains





biased when the test leads are not connected to any external circuit. If this bias were not maintained the triode might pass excessive current, with the possibility of damage to the meter.

Operation

The method of using the meter differs slightly for balanced and unbalanced ratio discriminators. The procedure employed with a balanced discriminator is described first.

When a receiver with such a discriminator is to be aligned, both the "dead" and "chassis" test leads are clipped to the chassis of the receiver. The "live" clip is then primarily connected to the negative end (clearly apparent when an electrolytic component is employed) of the stabilising condenser. Switch S_2 is set to "align I.F.," and switch S_1 is set to the "adjust meter" position. R_5 is then adjusted to give full-scale deflection of the meter. S_1 is next returned to the "operate" position and a signal generator output fed, at the correct frequency, into the I.F. strip. The I.F. stages are next aligned to give maximum "dip" in the meter; reducing the signal generator output, as alignment proceeds, if the voltage across the stabilising condenser appears to be too high. Care should be taken to prevent inaccurate alignment due to the presence of limiting valves or an a.g.c. loop in the I.F. strip. If such valves or circuits are employed in the receiver it would probably be advisable to use a low-level output from the signal generator. The process of alignment incurs adjusting all the I.F. transformer iron-dust cores, including that in the primary of the discriminator transformer. After alignment has been completed, the signal generator should be rocked about the centre frequency, whereupon a fairly accurate measure of bandwidth response may be obtained by watching the deflection of the meter in the test gear.

The signal generator is next returned to the centre frequency, and the "live" test clip transferred to the audio take-off point. S_2 is set to the "disc. sec." position; whereupon the meter will give half-scale indication for correct adjustment of the discriminator secondary core. (This half-scale indication will, of course, correspond to zero voltage at the audio take-off point with respect to the receiver chassis.) If necessary, the signal generator output may be slightly increased at this stage to provide more sensitive indications. After the discriminator secondary core has been adjusted, the signal generator should again be rocked on either side of the centre frequency. Rocking the signal generator one way should cause the meter needle to rise, rocking it the other way should cause it to fall. If the meter does not respond to the changing frequency of the signal generator output, either the discriminator secondary core has been adjusted incorrectly (causing the secondary winding of the discriminator transformer to be outside the I.F. band altogether) or a fault condition exists.

When an unbalanced discriminator circuit is employed, the "chassis" test lead of the alignment meter remains connected to the receiver chassis, but the "dead" lead has to be connected to the centre of the discriminator diode load. This is done as shown in Fig. 2, in which a centre-tap is obtained by means of two additional 100kΩ resistors connected in series across the stabilising condenser. It is advisable to employ this arrangement for the whole process of I.F. alignment, since the discriminator secondary may then be adjusted immediately after the primary.

Component Values

As was mentioned earlier, few of the component values for the circuit of Fig. 1 are at all critical. The valve may be any low-mu triode of the 6J5 class, or it may consist of an r.f. pentode triode-strapped. (A vari-mu pentode should not be employed.)

The meter may have an f.s.d. ranging anywhere between 1 and 5mA. It is desirable, however, to work the triode at a fairly linear portion of its Ia-Vg curve. In consequence, if a 0–1mA meter is employed it might be advantageous, with some valves, to shunt the meter to give an f.s.d. around 3mA.

The value of the resistor R_6 is best found empirically. It should have a value enabling the meter to be adjusted to full or half-scale deflection (according to the position of S_2) for a roughly central setting of R_5. Normally, R_6 will lie between 100 and 300 ohms.

The shunt resistor, R_2, should be such that throwing S_2 to the "disc. sec." position causes the meter to show exactly half the reading given at the "align I.F." position. The correct value should be found experimentally quite easily, and may be obtained by paralleling two, or more, low-tolerance resistors.

The Power Pack

A suitable power pack is illustrated in Fig. 3. This circuit is quite conventional, with the possible exception that, owing to the low h.t. current required (20mA), only a small mains transformer is needed.

There is one important point to note with regard to the power pack, however, and this is the fact that it is essential to ensure that no leakage exists between the primary and secondary windings of the mains transformer. Otherwise, it is impossible for incorrect readings to be given with the circuit arrangement shown in Fig. 2. Similar inaccuracies would be given, also, if C_4 were leaky.

In which J. R. D. discusses Problems and Points of Interest based on Letters from Readers and his own experience.

READERS MAY RECALL THAT OVER THE last year or so I have been devoting a certain amount of space in these columns to the subject of f.m. reception. In consequence I have, from time to time, received quite a few letters; most of which I have answered individually. Quite a few of these letters raised points which are worth airing here, and which should be of interest to others.

Incidentally, whilst on the subject of letters, I hope that those readers who have been good enough to write to me will forgive the slight delays which have occurred before receiving a reply. I have recently been extremely busy and it is usually only at the week-ends that I can find time to deal with correspondence. In addition, I have received quite a few letters raising questions which could hardly be described as being even remotely connected with material appearing in "In Your Workshop." Whilst I am only too happy to help anyone to the best of my ability, I would appreciate it very much if such letters could be sent along to Query Corner, where, of course, they really belong.

The Discriminator

However, to return to our *moutons*. The subject which features most frequently in readers' letters is concerned with the ratio discriminator circuits which are nowadays employed in modern f.m. receivers. For the record, a simple ratio discriminator is shown in Fig. 1.

In this diagram, C_1 and C_5 are parallel tuning condensers, performing the same function as in a conventional i.f. transformer. C_2 is a decoupling condenser and would normally have a value around 0.01µF. C_3, C_6 and C_7 are r.f. decouplers, a typical capacity for each being 200 pF; whilst C_4 is a d.c. blocking condenser of around 0.01 µF. C_8 would normally be between 4 and 8µF. R_2 and R_3 should be equal to each other in resistance, a typical value for either being 8kΩ. (De-emphasis components are omitted.) There is little else of especial note in this circuit, and it will be quite familiar to those who have already taken an interest in f.m. receivers.

One of the things that puzzled one or two correspondents is the use of the adjectives "balanced" and "unbalanced," as applied to discriminator circuits. The circuit shown in Fig. 1 is that of a "balanced" discriminator, and it is so described because the chassis connection is taken to the junction of the two equal resistors, R_2 and R_3; with the result that the voltages on either plate of the stabilising condenser, C_8, are "balanced" about chassis. If the right-hand half of the circuit (that constituting the diode load were) redrawn as shown in Fig. 2, the arrangement would become an "unbalanced" ratio discriminator. As may be seen, all that has happened is that the chassis connection has been taken away from the junction of R_2 and R_3 in Fig. 1, and re-connected at the bottom. Nothing else in the circuit of Fig. 1 is changed. However, the "unbalanced" method of connection enables R_2 and R_3 to be combined in a single resistor, shown in Fig. 2 as R_4. R_4 has the same value as R_2 and R_3 in series. Also C_6 and C_7 of Fig. 1 are similarly combined in the single condenser, C_9, of Fig. 2. To go a stage further, we could delete C_9 of Fig. 2 altogether if we wished, relying on the stabilising condenser C_8 to decouple the r.f. voltages appearing across its plates in addition to carrying out its normal function of stabilising the voltage across the diode load. As may be seen from Figs. 1 and 2, the terms "balanced" and "unbalanced" merely qualify a particular circuit arrangement.

The circuit of Fig. 2 has an obvious advantage over that of Fig. 1, this being given by the fact (just discussed) that it employs one less resistor and one, or perhaps two, fewer condensers.

So far as one can judge from what has been written elsewhere, the unbalanced discriminator circuit works just as well as does the balanced circuit so far as f.m. discrimination is concerned. On the other hand, it may not be *quite* as good from the point of view of a.m. rejection. There are, however, a number of other points to consider concerning the relative advantages and disadvantages of these two circuits. Unfortunately, space does now allow a detailed discussion in this particular article.

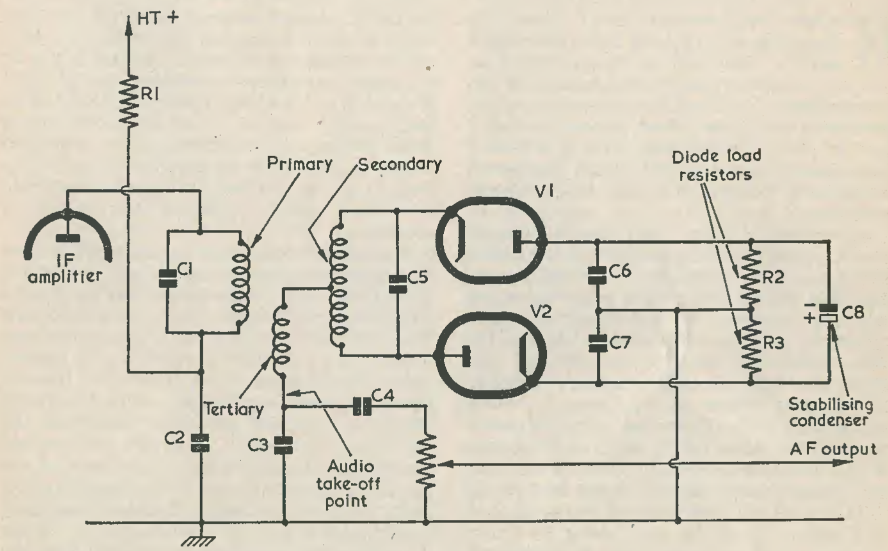


Fig. 1. A simple balanced ratio discriminator circuit. De-emphasis components are omitted

Phase Discriminator

One reader writes to state that he has been looking at the f.m. receivers advertised in current American magazines, and has noted that phase discriminator circuits appear to be used more frequently than are ratio discriminators in high-fidelity receivers intended for the more expensive, "custom-built," market. Why, he asks, are American manufacturers "reverting to phase discriminators while everyone over here and on the Continent is going crazy over ratio discriminators?"

To be frank, I don't think that this question really infers anything approaching a true picture of the f.m. scene. This is partly because American manufacturers are not "reverting" to the phase discriminator at all. So far as I know, they have used it quite frequently in their more expensive receivers. Considered on its own, it is usually agreed that a good phase discriminator circuit gives better f.m. discrimination than does a good ratio discriminator circuit. (It is often, also, a less fiddling circuit to get into good working order.) However, the great snag with the phase discriminator circuit is that it requires a limiting valve immediately preceding it to provide a.m. rejection. This limiting valve can usually only be obtained satisfactorily by fitting an extra valve into the receiver. The addition of this extra valve then not only increases the cost of the receiver; it also introduces an extra stage in the i.f. strip. Because of this, more attention has to be paid to layout, decoupling and i.f. bandwidth. Further, the fact that the extra valve is acting as a limiter means that it is not handling a *sine-wave*, but what becomes virtually a *square-wave*, at intermediate frequency. In consequence, the output of the

limiter valve is rich in harmonics and care has to be taken to prevent these from being radiated.

The outstanding advantage of the ratio discriminator is that it does not, usually, have to be preceded by a limiting stage. By reason of its own operation it provides inherent a.m. rejection.

Rejection Efficiency

This brings me to the point which appeared most frequently in the letters I had from readers. Summarised, these letters could ask the question: how good is the a.m. rejection given by the average ratio discriminator circuit? One reader pointed out, also, that if the a.f. voltage given by a ratio discriminator is proportional to frequency deviation, why does a.f. output increase for an increase in signal input? Surely, he adds, the circuit is then responding to a.m.!

In order to answer the first of these questions, it might be advantageous to examine briefly the reason why the ratio discriminator provides inherent a.m. rejection. This we could do by imagining that an f.m. carrier is amplitude modulated; and that the resultant signal is applied to the ratio discriminator circuit of Fig. 1. We may then commence by considering what happens in this circuit at a moment when the amplitude modulation is such that the carrier is increasing in amplitude.

As can be seen from Fig. 1, the increase in amplitude must cause a higher voltage to be applied from the secondary of the discriminator transformer to the two diodes, V_1 and V_2. This higher voltage tends to charge the stabilising condenser, C_8. C_8, therefore, commences to draw current from the diodes; with the result that the effective load resistance presented to the discriminator transformer by the diodes decreases in value. In consequence the secondary and primary windings of the discriminator transformer become more heavily damped than is normally the case, and the increase in amplitude is largely lost.

Similarly, at a moment when the amplitude modulation is such that the carrier is being reduced in strength, the voltage applied to the diodes is less than that which exists across the plates of the stabilising condenser. As a result, this condenser commences to discharge into the diode circuit. The effective diode load resistance consequently increases, and the damping on the discriminator transformer windings is reduced. Because of this reduction in damping the signal applied by the transformer to the diodes increases and the drop in carrier level is largely offset.

It will be obvious from the above that the ratio discriminator does not provide perfect limiting. Nevertheless, it always *tends* to give a.m. rejection. In practice most discriminator circuits give good a.m. rejection, and a really well-designed circuit can give excellent a.m. rejection. However, for the latter to occur it is usually necessary to take great care with component values in the diode load circuit; and to try also to ensure that the signal amplitude applied to the discriminator transformer primary is sensibly constant for different transmissions. Fortunately, the requirements of reasonably constant signal amplitude will be rather easy to ensure in the conditions to be expected in this country, since almost every receiver will receive its three programmes from the same transmitter over the same route. The situation can be eased further by the use of quite simple a.g.c. circuits; or by making one (or more) of the valves act as a limiter.

The above paragraphs should help to give a rough idea of what is to be expected from the ratio discriminator circuit from the point of view of a.m. rejection. In practice the situation is by no means as black as it seems to be painted. This is due to the fact that most districts in the U.K. should be receiving signals that will be strong enough to mask all but the worst cases of a.m. interference, even when discriminators with poor a.m. rejection

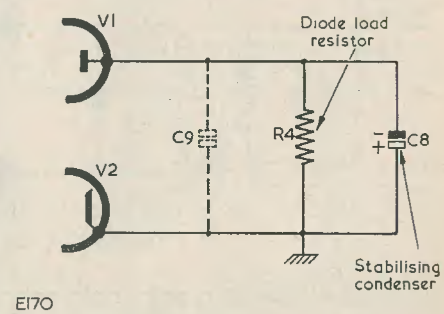


Fig. 2. How the diode load circuit of Fig. 1 is altered to provide an unbalanced discriminator. The condenser C_9 is optional

characteristics are being employed. Probably the only people who will have to worry seriously about a.m. rejection are those residing in "fringe" areas, or those who live in areas where strong impulsive interference is prevalent. To give an idea of the signal levels anticipated, quite a few of the f.m. receivers now being produced by manufacturers are fitted with compressed dipoles inside their cabinets, and it is expected that these "internal" aerials will cope quite adequately in most localities.

The other question—why does a.f. volume increase as signal strength increases?—is quite simple to answer. The a.f. voltage provided at the audio take-off point of a ratio discriminator for a given frequency deviation is a function of that appearing across the stabilising condenser. If the latter increases, due to increased signal strength, so also does the a.f. voltage.

Improving Rejection

The simple discriminator circuits of Figs. 1 and 2 can sometimes be made to give improved a.m. rejection characteristics by connecting the stabilising condenser such that it is "tapped down" the resistive diode load.

A typical example is shown in Fig. 3. This diagram illustrates a discriminator transformer and circuit developed by the G.E.C., and employing GEX34 germanium diodes instead of valves. As will be noted, two series resistors are connected between the diodes and the stabilising condenser.

of Fig. 3 works quite nicely if RX has a value of 1kΩ.

By the way, I understand, at the time of writing, that the discriminator transformer shown in Fig. 3 is now being made commercially and will shortly be available, complete with matched diodes mounted inside the can, to the home-constructor.

The Stabilising Condenser

One correspondent was a little unhappy about the working voltage and capacity needed for the stabilising condenser.

This *is* something of a problem because it is usually recommended, owing to the large value of capacity required, that an electrolytic component be employed here. Unfortunately, the polarising voltage at which the condenser will work is not known since it will, of course, vary for different signal strengths. Assuming that the f.m. receiver has an a.g.c. circuit or a limiter stage, it is doubtful whether the

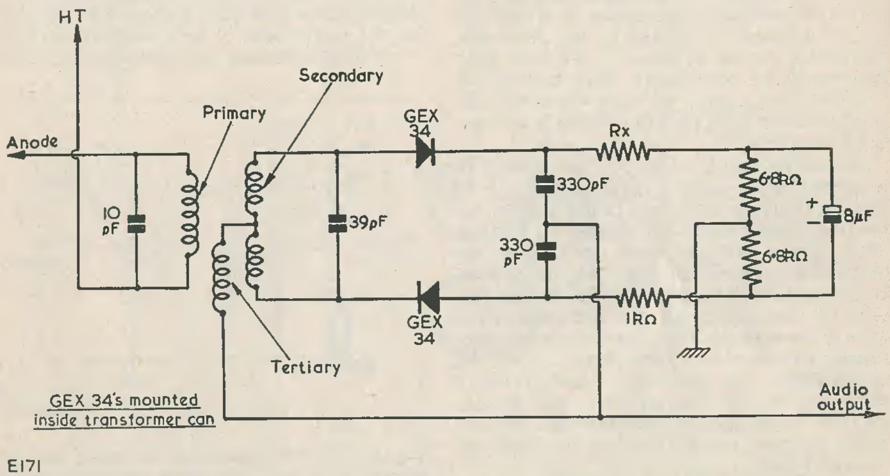


Fig. 3. A circuit using GEX34's and a discriminator transformer designed by the G.E.C. This arrangement is capable of providing a very high degree of a.m. rejection

Of these two resistors, RX is intended to be adjusted in value for maximum a.m. rejection. This adjustment then allows for conditions of unbalance existing in the diodes and in the transformer itself. (The word "unbalance" used here has nothing to do with the same term when it was applied, previously, to the "unbalanced" ratio discriminator of Fig. 2. "Balance" or "unbalance" in the previous context referred merely to the type of circuit employed.) Normally, incidentally, the circuit

voltage across the stabilising condenser will rise above 20 volts under most conditions. (However, a friend of mine, who has been testing some commercial f.m. receivers, reports stabilising voltages up to 40 for several particular models.) At the same time it has to be rememberd that the voltage across the stabilising condenser may, with weak signals, be as low as 1 volt.

It is tempting to employ a stabilising condenser whose working voltage is just slightly

above the voltage normally expected to appear across it. Unfortunately, however, when the working voltage of an electrolytic condenser is approached, its leakage current tends to rise very quickly, and the consequent non-linear operation may upset the a.m. rejection properties of the circuit for signals of differing amplitude.

On the other hand, there is the fact that polarising voltages which are considerably lower than the rated working voltage of the condenser result in altered effective capacity values. Fortunately, such changes in capacity are "on the right side," as it were, since most electrolytic condensers increase in effective capacity as the polarising voltage decreases. The only consequence of too high a stabilising capacity is that the discriminator circuit responds slowly to changes in tuning, and a rather "sluggish" effect can be produced. This effect is not, of course, so serious as would be given by a *reduction* in effective capacity; which would result in reduced rejection to low frequency a.m.

So far as practical values are concerned, a stabilising condenser having a nominal capacity around 8μF should cope quite comfortably when the load resistor connected across it has a total value between 10kΩ and 15kΩ. Increased load resistors would require a stabilising capacity reduced in proportion; and vice versa. A working voltage figure of 100 to 150 should also be quite satisfactory, even for very weak signals. In practice, condensers with these values appear to offer a good compromise between rejection of very low frequency a.m. and sluggishness of response to tuning adjustments.

Can Anyone Help

S. Baker, 84 Northumberland Avenue, Welling, Kent, who needs data on the ex-Army 1481 Receiver?

* * *

E. W. Kerridge, 11 Tudor Way, Windsor, Berkshire, who wishes to obtain data on the U.S.A. Aircraft Receiver CRV46151?

* * *

J. A. Horton, Laund Farm, Far Laund, Belper, Derbys., who requires the manual for the B.C.342, temporarily or permanently.

* * *

M. Collins, 1 Cranbrook Park, Wood Green, London, N.22, who needs details such as removal of D.F. valves, type of aerial to use, removal of redundant controls, etc., relating to the R1155A?

* * *

John C. Priest, 1 Chapel Street, Blackpool, Lancs., who wants to obtain the manual and valve data sheets of the ex-R.A.F. Valve Tester type 4; or the identity of the makers—the inspection stamps bear the initials G.B. & Co. Ltd.?

* * *

N. J. Parker, 96 Dumbarton Road, Brixton Hill, London, S.W.2, who would appreciate any information or service sheet for the American Mid-West Radio Receiver No. U335 (6-wave, 8-valve plus magic eye) made pre-war in England?

R. Bateman, 103 High Street, Crosskeys, nr. Newport, Mon., wonders if any reader can help with the circuit or information on the Transmitter/Receiver TR3171?

* * *

F. Allan Herridge, G31DG, 95 Ramsden Road, London, S.W.12, would like some information on the Etronic television receiver.

* * *

C. E. Rees, 83 Mirador Crescent, Upton Lea, Slough, Bucks., wonders if anyone could sell or lend to him the circuit of the ex-Govt. Receiver 161?

* * *

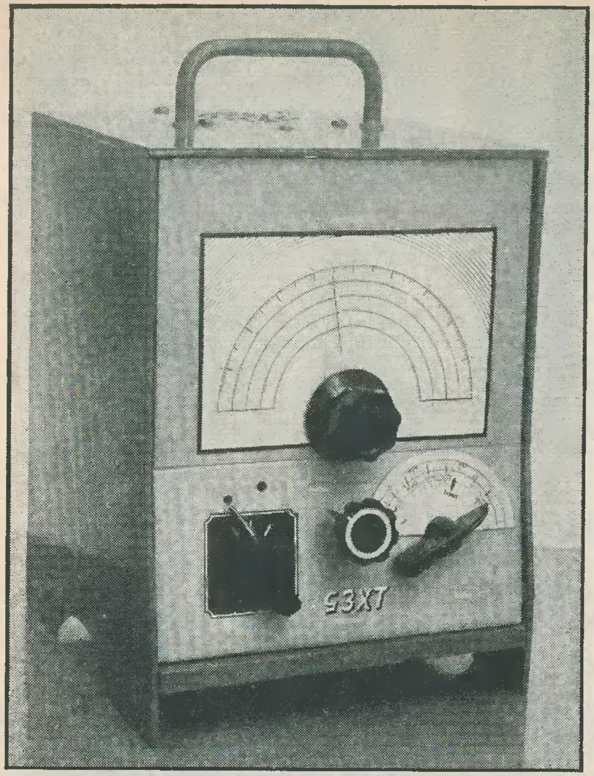
J. Bland, 56 Evington Street, Leicester, is in need of the circuit and data on the Marconiphone 7-valve Receiver type 256.

* * *

Robert R. Hosie, 178 Florence Street, Southside, Glasgow, would like some information on a transformer marked 347, 10KB/901, and also on a unit built on paxolin strip and marked GU2.

* * *

Chas. W. Wright, 19 Shrubbery Road, Worcester, would like, on loan or otherwise, a manual of the SC1183 Combined Valve Tester and Multirange Meter manufactured by Triplett. He is willing to exchange a manual for the BC221 Frequency Meter.



The 1955 TWO

By

G3XT

PART 1.

THOSE WHO LIKE EXPERIMENTING WITH unusual circuits may find it interesting to try out this novel two-valve superhet. There is nothing complicated about it, and although decidely out-of-the-ordinary it is perfectly straightforward and does not employ a reflex arrangement or any of the "tricky" circuit devices sometimes found in unorthodox types of receiver.

The circuit has been designed around two modern noval-based all-glass valves, namely, the Mullard ECH81 heptode-triode and the Mullard ECL80 triode-pentode.

The heptode section of the ECH81 is used, in this set, as combined mixer and oscillator, while the triode section acts as a leaky-grid detector with reaction applied at intermediate frequency (giving a virtually constant-reaction effect throughout the tuning range, thereby simplifying the adjustment of the various controls).

No i.f. amplifier is used, and the reaction largely compensates for its absence, by improving strength and selectivity. The triode section of the ECL80 is used as an audio amplifier, resistance-capacity coupled to the pentode section which forms the output stage. A simple form of negative feedback is used to improve quality, though at a slight sacrifice of volume.

A small loudspeaker is housed in the cabinet with the set, but the power pack is accommodated in a separate case. A three-core cable carries h.t. and l.t. supplies from the power-pack to the set, a four-pin plug and socket connector being used. This arrangement increases the versatility of the receiver, for, if a suitable car-type power unit running off a 6-volt car battery is available, this can be fitted with a similar cable and plug, making it interchangeable with the mains power-pack. The receiver is then instantly adaptable for occasional mobile use in a car or on an outdoor picnic, field-day or other outing. With a small mobile aerial, however, reception will be limited to the stronger signals.

As the set is small, light and easily transportable, it forms a useful bedside or kitchen receiver as an auxiliary to the full-size domestic receiver which is doubtless permanently installed in a sitting-room.

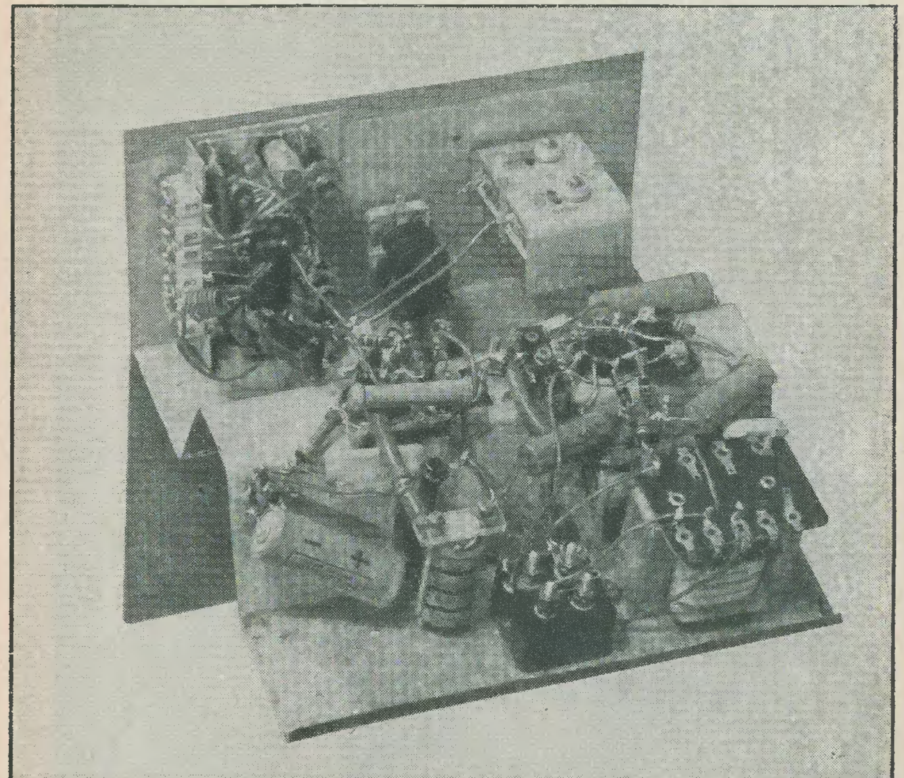
Owing to its obvious limitations, one would not be justified in making extravagant claims for the performance of this small set. But it is certainly superior to the normal straight two-valver, although on the other hand the absence of r.f. and i.f. amplification inevitably means that results are inferior to those obtainable with a standard multi-valve superhet. The performance depends largely on the use of a reasonably efficient aerial (preferably an outdoor one) and the judicious adjustment of reaction.

With the Maxi-Q coil-pack and i.f. transformer specified, selectivity is good. The reaction winding, by the way, is added to the secondary of the i.f. transformer. With the Maxi-Q i.f.t., this job is quite easy; but if you use some other type you may find it rather tricky, and to overcome the difficulties you are advised to refer to my article on adding reaction to i.f. transformers which appeared in the January 1955 issue of *The Radio Constructor*. (A suitable i.f.t. with reaction winding is obtainable from The Teletron Co. Ltd.—Editor).

Although—obviously and admittedly!—this set is not in the high-fidelity class, you may be pleasantly surprised at the quality obtainable, provided you use a good loudspeaker. It is clear, pleasing and a good deal better than one would expect in view of the leaky-grid detector and reaction.

Tuning Arrangements

The coil-pack covers long, medium and short waves in three ranges, of about 16–50, 200–550 and 800–2,000 metres. These are the nominal coverages claimed by the makers; but in actual practice you can extend them somewhat if desired. I found it possible to cover the 80 and 160 metre amateur bands as well; this adaptation will be dealt with later on.



Under-chassis arrangement—see text

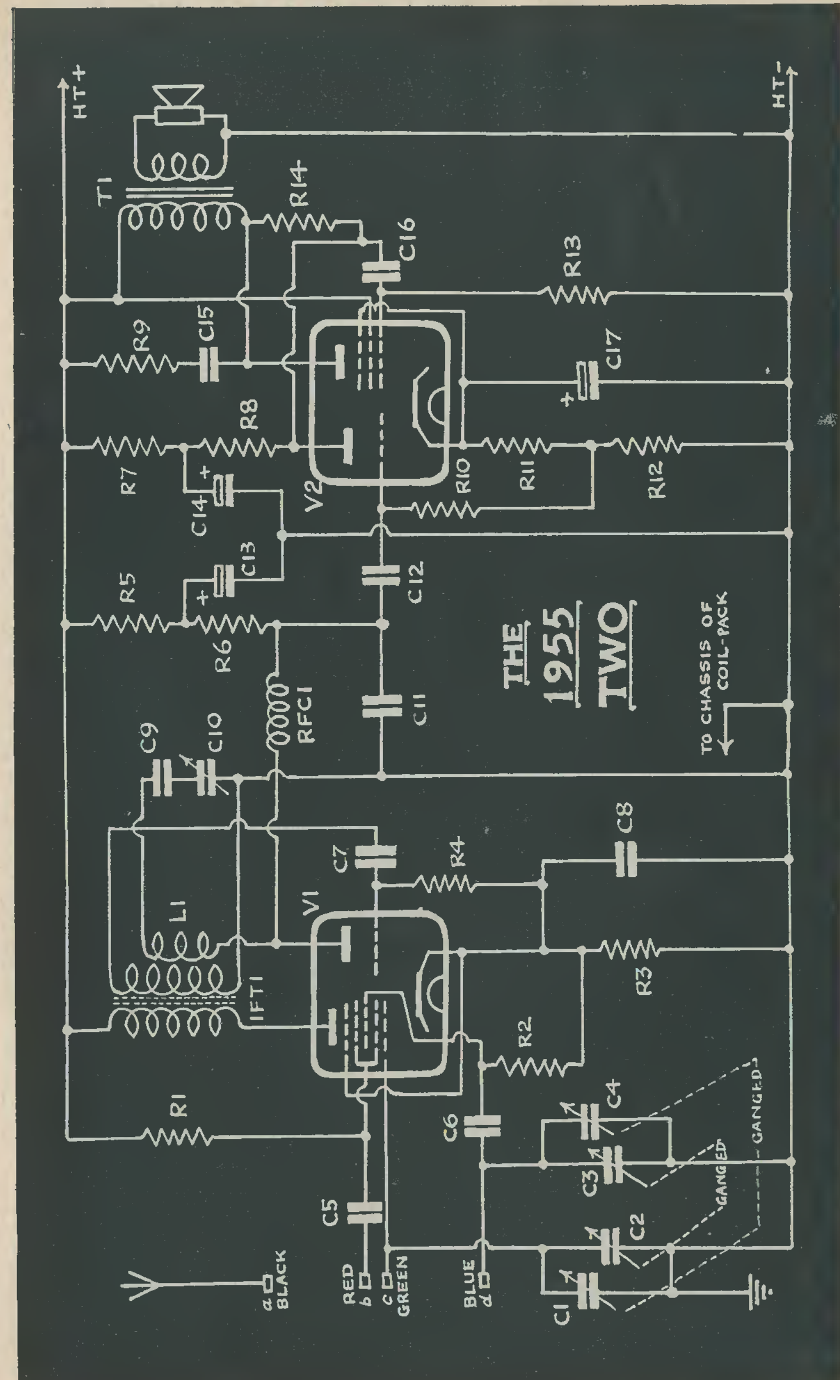


Fig. 1. The circuit of the 1955 Two

COMPONENT LIST

R1	33kΩ 1W
R2	47kΩ
R3	220Ω
R4	1MΩ
R5	10kΩ
R6	50kΩ
R7	68kΩ
R8	220kΩ
R9	10kΩ
R10	220kΩ
R11	180Ω
R12	220Ω
R13	680kΩ
R14	680kΩ (negative feedback)

All resistors ½W except R1.

C1, C4	Twin-gang bandspread, say 100pF each section
C2, C3	Twin-gang bandset, 500pF each section, *miniature* type
C5	1,000pF mica
C6	100pF silvered mica
C7	100pF mica or silvered mica
C8	0.01µF paper
C9	1,000pF mica
C10	Reaction condenser, say 100pF miniature variable
C11	500pF mica
C12	0.01µF
C13, C14	8µF electrolytic 500 VDC
C15	0.01µF
C16	0.005µF
C17	100µF electrolytic

Coil pack Maxi-Q Type CP.3/500 or CP.3/F (see text), Denco (Clacton) Ltd.

RFC1 Maxi-Q Type RFC7B, Denco (Clacton), Ltd.

SET OUT FOR EASY REFERENCE TO Fig. 1

IFT1	Maxi-Q Type IFT11, 465kc/s, Denco (Clacton) Ltd.
L1	Reaction winding (see text) added to IFT secondary
T1	Output (speaker) transformer, 11kΩ primary impedance

Valves

V1	Mullard ECH81
V2	Mullard ECL80

Chassis (see text) developed from flat sheet measuring 15″ × 7½″

4-pin safety-type plug and socket connector for h.t./l.t. leads

Radio Constructor Panel-Sign transfers (see illustrations).

There are three variable condensers; one is the reaction condenser, the others are twin-gang tuning types. The larger one acts as bandset on waves below 200 metres and as main tuner on the remaining wavelengths. The smaller one acts as bandspread on short waves, and as a "fine-tuning" adjuster for precision tuning on medium or even long waves.

If you are not specially interested in short-wave work, the bandspreader can be omitted and the 500pF twin-gang substituted, with a slow-motion drive. The reaction condenser can be moved further to the right of the panel, to give a symmetrical layout. These modifications will also enable a larger scale or dial to be used on the broadcast bands; in the prototype it is the bandspread which uses the larger scale, while the ordinary broadcast calibrations have to be crowded into the smaller of the two scales.

Radio Constructor Panel-Sign transfers are used on the prototype. The large diameter scale on the bandspread can be calibrated for the various short-wave bands, and the smaller one for long and medium waves. The degree-markings on the smaller scale were trimmed off before fixing, owing to lack of space.

A method of covering the 80-metre amateur band is to connect additional capacities of about 0.0012µF (1,200pF) across each section of the 500pF twin-gang, with an extra double-pole switch to bring in the extra capacities when needed. The L/C ratio is admittedly outrageous; but I found it worked all right and is preferable to tampering with the coil-pack itself in any way.

The dust-iron cores of the coils permit considerable latitude of adjustment, and I found that with those on the medium-wave windings screwed out further than one would normally do, it is possible to tune in a number of "top-band" amateur stations working on c.w. at the low-frequency end of the 160-metre band.

The Chassis

A glance at the illustrations will show that the chassis used in this small superhet is not the ordinary flat type, but a special new version of my own design, which I described in the March 1955 issue of *The Radio Constructor*. This chassis gives much better accessibility to most of the components, thereby facilitating construction, testing and subsequent maintenance.

The front panel can be of metal or other suitable material. In the prototype I used ordinary builder's hardboard, with the smooth surface to the front. The latter

(*continued on page* 661)

A SIMPLE PATTERN GENERATOR

by **H. GARLICK**

BEFORE COMMENCING ANY OF THE NUMEROUS adjustments required to align a newly constructed television receiver, it is necessary to provide a strong r.f. signal at the aerial socket, suitably modulated to produce a pre-determined pattern on the tube face.

Obviously the best signal source is the transmitter itself and for final adjustments it is essential to use the test card, but for initial tuning, where the coils may be a long way off frequency, the signal strength available in the aerial is rather low. Again, the transmitter is not always radiating and for convenience, therefore, an alternative source must be considered.

So far as the average home constructor is concerned, the building of a suitable unit to fulfil the aforementioned conditions must be considered from the point of view of economy, and it was with this fact in mind that the possibility of designing a simple but useful Pattern Generator around a single triode valve was investigated.

Basically, the circuit must consist of an oscillator tuned to the desired channel and modulated at frequencies which are multiples of the line and frame timebase frequencies.

It is not essential that both modulation frequencies be combined, provided that either are available by simple switching.

The circuit finally chosen is shown in Fig. 1. The oscillator is similar to the Flewelling, where feedback is adjusted so that excessive oscillating current causes the valve to cut off, oscillation again commencing when the bias voltage at the grid has leaked away through the adjustable grid resistor.

If the condenser C_1 is adjusted to cause the circuit to oscillate at the frequency to which an existing receiver is tuned, and which has the line timebase correctly set, it will be seen that as the grid resistor is varied the rate at which the oscillator starts and stops can be controlled to be a multiple of the line frequency.

During the periods of oscillation, the r.f. voltage rectified by the demodulation and passed to the tube causes the spot to increase in brightness, with the result that a series of vertical lines (the number depending on the value of grid resistor) will appear on the screen.

Unless the modulation frequency is an exact multiple of the line frequency, however, the pattern will be completely irregular. The setting of the modulation frequency is rather critical as no normal synchronisation pulse is provided.

Due to the short duration of the modulation pulse, however, it will be found that the pattern will lock in and remain steady.

When a new receiver is being lined up, the fact that the line timebase must be set at the exact frequency to obtain a steady pattern is an advantage.

As previously stated, the generator must also supply modulation at a multiple of the frame frequency. The main purpose of frame frequency modulation is to enable the timebase to be set to run at the correct speed, as checks on linearity can be made by observing the scanning lines. In the former requirement therefore, two horizontal lines are sufficient and suitable modulation can be obtained from the cathode of a full-wave rectifier.

The rectifier conducts during the positive half of each cycle, and by applying an alternating voltage to each anode from the secondary of a centre-tapped mains transformer an output of 100 pulses per second will be obtained.

By preventing excessive oscillation (by reducing the value of grid resistor) the oscillations will be continuous, and if the anode voltage is provided as outlined above the oscillator will stop and start at the rate of twice the frame frequency. The effect on the face of the c.r.t. is to show two horizontal white bars when the frame timebase is correctly adjusted.

The choice of horizontal or vertical bars is made by means of a double-pole single-throw switch, wired so that the resistor R_2 is placed in circuit and the condenser C_4 is open circuited for horizontal bars, and vice versa for vertical bars.

For the sound channel the frequency of the oscillator must be lowered slightly, and this can conveniently be done by switching in a low value capacitor across the r.f. coil. This small capacity can be obtained by twisting two pieces of insulated wire together and then adjusting the twist until the oscillator is on frequency. It is essential that the sound frequency be exactly tuned, due to the narrow bandwidth of the sound receiver, but the vision frequency is not quite so critical. The single trimmer across the coil can, therefore, be used to set the sound frequency after the chassis has been housed in its case (with the switch closed, of course), the slight alteration in frequency due to the case being of no consequence as regards the vision frequency.

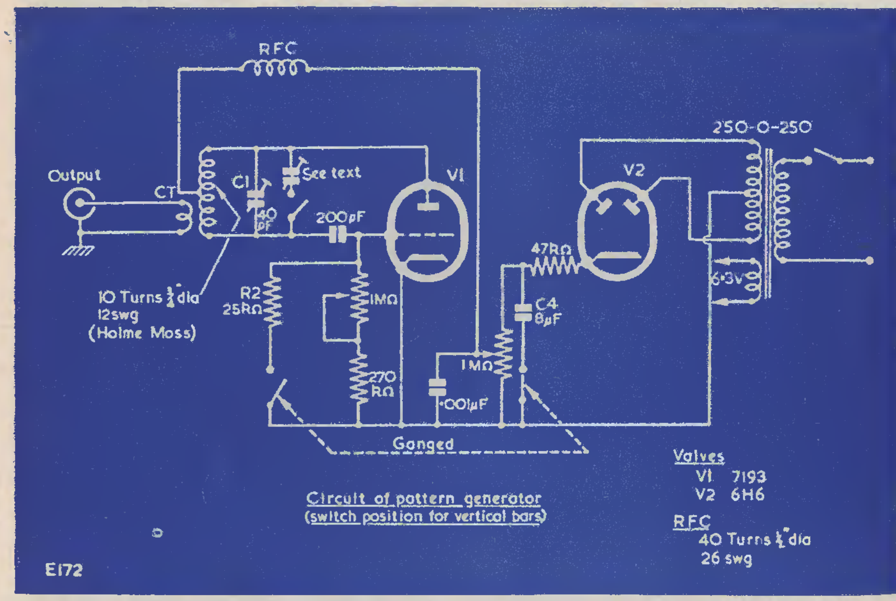
Modulation for sound is obtained by switching in the frame modulation so that a 100 c/s tone is heard.

Output is taken from the tuning coil by an inductive coupling consisting of half a turn of stiff wire spaced at least an inch from the coil.

None of the component values are critical, and any layout consistent with v.h.f. practice will be suitable.

The valve specified has the grid and anode brought out to top caps, making it convenient to mount the valve on a shallow chassis, with the front panel to carry all the controls, and yet keep wiring short. A 6J5 would be suitable, however, or a pentode strapped as a triode.

The rectifier is working at double its designed anode voltage, but no ill effects have been observed. The Pattern Generator should not be coupled directly to the receiver unless the tuning coils are well off frequency, as the output is high.



Circuit of pattern generator
(switch position for vertical bars)

A variable capacitor connected between this coil and the output socket will give a degree of attenuation. If the coupling is too tight, it will be found that operation of the variable capacitor will cause a variation in the frequency of the line modulation.

This effect must be avoided, as the correct setting for the line timebase depends upon the number of vertical lines seen on the screen.

It will normally be found sufficient to connect a few inches of wire to the output socket and then twist round it a piece of insulated wire connected to the receiver.

The unit will radiate strongly unless adequate screening is provided, and for this reason care must be taken not to interfere with nearby receivers during transmission times.

THE 1955 TWO—*continued from page 659*

was then painted with an enamel of the Chinese-lacquer type. The panel transfers were carefully applied (*without* moistening the gum) to the paint surface while it was still very slightly tacky, and they adhered perfectly. When completely dried, actually the following day (to be on the safe side!) the tissue was sponged off.

A simple cabinet can be fashioned out of wood or even hardboard strengthened with wood struts and jointing-fillets. A carrying-handle is screwed to the top of the cabinet to make the set easily portable.

(*To be continued*)

A CONSTRUCTOR AT THE 1955 RADIO COMPONENT SHOW

As occurred last year, the 1955 annual exhibition of the Radio and Electronic Component Manufacturer's Association was held, for a period of three days, at the Great Hall, Grosvenor House, in Park Lane, London. Possibly due to the fact that a different method of issuing tickets was in operation, the scene this year was less reminiscent of rush-hour in the Underground than has been the case in previous years. Despite this it was still not easy to move around quickly, and the writer gave his mental sympathy to the somewhat squashed staff on duty at some of the stands on the gallery.

Nevertheless, the fact that there was a good attendance only underlines the continuing success of the Show. It also reflects the increasing productivity and prosperity of the Radio Industry as a whole. In the Exhibition Press Office the writer was given access to figures which are of interest to everyone connected with the radio trade. Production output in the component industry rose by not less than a third in the past year; and it is still increasing. Before the war, 90 per cent of manufactured components went into the domestic radio market. Now, although radio and television receivers take three times as many components as they did before the war, only 45 per cent of the manufactured output is absorbed by the domestic market. Half the component output is exported, reaching a total, last year (counting direct and indirect exports) of approximately £22 million.

Television

Although the past twelve months have not seen any spectacular advance in television design, they have still been the occasion of considerable and valuable development work. At the last Show much emphasis was laid on Band III, and a number of turret tuners embodying the familiar cascode, triode-pentode combination were exhibited for what was virtually the first time in this country. These tuners were, in some cases, a preview of what was later to go into production. Now, of course, such tuners are an accepted part of present-day televisors.

In spite of this there was still much to see. For instance Cyldon (Sidney S. Bird, Ltd.) were exhibiting an improved type of turret "teletuner" which also incorporates the f.m. channels on Band II. Also, N.S.F. (Oak) were showing their 12K13 television tuner unit; this covering 13 carrier frequencies. Channel selection with the N.S.F. unit is achieved by switching incremental inductances mounted directly on the switch wafers. Plessey also included their own turret tuner in their display.

Mullard allowed a peep into the British television future with their castellated Ferroxcube cores for 90 degree deflection yokes. Readers may recall that most existing 70 degree scanning yokes employ castellated magnetic cores having eight slots arranged round their internal diameter. The frame and line windings then lie in these slots, whilst the cores bring the field up to the neck of the tube. The 90 degree Ferroxcube cores have sixteen slots spaced around the internal diameter. Each frame and line coil is then split into two, so that half of each individual winding fits into its own slot. In consequence, the coupling between the coils and the Ferroxcube is tighter, and the magnetic efficiency of the whole assembly is considerably increased. Furthermore, the Ferroxcube core intended for the front of the deflector yoke is shaped such that it may be placed further up the neck of the tube towards the flare, this reducing the risk of corner-cutting.

Another point of interest was given by the Ferroxcube U-pieces which form the cores of most line output transformers. These were now shown having a hexagonal cross-section. This development enables a closer coupling between the Ferroxcube core and the coil in which it is inserted than was given by the earlier square cross-sectional cores. The result is, again, greater efficiency.

Mullard also showed samples of typical applications of Ferroxcube. These included the new LO.352 line output transformer and DC.605 scanning yoke; both made by Allen Components, Ltd.

An interesting sidelight on television is given by the methods used for fastening components and chassis together. Simmonds Aerocessaries exhibited a large number of practical applications of their "Spire" Speed Nuts and Clips. These included a practical chassis illustrating all the points at which Spire fastening may take the place of nuts and bolts; a line output transformer assembled entirely with Spire fastenings; and a Ferguson Band III tuner unit, which also employs these production aids.

A firm not perhaps so well known to the amateur home-constructor is Aero Research Ltd., whose product—"Araldite"—is used in the manufacture of the television receivers made by many famous companies. Araldite is an epoxy resin which may be used as an adhesive, for potting and impregnating, and for other purposes. To illustrate the efficiency of Araldite, Aero Research showed an oscilloscope tube whose base and connections were sealed in Araldite, and which continually displayed an elliptical trace. The whole assembly was completely submerged in a tank of water! Araldite was also used for potting a line output transformer exhibited by Igranic.

There was not a great deal new in cathode ray tubes. G.E.C. and Mullard exhibited 21-inch tubes, that by Mullard being a 90 degree component. These 21-inch tubes appear to be taking some time finding their way into manufactured receivers.

Pullin Measuring Instruments Ltd. showed a brand-new e.h.t. voltmeter. This consists of a sensitive microammeter connected in series with a stable dropping resistor, and operating in accordance with normal voltmeter technique (except, of course, for the high voltages and low currents involved). The most interesting feature of the device was that it was arranged rather like a pistol, with the series resistor incorporated in the "barrel." At the end of the "barrel" was a metal probe (different probe shapes are available for different applications) and the meter itself was built into the handle of the assembly. The writer understood that the f.s.d. current of the meter was only 50μA.

Soldering

Soldering came to the fore to a surprising degree this year. This was partly due to the introduction of "self-soldering" wires. These wires are covered with enamel insulation in the conventional fashion, but the enamel becomes flux at soldering temperatures. Self-soldering wires were shown by the London Electric Wire Co., by F. D. Sims, Ltd. and by Henley's Telegraph Works. Henley's also showed a soldered-copper wire. The coating on the copper of this wire consists of solder and not of tin. In consequence, solder joints may be carried out more readily in some applications.

Multicore Solders exhibited a simple thermo-couple thermometer for checking the temperature of solder baths and soldering irons. The maximum reading was 400 degrees Centigrade. Multicore also showed a new solder (type 362) which contains approximately 2 per cent copper. This solder is claimed to increase the active life of a soldering iron bit by 10 times. Also exhibited were special materials for printed circuit soldering.

Enthoven Solders Ltd. also had materials and techniques available for printed circuits and dip soldering. A new development of this firm was an aluminium-cored solder which enables copper wire to be joined to aluminium surfaces with ease.

Printed Circuits

Printed circuits are here to stay. As yet, however, their greatest usefulness appears to lie with smaller assemblies only. Since this was an exhibition devoted to components, components were naturally given greater prominence than were completely manufactured assemblies.

Nevertheless, T.C.C. showed a complete high-fidelity amplifier, assembled in its entirety, on a printed circuit. The amplifier was the Osram "912." Bakelite Ltd. also showed a complete radio chassis, this employing a copper surface bonded to a plastic base.

Components suitable for printed circuits were exhibited by A.B. Metal Products (switches), McMurdo (valveholders) and Parmeko (transformers).

Sound Reproduction

So far as sound reproduction was concerned there was much of interest.

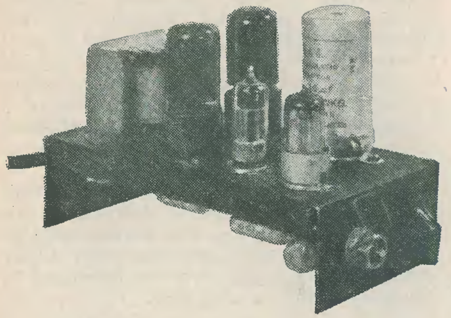
Cosmocord introduced two new pick-up cartridges. One of these was the GP.61-1, an improved ceramic type. Another was the GP.59-3. This uses the conventional crystal but, in company with the GP.61-1, employs the new flat-type stylus.

A new high fidelity speaker was introduced by Richard Allen. This is an elliptical model whose cone dimensions are 10 by 6 inches. Whiteley Electrical (Stentorian) had a new version of their cambric cone speaker. This is fitted with a "universal impedance" speech coil giving instantaneous matching at 3, 7.5 and 15 ohms.

Finally, G.E.C. introduced a Kraft-paper based recording tape known as "Puretone." This is claimed to have a performance comparable to materials costing twice as much.

J. R. D.

THE "FULL-TONE" 8 Watt AMPLIFIER



PART 2.

by M. HARVEY

Full constructional details of the latest Radio Constructor *design for the beginner*

In last month's issue of *The Radio Constructor* the "Full-Tone" amplifier was introduced and the salient points of its design and circuit discussed. We now carry on to full details of its construction and wiring.

The Chassis and Layout

To provide the constructor with an idea of the positioning of the main components Fig. 4 shows the top layout, as observed when looking down upon the chassis. This diagram will be of considerable assistance in carrying out the under-chassis wiring, and should be studied in conjunction with the photographs.

The first part of the construction to tackle is the chassis itself. This is quite simple in design and can be made with the complement of tools normally available in the home-workshop. The chassis may be made of any metal, although aluminium of 16 s.w.g. or thicker will probably prove to be the easiest to handle. (As was mentioned last month, those who wish to avoid carrying out this part of the construction may purchase the chassis ready-made from an advertiser in this issue.)

Fig. 5 shows the chassis dimensions before bending, providing details, also, of the mounting holes required for the various components. The view given in Fig. 5 is that looking at the under-side of the chassis, with the result that the four side aprons should be bent upwards from the page, towards the reader. Many constructors will prefer to drill the holes after bending, as this obviates the possibility of distorting the top surface of the chassis when only simple bending facilities are available. The two narrow side aprons along the length of the chassis are intended merely for strengthening purposes.

All the holes in Fig. 5 which are marked "A" are intended to be drilled out 6-BA clearance. Those marked "B" are 4-BA clearance. The two holes designated "C" are intended to t ke the two ⅜in di. grommets included in the component list. All other holes are marked in actual diameters where applicable.

Not shown in Fig. 5, however, is a hole for the locating lug of the volume control. Since the position of this lug will vary for volume controls of different manufacture, this hole will have to be marked out for drilling by the constructor himself. The locating lug hole should be positioned such that the volume control tags project sideways when it is later mounted (see Fig. 6). The diameter of the hole for the volume control bush is also not shown. This is due to the fact that this diameter, also, may vary slightly for volume controls of different manufacture. (For most instances, however, the hole would require a diameter of ⅜in.)

Mounting the Components

The next job consists of mounting the initial components. The layout of these, below the chassis, is given in Fig. 6. It is particularly important to ensure that the valveholders are fitted the correct way round. Fig. 6 shows the positions of the spigot keys for the octal valveholders, and of pin No. 1 of the two miniature valveholders. As was mentioned last month, the valveholder for V_1 is a plain component, and does not need the "skirt" shown in the photographs of the chassis.

Also mounted at this stage are the output transformer and the dual electrolytic condenser C_3, C_{10}. The siting of these last two components, above the chassis, was shown in Fig. 4; whilst Fig. 6 further clarifies the positioning of the coloured tags of the electrolytic condenser. Both condenser and transformer are mounted by 4-BA nuts and bolts. The bolt designated "X" in Fig. 6 should be sufficiently long to take another nut at a later stage in the assembly.

The three tag-strips are shown, occupying their correct positions under the chassis, in Fig. 6 as well. It is important to make certain that the centre, mounting, tags of these tag-strips make good contact with the chassis. Because of this point, all tag-strip mounting bolts must be as tight as possible.

Pye socket assembly must be fastened as tightly as possible as well.

The final step consists of fitting the volume control in the position shown in Fig. 6; i.e. with its tags projecting towards the Pye socket.

Wiring

The initial wiring may now be commenced. This is illustrated in Fig. 7. Note that the 4-way lead from the power-pack is now introduced, and that it is secured under two clamps. One of these clamps is held by a 6-BA bolt fitted in the 6-BA hole in the rear apron. The other clamp is held by an additional 4-BA nut passed on to one of the bolts (labelled "X" in Fig. 6) which already secures the output transformer above the chassis. The clamps may be made from thin metal strip or any similar material. No colour-coding, or any other method of marking the 4-way power cable, is shown in the diagram as its connections are obvious. Two of its leads connect to the heaters, the third connects to chassis, and the fourth to h.t. positive.

Although not shown in this and the succeeding diagrams, resistor and condenser

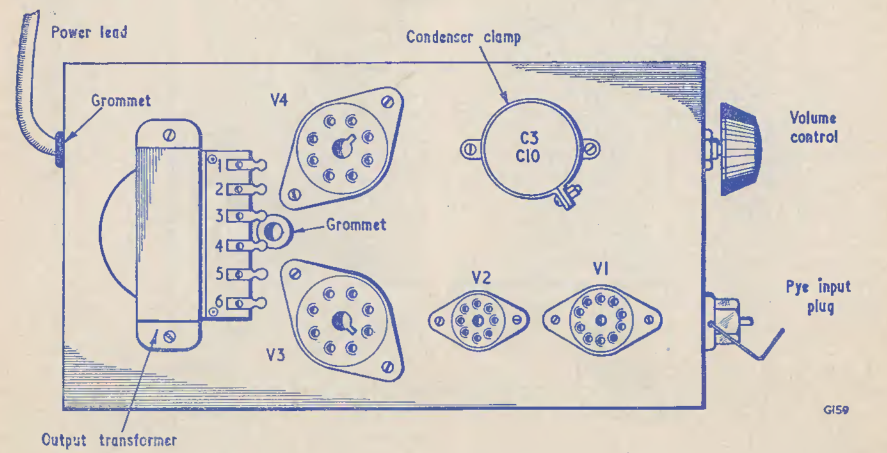


Fig. 4. The layout adopted above the chassis for the "Full-Tone" amplifier

The Pye socket assembly is, similarly, also of importance. This socket should be supplied with two solder tags: one 4-BA tag for its centre terminal, and one larger tag for the outside, earthed, section. This second tag must make good contact to the metal of the chassis, and so the large nut securing the

leads should be covered with sleeving except for cases where they are so short that short-circuits cannot possibly occur. The heater leads must be carefully twisted together, following the route shown in Fig. 7. One of these heater leads is continued from tag 4 of V_1 to the Pye socket earthing solder tag.

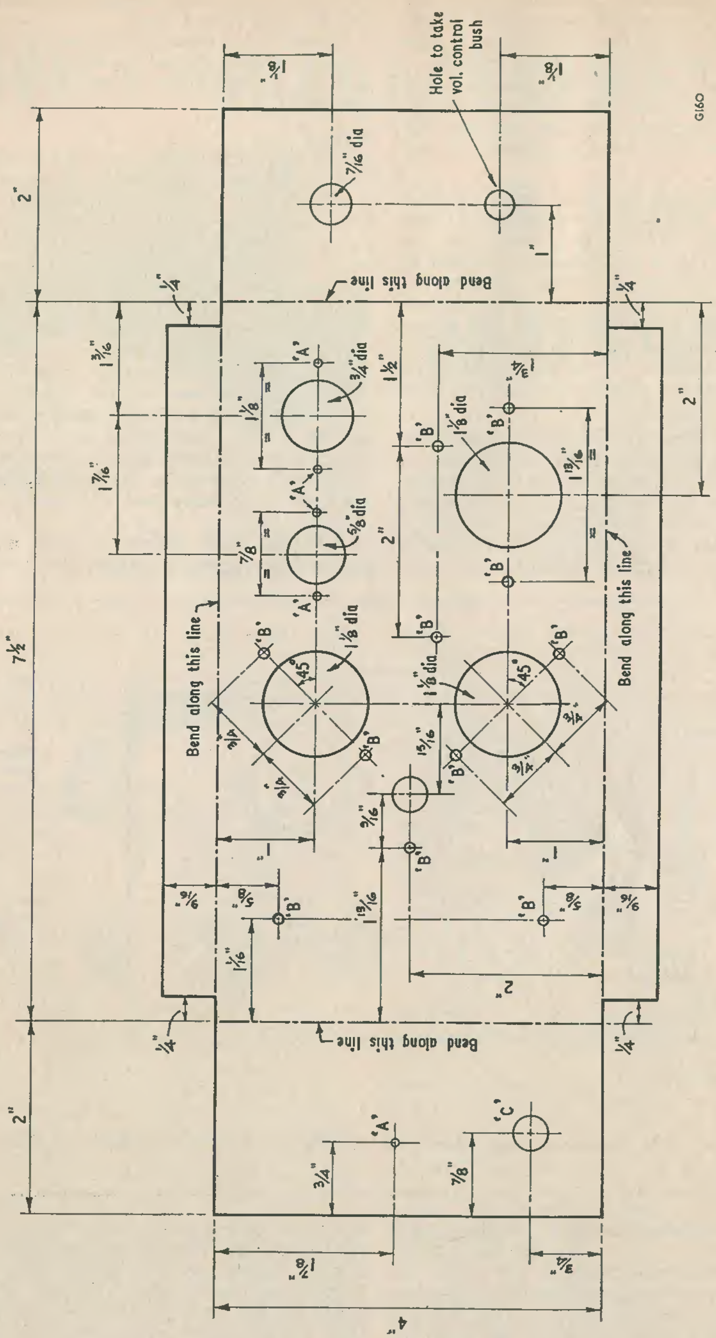


Fig. 5. The dimensions and drilling positions needed for the amplifier chassis. The letter references are explained in the text.

Further fitted to this socket are several other leads (all illustrated in the diagram) which may also be connected in at this stage. Additional parts fitted are the output bias components and R_4, R_6, R_7, C_2, C_3 and C_{10}. R_4 and R_7 should be positioned fairly close to the underside of the chassis, to leave room for later components. For clarity, C_9 is shown as having rather long leads: in practice, the negative end of this condenser lies directly underneath the negative end of C_8. Care should be taken to ensure that the sleeving fitted over the positive lead-out wire of C_2 is taken right up to the body of this condenser, otherwise it is possible for this lead-out wire to touch the chassis. In cases where connections are marked "Do not solder," this infers that more wires have to be fitted to the appropriate tag later, after which process the whole connection will be soldered. All joints not so marked may be soldered. The same instruction applies to succeeding diagrams.

The five leads travelling through the grommet hole to the speaker transformer are connected up in Fig. 8. It is important to note that the two anode connections to the transformer should be of a "temporary" nature only, as they may have to be changed over later. On no account, however, should these "temporary" connections consist merely of twisting the bare wires around the tags without soldering, as an intermittent connection to the anodes of V_3 or V_4 can damage these valves when power is later applied to the amplifier. Although "temporary," the anode connections must still be reliably soldered. The transformer tag numbers referred to in Fig. 8 are those shown in Fig. 4. (The actual component itself does not have numbered tags.) Also illustrated in Fig. 8 are the chassis connections to the spigots and screen of V_1 and V_2.

Fig. 9 shows the next stage in wiring the amplifier. Note that C_5 now partly hides R_7, which was fitted in Fig. 7. The leads to R_9 and R_{10} are shown slightly longer than they would be in the actual amplifier, in order to ensure clarity in the diagram. These two resistors should, in practice, be mounted close to the tag-strips. All other components are shown in their final positions.

We now carry on to Fig. 10. This diagram shows all the remaining components which are connected into the input valve circuit. The bulky decoupling condenser, C_1, is fitted by one lead-out wire only at this stage. The other wire is connected to the central terminal of the adjacent tag-strip, and the condenser finally positioned, in the manner shown in Fig. 11. Soldering this "earthy" connection also solders the negative lead from C_3–C_{10} fitted in Fig. 7. Figs. 10 and 11 emphasise that the outside foil (O.F.) lead-out wire of C_1 (at that end of the condenser which is marked with two parallel bands) connects to chassis. (Condensers C_4, C_6 and C_7, fitted earlier, are not used for decoupling and may be connected either way round.)

Testing

Apart from the absence of the negative feedback loop, and the fact that the connections made to tags "A" and "B" (Figs. 10 and 11) are as yet unsoldered, the amplifier is now complete and ready for checking. (If a testmeter is available, a quick check for h.t. short-circuits may now be made by testing between chassis and the positive tags of C_3, C_{10}. If the wiring has been carried out carefully, however, such a test is not really necessary, of course.) The amplifier can next be connected to its power-pack, and the loudspeaker to the output transformer. Tags 1 and 2 (Fig. 4) are for 3 ohm loudspeakers and tags 1 and 3 for 15 ohm loudspeakers. Ensure that the unsoldered leads fitted to tags "A" and "B" (just mentioned) are not liable to work free and cause any short-circuits.

An a.f. input signal should next be applied, from any suitable source, to the input of the amplifier. The input connection should, of course, be made via screened cable whose outer conductor is earthed both at the amplifier plug and at the input source. Television co-axial cable is excellent for this purpose, and has the advantage of enabling a simple connection to be made to the Pye plug. Also, its self-capacity is low.

In its present condition (i.e. without feedback) it will be found that the amplifier is very sensitive and that it gives a high degree of gain. Fidelity of reproduction should be good and there should be no trace of instability whatsoever. There may be a slight amount of hum—which can be reduced considerably by connecting the amplifier chassis to a good earth connection or, in some instances, merely by reversing the mains plug in its socket.

In any event, any hum that is evident at this stage should drop to an inaudible level when the feedback loop is completed.

Feedback

The feedback circuit may now be connected. This is done by soldering R_{13} across the tags marked "A" and "B" in Figs. 10 and 11, keeping the resistor reasonably close to the tag-strip. The next step consists of ensuring that feedback is of the correct phase.

To do this, V_3 should first be removed from its socket (to reduce the available power output) and the amplifier switched on. It is advisable to keep one's hand on the on-off switch during the time that the amplifier is warming up, as it is necessary to be able to switch off at once should the feedback

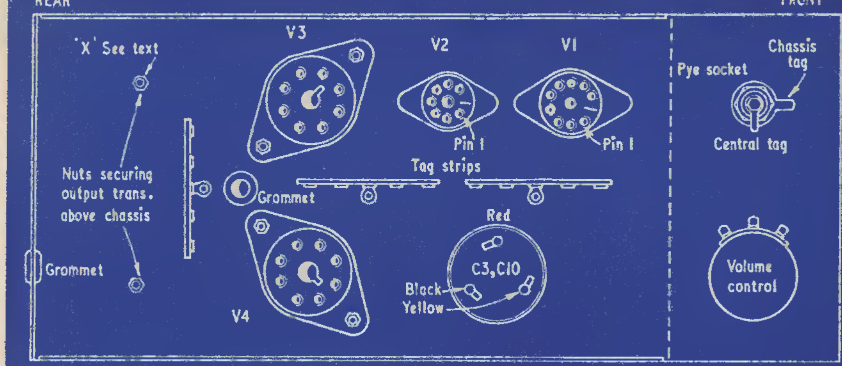


FIG.6.

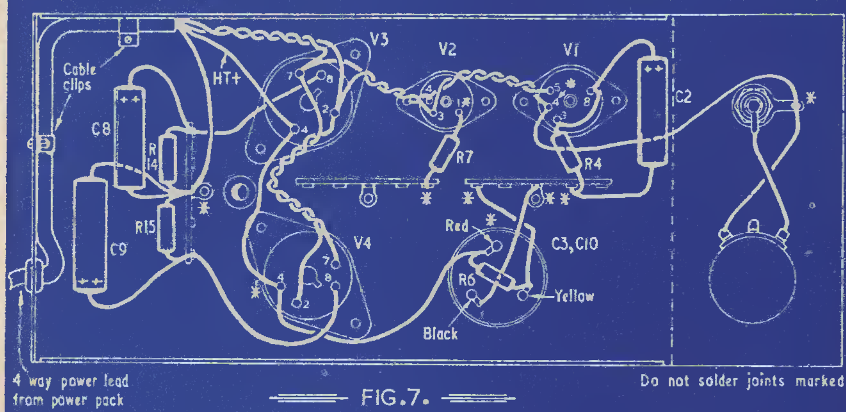


FIG.7.

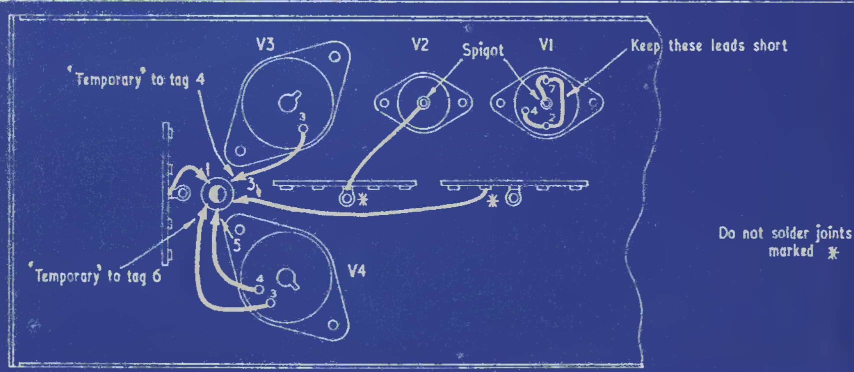


FIG.8.

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Fig. 6. Layout of the principal components below the chassis. Fig. 7. Initial stage in the wiring of the amplifier. Fig. 8. Connecting up the speaker transformer

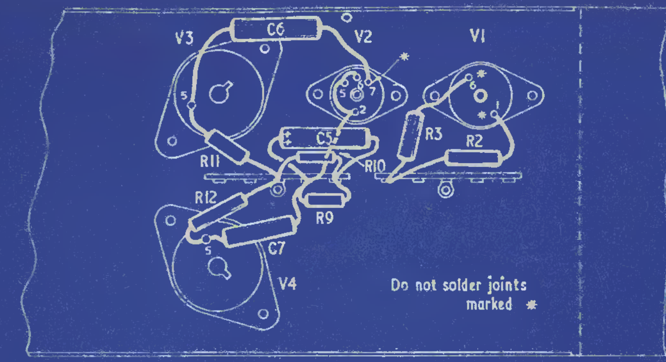

FIG.9.

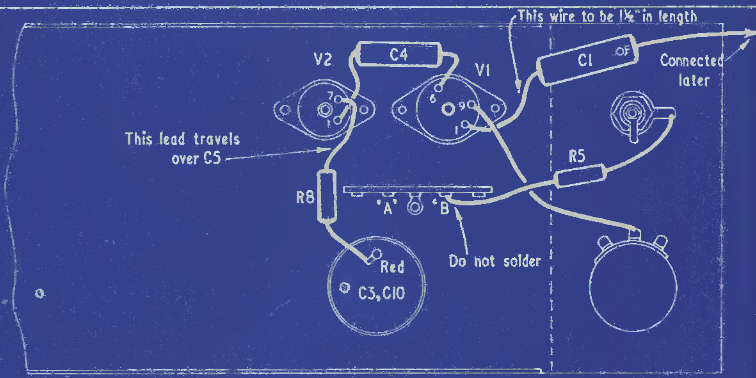

FIG.10.

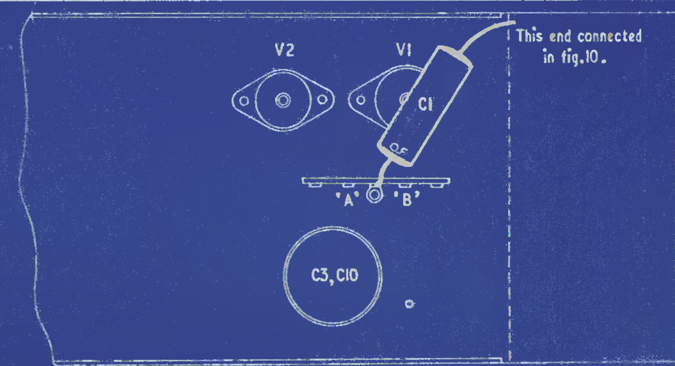

FIG.11.

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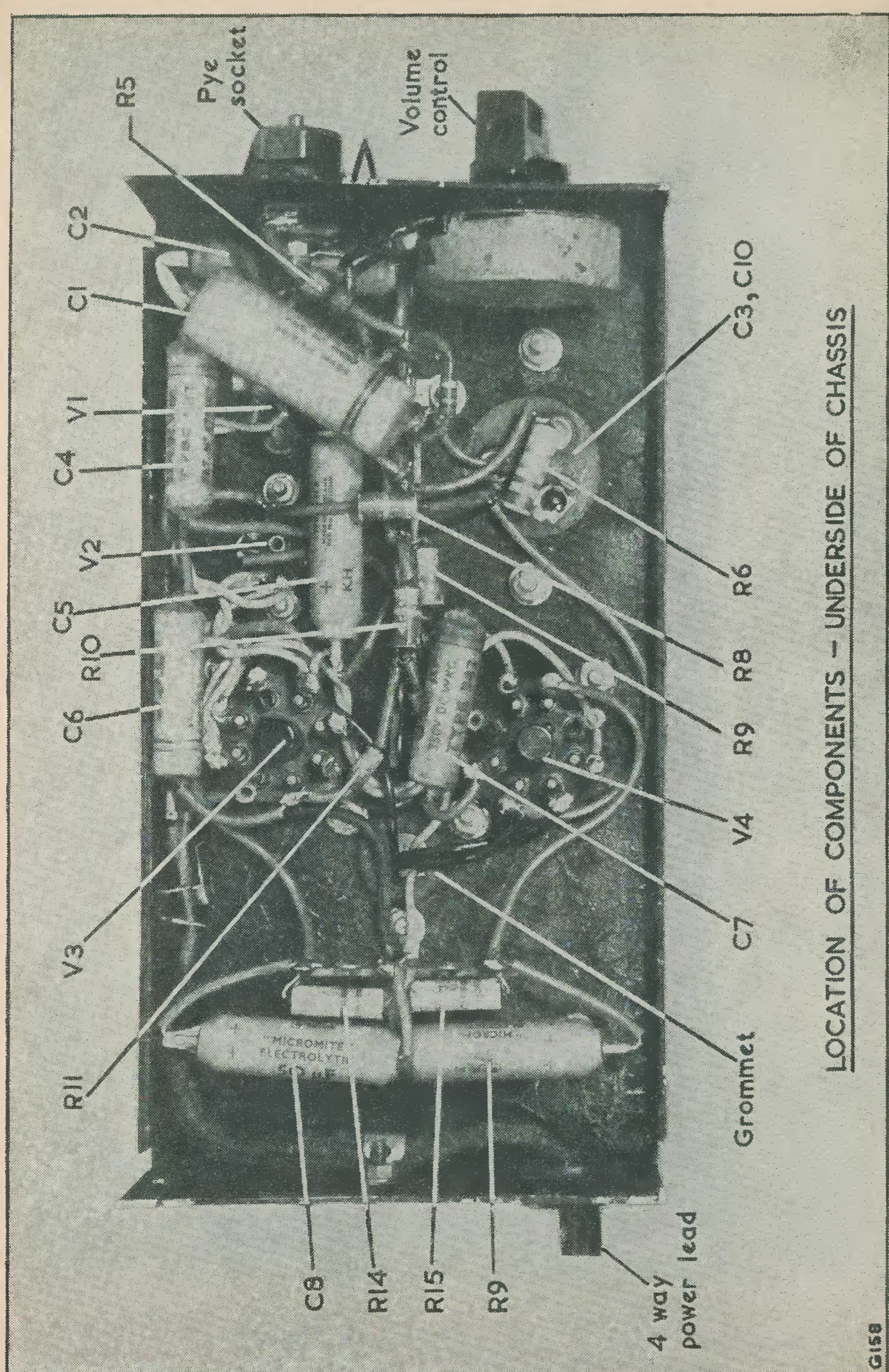
Fig. 9. Completing the wiring around V2. Fig. 10. Final stage—the components in the input valve circuit. Fig. 11. How C1 is fitted and positioned. The letter references in this and Fig. 10 are discussed in the text



LOCATION OF COMPONENTS – UNDERSIDE OF CHASSIS

happen to be positive instead of negative. The reason for this precaution is that positive feedback will cause a continuous oscillation on one note which may cause damage to certain models of loudspeaker if sustained for too long a time. Should the feedback be negative, this will show itself immediately in the form of reduced volume and lower noise and hum level. If it occurs, the positive feedback condition can be altered to negative feedback simply by changing over the two anode leads temporarily connected to the output transformer in Fig. 8.

After completion of this test, the anode leads may be connected finally and permanently to their tags, and V_3 re-inserted in its socket.

The "Full-Tone" amplifier is now complete and ready for use. The writer trusts that constructors will obtain as much pleasure from its performance as he has gained with the prototype.

AN IMPORTANT ANNOUNCEMENT

Band III for the Home Constructor

As our readers are aware, *The Radio Constructor* has always been active in new developments which affect the home constructor. Readers may recall that we were among the first to introduce articles describing the construction of television receivers from Government Surplus materials in the years which immediately followed the war, at a time when manufactured components were almost completely unobtainable. This was our "Inexpensive Television" series; later to become a popular handbook, and one which is still current, in the Data Book series.

These articles were followed by the publication of details of the "Magna-View," the first 70 degree wide-angle home constructor televisor in this country. The sound design of this receiver has been amply demonstrated by the fact that two leading manufacturers of cathode ray tubes and valves have since published booklets devoted entirely to its construction.

In the field of frequency modulation we have also played a leading part, producing designs which are *practical* and which are intended *specifically* for the home constructor. Our policy of catering for the constructor in his own workshop has shown its success in our continually increasing circulation figures, now in excess of 27,000 copies monthly.

During the last 12 months the staff of *The Radio Constructor* has paid a considerable amount of attention to the feasibility of Band III reception by the home constructor. This particular situation is considerably complicated by the fact that the home constructor does not have access to the expensive test gear available to the manufacturer of Band III tuning equipment. In consequence, home constructor Band III television design has to be carried out under the assumption that the reader may be in possession only of a simple testmeter. On the other hand, of course, it assumes the fact that he has the necessary skill and ingenuity to put published circuits and drawings into concrete, workable form.

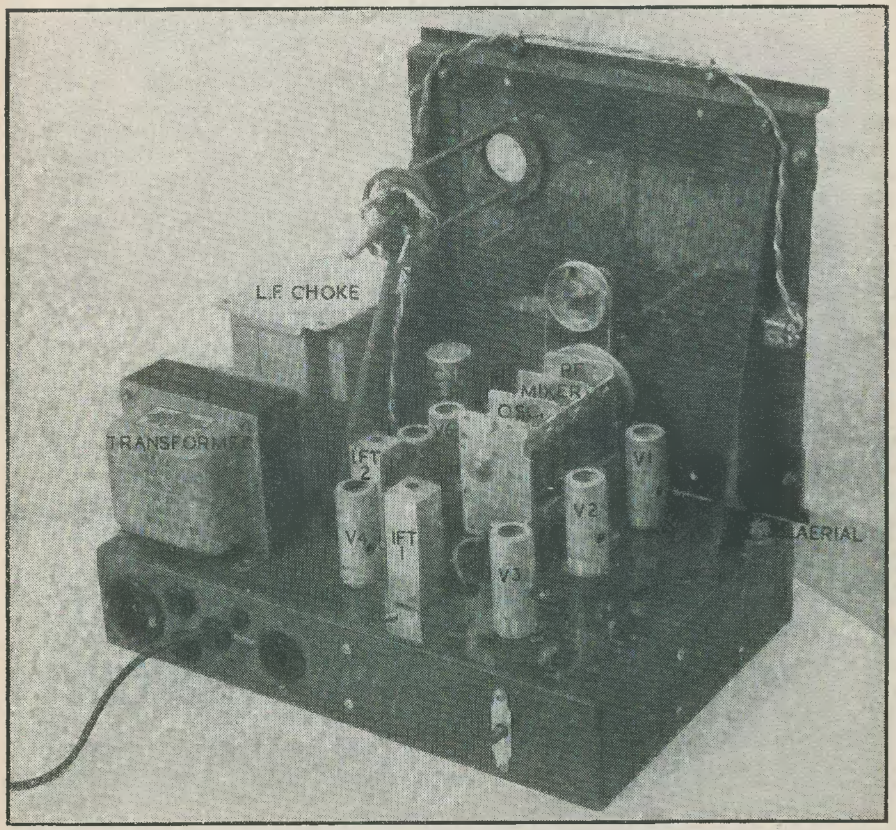
We feel that we now have available a suitable receiver unit for reliable and satisfactory reception of Band III transmissions in the anticipated service area. Preliminary checks with the experimental broadcasts from the Belling-Lee transmitter on Channel 9 have given excellent results. Furthermore, our design has been largely the result of considerable co-operation between ourselves and leading manufacturers, and we anticipate no difficulties due to the non-availability of component parts.

We have pleasure, therefore, in announcing that "Band III For The Home Constructor" will commence in next month's issue. Once again, *The Radio Constructor* leads the way in practical design.

HIGH QUALITY TUNER UNIT

by **H. S. G. THORPE**

PART 1.



Three-quarter rear view showing layout of above-chassis components—see also cover illustration

Circuit

THIS TUNER UNIT IS INTENDED PRIMARILY for use with a high quality amplifier, but by adding a triode amplifier stage and an output stage a complete receiver can be built. The circuit diagram is shown in Fig. 1 a and b.

The r.f. stage uses a variable-mu r.f. pentode 6BA6 to which a.v.c. is applied. The use of an r.f. stage is particularly advantageous on the short-wave bands to minimise second channel interference which would otherwise be very troublesome. Also the sensitivity of the receiver is increased on the short-wave bands as signal level is raised in relation to the mixer noise.

It will be noted that provision is made in the coil switching for shorting out coils not in use, so that absorption effects do not mar performance.

The i.f. stage is another 6BA6 with a.v.c. and the selectivity switch S_2 switches resistors across the primary and secondary of T_1 in the "broad" position. T_2 is already sufficiently damped by the diode to make further switched resistors unnecessary.

In the detector stage the filter components, R_{18}, C_{24} and C_{25} are chosen so that the stage can handle signals with 95% modulation up to 8 kc/s.

The output of the detector feeds into a cathode follower (6C4). This has the advant-

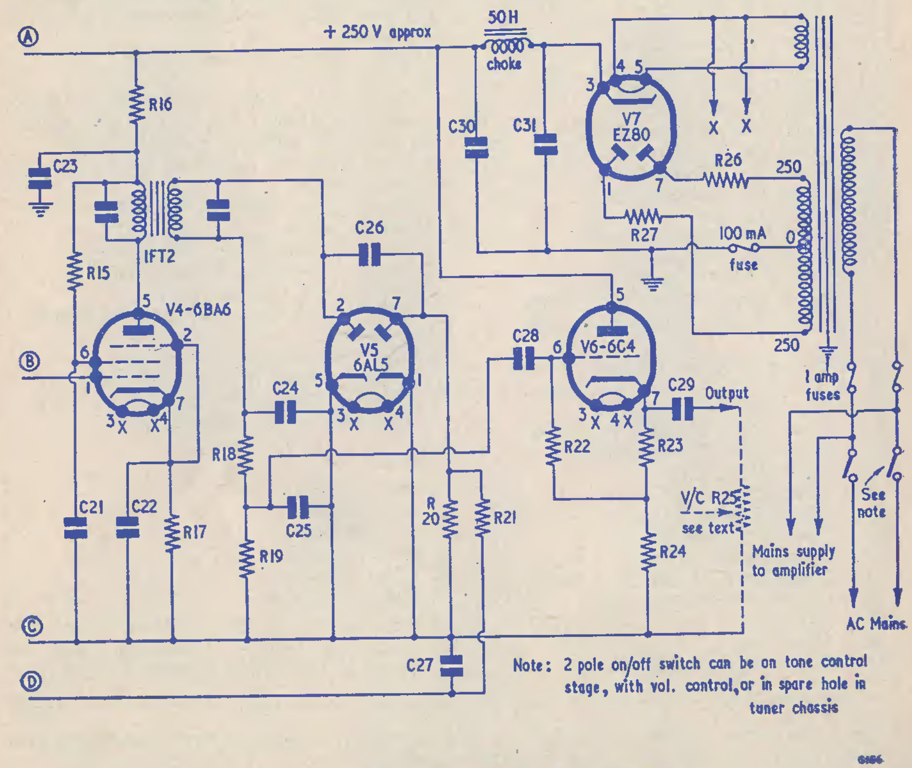


FIG.1(b) QUALITY TUNER — CIRCUIT DIAGRAM

The mixer stage is a 6BE6 with a 6C4 separate oscillator. This arrangement permits the oscillator stage to be built in a separate screened compartment, the only coupling to the mixer being through C_{18}. Thus undesirable stray coupling is avoided and the resulting "pulling" effect on short waves reduced to negligible proportions.

age of providing a low output impedance so that the tuner unit may be connected to an amplifier with a lengthy coaxial cable with negligible effect on the high frequency response.

Also, the use of a volume control is avoided at this point in the circuit so that the undesirable effect of a high frequency response which

PROTOTYPE COMPONENT LIST

R1 220kΩ ½W, Radiospares
R2 33kΩ 1W, "Labpack," R.R. Co.
R3 68Ω ½W, Radiospares
R4 1,800Ω ½W, Radiospares
R5 1,800Ω ½W, Radiospares
R6 22kΩ ½W, Radiospares
R7 1,800Ω ½W, Radiospares
R8 22kΩ 2W, R.R. Co.
R9 150Ω ½W, Radiospares
R10a, R10b } 100kΩ ½W, Radiospares
R11 100kΩ ½W, Radiospares
R12 47kΩ ½W, Radiospares
R13 47Ω ½W, Radiospares
R14 270kΩ ½W, Radiospares
R15 33kΩ 1W, R.R. Co.
R16 1,800Ω ½W, Radiospares
R17 68Ω ½W, Radiospares
R18 250kΩ ½W, Radiospares
R19 500kΩ ½W, Radiospares
R20 1MΩ ½W, Radiospares
R21 500kΩ ½W, Radiospares
R22 1MΩ ½W, Radiospares
R23 5.6kΩ ½W, Radiospares
R24 47kΩ ½W, Radiospares
R25 see text
R26 125Ω 3W, Radiospares
R27 125Ω 3W, Radiospares
C1 0.01μF 150V, Hunts, TU1
C2 0.1μF 150V, Hunts, TU1, A300
C3 0.05μF 150V, Hunts, TU1, A300
C4, C5, C6 } 3-gang 0.0005μF Osmor
C7 0.1μF 500V, Hunts, A58
C8 0.1μF 150V, Hunts, TU1, A300
C9 0.1μF 500V, Hunts, A58
C10 0.1μF 350V, T.C.C.
P4 4,500pF padder, Osmor
P3 4,500pF padder, Osmor
P2 2,500pF padder, Osmor
P1 470pF padder, Osmor
C15 0.1μF 150V, Hunts, TU1, A300
C16 0.1μF 500V, Hunts, A58
C17 0.1μF 150V, Hunts, TU1, A300
C18 50pF Mica
C19 0.1μF 500V, Hunts, A58
C20 100pF Mica
C21 0.05μF 350V, T.C.C.
C22 0.05μF 150V, Hunts
C23 0.05μF 350V, T.C.C.
C24 50pF Mica
C25 50pF Mica
C26 100pF Mica
C27 0.1μF 150V, Hunts TU1
C28 0.1μF 150V Micamold
C29 0.1μF 350V, T.C.C.
C30 32μF
C31 16μF+32μF in= } 350V wkg B.E.C. CE923

12 Trimmers, 50pF. Concentric or similar
Mains Transformer, 250-0-250V 80mA, 6.3V 4A, Woden, RMS11A or similar
Choke, 50H, 50mA, Woden PCF16 or similar
1 Fuse 100mA; 2 Fuses 1 amp.
12 Coils, Osmor
QA1, QA3, QA4, QA8, QHF1, QHF3, QHF4, QHF8, QO1, QO3, QO4, QO8
1 Pair IFT's, 465kc/s, Midget, Osmor
1 Dial Assembly complete, with Type G2 scale, Osmor
1 Coax Plug and Socket, Aerialite
1 Switch, see text
1 Switch, 2-pole, 2-way, Selectivity
1 Mains Connector, Bulgin P463
3 Fuseholders, Belling-Lee
6 B7G Valveholders with cans, McMurdo
1 B9A ditto.
2 Octal valveholders, Amphenol (only 1 needed if Magic Eye not fitted)
1 Chassis, Aluminium, size 12″×8″×2¼″
1 Two-speed drive, Jackson Bros.

Valves
2 6BA6, Brimar
1 6BE6, Brimar
2 6C4, Brimar
1 6AL5, Brimar
1 EZ80, Mullard
1 EM34, Mullard

Wire, Systoflex, 6BA Solder Tags, Self Threading screws. Screened wire as required for output lead, T.V.I., Henley.

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varies with volume setting is avoided. If a volume control is required it can be fitted after C_{29}, and may be of a low value.

Gram switching is not incorporated in the tuner, as it would normally be done in a pre-amp tone control unit following the tuner.

The wavebands covered are as follows:

1. 13–35 metres .. SW. 1
2. 35–120 metres .. SW. 2
3. 70–230 metres .. Trawler
4. 190–560 metres .. MW

Chassis

The main chassis is made up of 16 s.w.g. aluminium; welded corners would be preferable.

The layout is as shown in the illustrations. The dial is held in the correct position on the chassis and the fixing holes on the mounting brackets are marked through on to the main chassis, and a $\frac{1}{16}$in. drill run through the centre of the marked hole. The brackets are then screwed to the chassis with self-threading screws. The condenser is placed on the main chassis with its spindle exactly under that of the pointer on the dial, and then the holes in the feet marked on to the chassis. Drill 4-BA

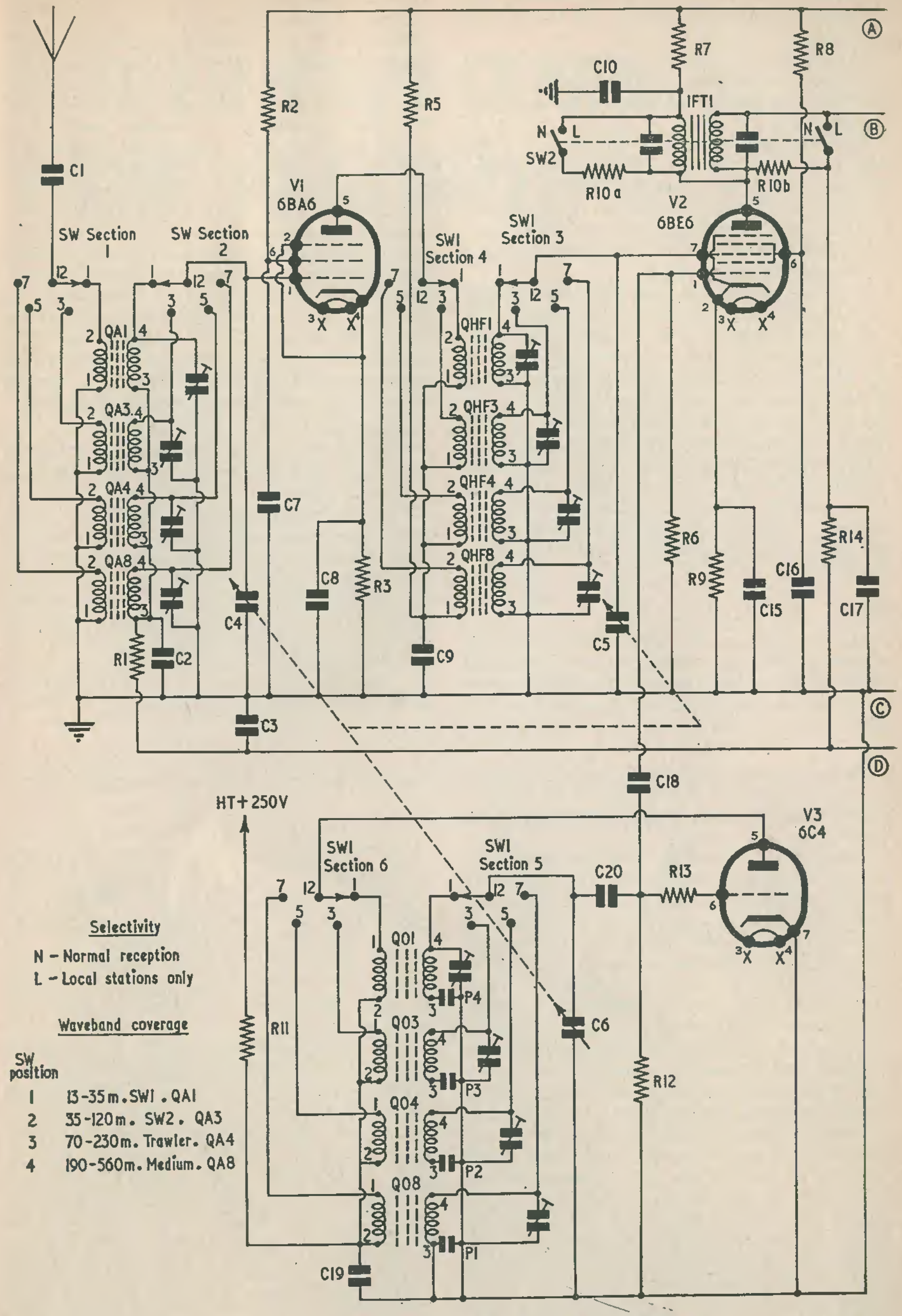

FIG.1(a).QUALITY TUNER ~ CIRCUIT DIAGRAM

G155

clearance, and fix condenser to chassis, not forgetting to use rubber feet on the tuning condenser.

The interstage screens are the most difficult operation to perform, and the author found the following method of bending and marking out the best.

Cut the long screen to the correct width and fold over the $\frac{1}{4}$in. on one end only, measure the exact internal width of the chassis after bending, subtract the thickness of the screen material (approximately $\frac{1}{16}$in.) from this and mark the length of the screen including the bent portion.

Bend along this line, and the screen should then be exactly the width of the chassis. Fix this screen across the chassis with self-threading screws, and then measure the width for the two shorter screens as above, fixing these with self-threading screws also. When the screens are fitted satisfactorily, remove them, and place one of the shorter screens on a flat surface, and use dividers to scribe the height of the switch fixing holes, taking the exact length from the holes in the main chassis. Repeat for the second screen. Drill all holes in the three screens and fix them to the chassis.

Coils

Osmor "Q" coils are used, 12 being required. These coils are very small and easily mounted, the tags on top allowing ease of wiring in the screened compartments.

Wavechange Switch

The wavechange switch consists of six wafers, each wafer being single-pole, four-way, with shorting plates on wafers 2, 3 and 5, to short the grid coils not in use to earth. The spacing of the locating plate is 60°, but 30° spacing would do equally well. The switch locating plate is mounted outside the front of the chassis, to facilitate removal of the switch spindle for wiring up in the screened compartments, and to allow extra space in the aerial compartment. The switch wafers are bolted to the screens and chassis, spacers being used to separate the wafer from the screen. This method of fixing is to be preferred to using long bolts the width of the chassis, as it allows more space in the compartments, and easy removal of wafers and switch spindle. The author made up the switch from a number of modified wafers.

Components

The complete dial assembly and 3-gang condenser is made by *Osmor*, the dial type G2 being used.

The i.f. transformers are *Osmor* miniature type, their operating frequency being 465 kc/s. The mains transformer and smoothing choke are *Woden*, but any reliable make would do equally well. The majority of condensers and resistors are of the midget type, especially those used in the r.f. sections, and while any type would do it is recommended that those specified should be used, as their physical size allows neatness and ease of wiring.

(To be Continued)

COPYRIGHT AND TAPE RECORDING—*(Continued from facing page)*

But it is playing with dynamite to venture outside one's own door or a friend's house, with a view to playing a home recording before an audience, for then, in addition to the copyright administered by Mechanical Copyright Protection Society, the public performing rights may be infringed. These are looked after by the Performing Rights Society on behalf of all authors and composers, and by Phonographic Performance Ltd. for the gramophone companies.

It might be as well to examine what is actually a public performance. In a test case, a judge in the High Court said that any performance outside a person's own home may be a public one, and by a variety of test cases, it has been proved that music played by any means, in clubs, factories, public houses and cafes, is public, as well, of course, in theatres, cinemas and dance halls. Even hairdressers, railway authorities, owners of ocean liners, pleasure boats and football grounds, hold annual licences from these bodies.

All are supposed to make periodical returns of the music that is played, so that they can be analysed, and the fees paid out accordingly to the individual members concerned, which is done twice yearly.

The Performing Rights Society, alone, deals with over a million programme forms a year, and don't the band leaders love writing them out!

Any reader desiring further information, or who is in doubt about any particular point in regard to the subject, which, being so involved and complex, has necessarily been briefly sketched in this article, can apply to Mechanical Copyright Protection Society Ltd., 29 Maddox Street, London, W.1, just off Regent Street, who will be happy to give sympathetic guidance on all these matters.

Having held the "Gorgon's head" in front of the readers, it is as well to end, by saying that the majority will only be using tape recorders for their own amusement at home, and therefore will not go in fear lest the long arm of the law reaches them!

COPYRIGHT AND TAPE RECORDING

by **F. NEVILLE HART**

TO THOSE WHO HAVE MADE OR BOUGHT tape recorders, the matter of copyright is of no little interest, particularly if they want to put on the tape a musical performance, including excerpts from radio or commercial gramophone records.

Gramophone enthusiasts may have noted, on the label of every disc, that the word "copyright" is written somewhere, and probably have only a vague idea what this really means. It is a word, simple and descriptive—the right to copy—and although on a piece of sheet music it states "copyright reserved," the second word is implied and often left out.

But the Copyright Act of 1911 was designed to ensure that those who create works of art, in any medium, that is, literature, authorship, music, painting and even photography, shall be protected from exploitation by any means, and shall derive the full financial benefit from their inspiration and work. Moreover, it is surprising how well thought out that Act was, for in spite of the vast changes that have taken place since that time, and the introduction of radio, radiograms and television, the protection afforded to copyright owners is still as strong as ever.

As we are only considering tape recorders, however, we are mainly concerned with music, songs and plays, and gramophone records. The Act clearly defines that authors and composers, or their agents, have the sole right to permit their work to be published, recorded or played in public, and naturally, since they write for a living, we have to pay them if we wish to do any of these things.

So in simple terms, we are infringing their copyright if we do anything to deprive them of any part of that livelihood.

One might go so far as to say that if we record a song from the radio, we are saving ourselves the cost of a copy of the music or a record disc, and thus depriving the writers of their royalty.

Strictly speaking, then, the copyright is infringed. But it is, of course, appreciated by copyright owners that they cannot be aware of all tape recordings made in the privacy of the home, and although such recordings constitute infringements of copyright, the policy has been to take no action in those cases brought to their notice, although the right to do so is reserved.

But still, it is interesting to explore just how deep this copyright business goes, for it is not only confined to the authors and composers, as there is copyright in a gramophone disc itself, regardless of what is recorded on it, and such recording may not be copied or "dubbed" without the permission of the manufacturer. Incidentally, permission is rarely granted except in most exceptional cases, a severe view being taken of infringement of this right.

Even then, the complications do not end there, for in addition to the law of copyright, there is the position of the performing artiste to be considered. His rights are protected under the provisions of the Dramatic and Musical Performers Protection Act of 1925, under which it is an offence to record his performance without his written consent. This would extend to every member of a band or orchestra performing the piece to be recorded. Imagine trying to obtain the written consent from every member of the Halle Orchestra if one wanted to make a tape recording of a broadcast of their performance! However, this Act continues by stating that it shall be a defence to any proceedings, brought under its provisions, if it can be proved that the recording was not made for the purpose of trade or public performance.

In any case, there is fortunately an organisation, called Mechanical Copyright Protection Society, which deals collectively with the majority of copyright owners, and to whom those making recordings apply, and pay their mechanical royalties to the publishers, authors and composers.

(continued at foot of opposite page)

Query Corner

A *Radio Constructor* Service for Readers

Indicator for F.M. Tuner

I am using the F.M. Tuner Unit, described in the July 1954 *issue of* The Radio Constructor, *and would like to add a tuning indicator. Your recommendations regarding a separate power pack would also be appreciated.*

*J. Lawn, London, S.W.*1

Judging by the correspondence recently received, the F.M. Tuner first described in the July issue, and afterwards improved by modifications included in the September issue, has aroused considerable interest. This tuner is of a design which is readily suited to home construction, and is capable of giving really first-class results when fed into the p.u. sockets of a radio receiver or the input terminals of a high quality amplifier. We are sure that now the B.B.C. plans for a wide coverage of the three programmes on f.m. are well under way, there will be increased interest shown in this superior form of broadcasting. It is planned, at the time of writing, that the transmitter at Wrotham should relay all three programmes continuously as from the 2nd May.

There are two points on the circuit from which the grid control voltage for a tuning indicator may be obtained; the grid leak of the limiter valve, V_4, or the biasing network for the ratio detector. Of the two sources, the latter provides the greater range of control voltage, and hence is capable of giving a more sensitive indication of the optimum tuning point. However, because of the use of a.v.c., the exact mid-tuning point may still be a little indefinite, and to sharpen up the indication still further the anodes of the tuning indicator are fed from the decoupled h.t. point for the limiter valve.

As the signal level increases, so the negative bias on this valve rises, reducing the anode current and thus increasing the voltage at the junction of R_{11} and C_{16}. This variable voltage when applied to the anodes and deflector plates of the tuning indicator serves to increase its sensitivity.

The complete circuit diagram of a full-wave power pack and tuning indicator for the F.M. Tuner is shown in Fig. 1. The method of connecting the indicator to the limiter and detector circuits will be apparent. The leads between the indicator and the main unit may be of any reasonable length. As the unit may well be used to feed into a high quality amplifier, it was thought desirable to recommend an isolated full-wave rectifier type of power pack to reduce the possibility of hum being introduced into the audio section. The Mullard EM34 is one of the most satisfactory types of tuning indicator for this unit, as its dual sensitivity provides a good indication over a wide range of signal levels.

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 matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like. Queries relating to ex-W.D. surplus or commercial equipment cannot be accepted.

(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.

Discrimination Alignment

Would you please advise me regarding the best method of aligning the ratio detector transformer of my recently constructed f.m. tuner? I believe that the rather poor quality of reproduction is due to an assymetrical response curve. *C. Bennet, Brighton*

The detector circuit of an f.m. receiver may be regarded as the heart of the set; any defect in this part can play havoc with the quality of reproduction. The f.m. detector is a device for producing a voltage which will vary in amplitude with changes in frequency of the incoming signal. It follows that the rate of change of amplitude of the detector signal varies in accordance with the rate of change of frequency of the incoming signal. If we are to plot the output from the detector against frequency variations on either side of the nominal value, we should have a curve such as that shown in Fig. 2. This curve assumes that the i.f. signal fed to the detector has a value of 10.7Mc/s, and that the circuit has a linear characteristic for 120kc/s on either side of this value. The difference between the maximum modulation deviation of ±75kc/s and ±120kc/s is necessary to allow for local oscillator drift. This drift is particularly marked during the warming-up time of the receiver, and is very unlikely to be less than ±40kc/s. Drift has the effect of shifting the centre working point up or down the response curve by altering the nominal intermediate frequency. To align the detector, a signal generator capable of covering the i.f. channel (normally 10.7Mc/s) and a voltmeter having a resistance of the order of 5,000Ω/volt are required. During alignment the meter must be connected at points A, B, C and D in Fig. 1. Should the ratio detector be of the assymetric type in which one cathode is earthed, the diode load resistor must be replaced by two equal value resistors in series to provide the centre tap. The value of the two resistors must be equal to the signal component which they replace temporarily during adjustment. If a high resistance voltmeter is not available, an oscilloscope which provides a reading of d.c. may be used.

Connect the voltmeter on the 10V range across A–B, and feed the output from the signal generator into the control grid of the last i.f. valve. Adjust the core in the primary (anode) winding to give maximum voltage output with the generator tuned to the i.f. The output from the generator should be kept

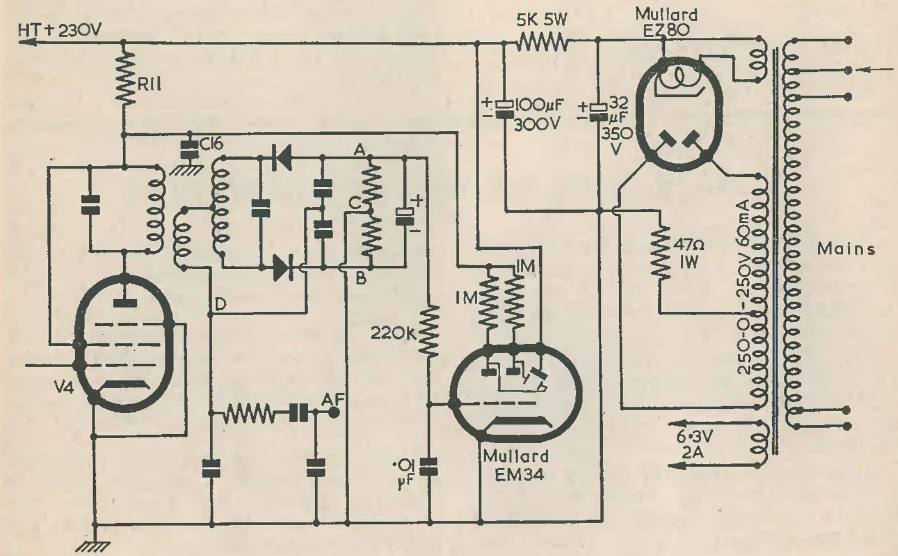

Fig.1

Tuning indicator & power pack for the FM tuner (all unmarked component values remain unchanged) low during this adjustment. Move the voltmeter to C–D, and with the generator still set

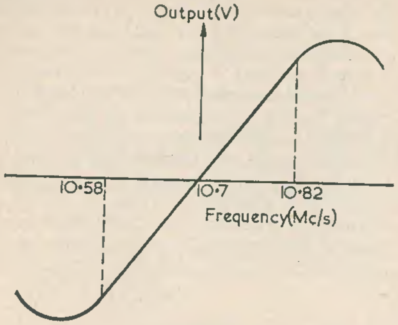

Fig.2
Response curve of ratio detector

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to give the i.f. adjust the secondary core for minimum output. For a well-designed detector transformer this will be very nearly zero voltage. Return the meter to A–B and readjust the primary core for maximum output.

The overall response can now be checked by connecting the meter at C–D, and with the nominal i.f. injected into the i.f. valve the reading will be a minimum. If, now, the frequency is first increased and then decreased, two voltage maxima will be found.

These should be equally spaced on either side of the centre frequency (i.f.) and about 240kc/s apart. The curve between the peaks should be reasonably linear as shown in Fig. 2. Slight readjustment of the cores is permitted to obtain optimum results.

This procedure is only applicable to the ratio detector; the method of aligning a Foster-Seeley type of circuit will be described in a later issue.

NEW PHILIPS L.F. VALVE VOLTMETER

Chief features of the new type GM6017 L.F. Valve Voltmeter recently introduced by Philips Electrical Ltd. are its excellent frequency range—2c/s to 200kc/s—and high sensitivity.

Designed for the acoustic and ultrasonic frequencies, this instrument can be used to measure a.c. voltages when investigating electro-acoustical and electro-mechanical phenomena.

There are 10 measuring ranges covering 0–10mV up to 0–300V. An extremely accurate R.C. Generator supplies fully-stabilised calibrating voltages of 10mV, 100mV, and 1V at 400c/s, which can also be used for other purposes such as bridge-feed circuits, impedance measurement, etc.

Output voltage to the moving-coil meter is obtained from a germanium diode bridge rectifier. By replacing this with an internal resistor, the GM6017 can be used as a wide-band amplifier with a gain of 1000X.

Other features are automatic protection against over-loading; a separate capacitor which can be shunted across the meter circuit to avoid needle vibration at low frequencies; and a linear anti-parallax scale.

New Brimar Valve Manual

We'd hate to be without this book—and now the 6th Edition of the Brimar Radio Valve and Teletube Manual has been released, bigger and better than before, but still at 5s. New type valves for F.M. and Band III are included, as well as the Brimar range of transistors, both Junction and Point Contact types. Replacement and obsolete types are retained for the benefit of Service Engineers who wish to refer to their characteristics in order to substitute modern types. The circuit section has been enlarged, and the CV Series has been added to the Equivalents List.

ERRATA

In "A Progressive Receiver," Part 1, in the April issue, the coil L_1 was incorrectly quoted as an Osmor type QA5. The correct type number is QA8.

APOLOGY

Owing to a printer's error, the price of the Litesold soldering instrument was given as "from 9/6" in their advertisement on p. 635 of the May issue. This should have read "from 19/6." We apologise to readers and to Light Soldering Developments Ltd. for the inconvenience which resulted from this error.

Let's Get Started 24:

HEARING'S NOT BELIEVING

by A. P. BLACKBURN

YOU DON'T HAVE TO HAVE BEEN READING or talking radio long before the term 'db' crops up. And thereafter you are always meeting it. You know how it is—see an unfamiliar word once and for the next fortnight it finds its way into every conversation, somehow. The maddening thing is that, at the first meeting, one rarely troubles to find out what these words mean, or why they appear in that particular context. It's only when they repeatedly thrust themselves before you that you are driven to making enquiries.

Now this term 'db'. You've probably seen or heard it countless times, and you probably realise that the letters stand for decibel. The highbrow definition of decibel is a unit of transmission, but we needn't worry about that yet. The name decibel was derived from Alexander Graham Bell, the inventor of the telephone, and came into use way back in the 1920's. In those days, communication by telephone had reached a relatively advanced stage, but the absence of valve amplifiers caused the engineers some concern about the loss of signal along the line. Naturally, power the symbol P_1 and the received power P_2, and we can express this as

$$\frac{P_1}{P_2} = 10^{0.1} \qquad \ldots\ldots\ldots(1)$$

($10^{0.1}$ is only another way of saying the tenth root of 10). This expression gives us a unit of attenuation, so if a system has N units of attenuation,

$$\frac{P_1}{P_2} = 10^{0.1N},$$

or, in a logarithmic form,

$$N = 10 \log_{10}\frac{P_1}{P_2} \qquad \ldots\ldots\ldots(2)$$

The unit of attenuation that we defined in (1) above is called the decibel. So we may say that the attenuation N in (2) is N decibels.

In a nutshell, that is the history of the decibel. We come now to its place in present-day radio.

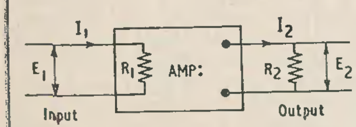

FIG. 1.

FIG. 2.

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various standard methods were adopted to compare the quality of the lines, and one attempt to lay down a satisfactory standard was the '800 cycle mile.' It was found that the standard cable had a very convenient attenuation at 886 c/s. At this frequency the ratio of the transmitted power to the received power at the other end of the cable, was found to be $10^{0.1}$ Give the transmitted

Gains and Losses

The decibel is not confined only to attenuation, of course. It has the happy disposition of being able to lend itself equally well to gain, so that we can use it when dealing with amplifiers, etc. Since we have also expressed the decibel in terms of power, we can find a way of using the db in terms of voltage, which is very useful in radio circuits where we are often primarily interested in voltage gains and losses.

Fig. 1 shows a network—in the box—which may be an amplifier or an attenuator; at the moment it doesn't matter which. The input resistance of the network is R_1 and the output resistance R_2. The power in R_1 is, therefore, $\frac{E_1^2}{R_1}$, and the output power is $\frac{E_2^2}{R_2}$

If we substitute these values for P_1 and P_2 in (2), we get,

$$N = 10 \log_{10} \frac{\frac{E_1^2}{R_1}}{\frac{E_2^2}{R_2}}$$

$$= 10 \log_{10} \frac{E_1^2 R_2}{E_2^2 R_1}$$

Now, if R_1 and R_2 were of equal value, the expression becomes:

$$N = 10 \log_{10} \frac{E_1^2}{E_2^2}$$

A further simplification is to take the square outside the log, and we get,

$$N = 20 \log_{10} \frac{E_1}{E_2} \qquad \ldots\ldots..(3)$$

and by a similar process, except that $P = I^2R$,

$$N = 20 \log_{10} \frac{I_1}{I_2} \qquad \ldots\ldots..(4)$$

The important thing to notice is that the ratio of input and output voltages and currents may be expressed in db, *only if the input and output resistances are equal.*

As an example of the use of (3), consider Fig. 1 as an amplifier with an input voltage of 0.1 volts and an output of 120 volts, R_1 and R_2 being equal.

From (3)

$$N = 20 \log_{10} \frac{120}{0.1} = 20 \log_{10} 1{,}200 \text{ db.}$$

For this next little bit we need a table of logarithms to the base 10. The log of 1,200 = 3.079.

$\therefore$ N = 20 × 3.079 = 60.98 db.

Well, of course, that's all very interesting, but we all know that it would have been just as easy to say that the gain was 1,200 times. In this simple case, that is true. But look at Fig. 2, where we have three boxes, one containing an amplifier, followed by an attenuator followed in turn by an amplifier.

The first amplifier has a gain of 50 times, the attenuator a loss of 12 times and the second amplifier a gain of 34 times. The ratio of output to input voltage is, therefore,

$$\frac{50}{12} \times 34 \text{ times} = 141.8 \text{ times}$$

Not nearly so elegant or straightforward as losses and gains expressed in db, like this,

1st amplifier gain	..	33.9 db.
2nd amplifier gain	..	30.63 db.
Attenuator loss	..	21.58 db.

Admittedly, these are still awkward figures, but the point is, you can *add* them together in the case of gains, and *subtract* the attenua-

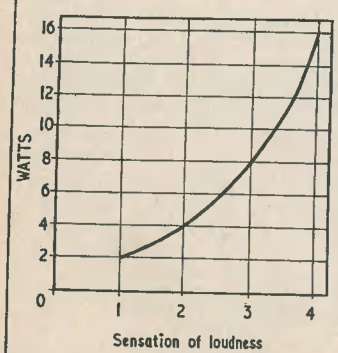

FIG.3.

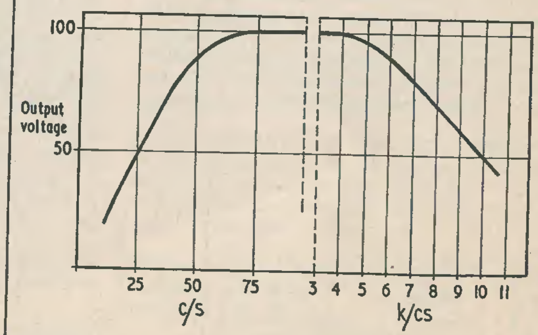

FIG.4.

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tions. The total is, therefore, 33.9 + 30.63 − 21.58 = 43.03 db. Another advantage is that the use of db involves far smaller numbers, as for example, a voltage gain of 1,000,000 which is 120 db.

We have, therefore, two advantages in expressing gain or loss in db's. We cut out the extra work of multiplication or division, but merely add or subtract successive gains or losses; and we do not have to juggle with large numbers which tend to get out of hand.

Further Justification

Many of you may feel that so far I haven't made out much of a case for the use of the decibel. However, there is a strong justification for its use.

The ear is non-linear. This means that if a sound impinging upon the ear produces a sensation of magnitude to the listener, then doubling the intensity of the sound will not produce a sensation twice as loud. That is, the magnitude of sensation would not be 2S. In fact, the listener will judge the sound to have increased by the logarithm of 2 times S. He will think, therefore, that the sound has increased by 0.3 times. In practice, this change is too small for a normal observer to detect, but if the original sound were increased ten times and then ten times again, the listener would feel that there had only been a doubling of volume between the two increases from ten times to one hundred times.

Now this results in a remarkable fact. Suppose an amplifier were producing 1 watt into a loudspeaker. If the volume were increased and the output became 2 watts, the ear would detect the same difference in loudness as when the output were increased from 2 to four watts, and 4 to 8 watts, etc. In other words, the ear will give an impression of equal *changes* in volume at any level if the power change is 2 to 1.

Fig. 3 shows how the ear responds to sound. The vertical axis represents the power delivered from the amplifier, and the horizontal axis represents the sensation experienced by the listener. At 2 watts the listener experiences one unit of loudness; at 4 watts, 2 units; at 8 watts, 3 units, and so on. All these facts help considerably in assessing amplifier performance.

Response Curves

We already know that in amplifier work all frequencies are not amplified equally. We normally expect to find a tailing-off of the gain at high frequencies and low frequencies.

Response curves are usually drawn with gain on the vertical axis and frequency along the horizontal one. We can try this first of all on ordinary graph paper, and we will get a curve rather like that in Fig. 4. This shows us that the output voltage falls to half of its maximum value at 25 c/s and at something over 10 kc/s. The break in the middle of the curve is to enable all the curve to fit into the paper.

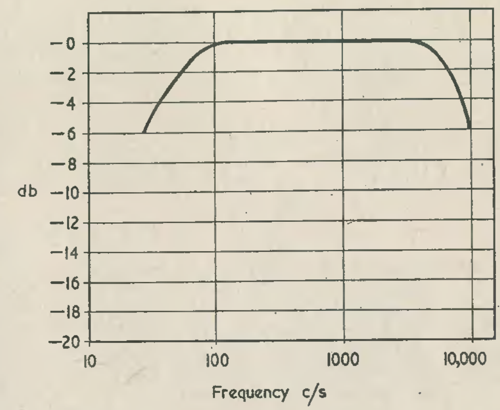

FIG.5.

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We have already seen that an increase or decrease of 50%, say, of gain, does not give the listener an impression of a 50% change in loudness. Fig. 4 then, gives a false impression of the amplifier performance from the point of view of the listener, and what is more, it is on the pessimistic side. Since no radio manufacturer would care to publish erroneous details of his latest masterpiece, the vertical scale of Fig. 4 would be marked off in decibels. At the same time, the horizontal scale would be marked off logarithmically, as shown in Fig. 5. Special paper is used for this purpose, called log. graph paper. This enables the whole of the frequency scale to be shown without the break as in Fig. 4. The way in which this graph is prepared will probably need a little explanation.

The amplifier response would be measured by one of the usual methods, say by applying an input signal of constant amplitude at various frequencies.

The output voltage would be noted at these frequencies, and from the results Fig. 4 would be drawn. However, we don't want to draw Fig. 4, because it doesn't give a true picture, but Fig. 5 does.

The maximum output voltage is taken as zero db. The requirement is to express the gain in db in terms of the maximum gain. An extract from our table of results might look as follows:

Frequency	*Gain*	*db*
150 c/s	100	0
100 c/s	100	
50 c/s	94	
25 c/s	50	

To complete the third column, we can use expression (3) . . .

Then, $\quad Ndb = 20 \log \frac{V_1}{V_2}.$

and $\quad Ndb = 20 \log \frac{100}{94} = -0.906\text{db}$

$$Ndb = 20 \log \frac{100}{50} = -6.02 \text{ db.}$$

and so on.

Now these figures merely state that at a certain frequency, say 50 c/s, the gain is 0.9 db down on the maximum gain. Note that maximum gain does not mean the gain when the volume control is hard over; that is kept constant the whole time. It means the gain over the middle portion of the graph, between about 150 c/s and 4 kc/s.

As the gain is so many db down on the maximum, a minus sign is placed in front of it. Losses are always prefixed by a minus sign.

Having completed the table, we can now draw Fig. 5.

Difficulties

Calculating db values and getting back from db's to voltage or power ratios can lead one into an awful tangle. Most of us remember logarithms best for their association with irate schoolmasters on summer afternoons, so perhaps a refresher course is called for.

There is insufficient space to deal adequately with such a mathematical concept as logarithms here. However, the use of log. tables is not as complicated as may be imagined. Suppose we wish to find the log. of 2.54. Simply look in the tables for 25 in the left hand vertical column, and 4 in the top horizontal column. Where the two columns extending from these numbers intersect, we find the figures 4048, which gives us the answer of 0.4048. If the number had been 25.4, we get 1.4048. You will remember, now that all this is coming back to you, that if the number is between 1 and 10, the log is less than 1; if the number is between 10 and 100, the log is 1. something; if the number is between 100 and 1000, the log is 2. something, and between 1,000 and 10,000, 3. something. So that the log of 1,350 is 3.1303. The number found from the log. table always comes after the point. The number in front of the point is decided by the above rule.

The easiest way of dealing with the voltage or power ratio involved is always to ensure that it is more than one. For example, from expression (3), E_1 might be 2 volts and E_2 2.8 volts. This will mean finding the log of $\frac{2}{2.8}$, or 0.7. This can lead to trouble unless you are pretty familiar with the use of log. tables. Instead, all you need to do is turn E_1 and E_2 upside down so that (3) becomes:

$$N = 20 \log \frac{E_2}{E_1} \text{ db.}$$

Then, $\quad N = 20 \log \frac{2.8}{2} = 20 \log. 1.4$

From the tables, log. 1.4=0.1461,

$\therefore \quad N = 20 \times 0.1461 \times 3\text{db}$ approx.

The next snag is, given a number of db, how we convert them to voltage or power ratios. For voltage, the expression is:

$$\frac{E_1}{E_2} = \text{antilog} \frac{N}{20} \qquad \ldots\ldots\ldots(5)$$

and for power,

$$\frac{P_1}{P_2} = \text{antilog} \frac{N}{10} \qquad \ldots\ldots\ldots(6)$$

Suppose an amplifier were said to be 6db down at a particular frequency, and we wished to check the amplifier we had just built to this design. As this will be in terms of voltage, we use expression 5. We shall need a table of anti-logarithms, here.

Then, $\frac{E_1}{E_2} = \text{antilog} \frac{6}{20} = \text{antilog } 0.3 = 1.995$

from the tables.

In other words, the voltage at the middle frequency is approximately twice that of the voltage at the stated frequency. Or the voltage at the stated frequency falls to half that at the middle frequency.

A Conversion Chart

Many readers may, quite justifiably, find it tedious to wade through tables of logs., etc., and for this reason the chart shown in Fig. 6 has been included. This enables conversions to be made from db's to voltage or current ratios direct. Conversion in the opposite way can be made equally easily.

Its use is best illustrated by example.

1. An amplifier gives 10 volts from the secondary of an output transformer at 1kc/s, and 5 volts at 10kc/s. How many db down (i.e., –db) at 10kc/s is this?

The same result is achieved if the loss ratio scale is used. In this case we divide 5 by 10, and from 0.5 travel to the left on the right hand vertical scale until we reach the same point as before, 6db.

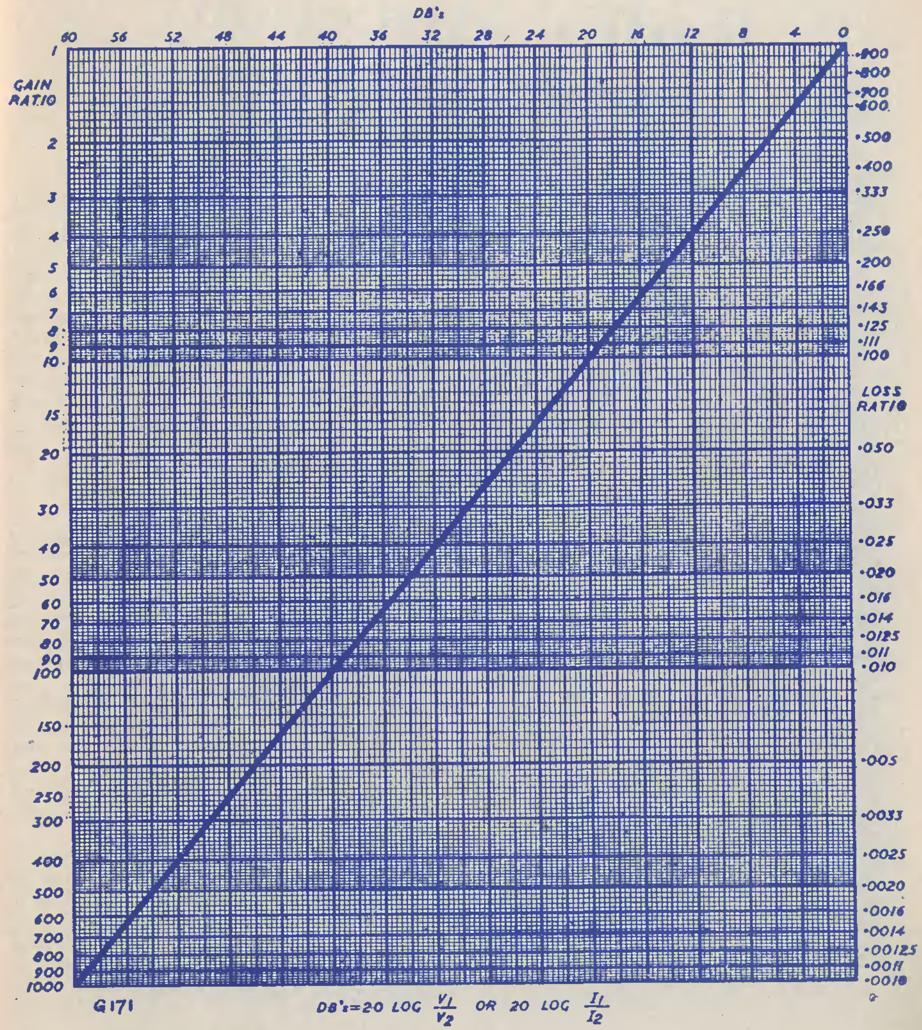


Fig. 6. Courtesy E.M.I. Sales and Services, Ltd.

First we take the ratio of the two voltages which is near the top. Moving to the right from 2 we meet the line where it corresponds to 6db on the upper horizontal scale. The amplifier is, therefore, 6db down at 10kc/s.

The latter method is technically more correct, because there is a loss of voltage at the point being considered (10kc/s) compared to the reference point at 1kc/s.

(continued on page 692)

Radio Miscellany

RECENTLY I REFERRED TO THE USEFULNESS of the so-called plastic solders for filling in unwanted holes in either metal panels or chassis. At least two brands I have tried could very effectively be used for jobs of this nature. They "work" easily, and set really hard with only a small amount of shrinkage. A good plan when using it for stopping is to cover the hole on the side which is going to show with gummed paper, which can be soaked off when the compound has set hard. This ensures a neat finish, and requires little or no rubbing down to become a virtually "invisible" repair.

I hope that no readers of this column took anything I said about this use for these compounds to mean they were also useful for the cold soldering of connections. They aren't! True, they will firmly anchor a wire to a tag and IF the two metal surfaces were making firm contact they MAY make a fairly reasonable electrical junction for a time, although they would probably give trouble later.

More experienced readers will no doubt raise their eyebrows and wonder why I drag this up. Strange as it may seem to them, there are beginners who wire up their sets this way! Sometimes the list of uses printed on the packings (or even on the tubes of plastic solder themselves) suggest it can be used for "electrical" repairs.

Mr. Thompson, of R.C.S. Products, who specialise in kit sets, tells me he has had repeated instances of beginners who have complained that either the sets don't work at all or give a much poorer performance than they should. He has followed up such complaints, not only to give satisfaction to the purchaser but also with a view to making the kit instructions more fool-proof if possible. Frequently he has found the wiring to be carried out, often quite neatly, with plastic solder. Some joints made contact of a sort, others just didn't.

Few components nowadays have terminal connections, so one of the first things a beginner must learn is how to handle a soldering iron. Normally, within a quarter of an hour's practice he gets the knack, and he wonders why anybody ever suggested it was difficult. I remember I once found a beginner who bound all the joints together with very fine wire. The set worked all right, but after two or three weeks the surfaces began to oxidise. Then the crackles started. In fact, I decided if ever I was in charge of the B.B.C.'s Effects Department to borrow that set, tune it to a point of no signal, and use it whenever it was necessary to imitate the sound of sizzling bacon over burning twigs round the old camp fire.

New Look

The recent uninformed allegations about the "excessive" cost of TV-tubes seems to have blown over. This was to be expected, as it chiefly emanated from the type of newspapers which specialise in creating sensations where no sensations exist. It has, however, led to a lot of silly notions among unthinking people.

Undoubtedly there are many receivers with faulty tubes whose owners are unable (or insufficiently enamoured with the programmes) to replace them. A few timid viewers have been unnecessarily alarmed and live in dread that their c.r.t. should suddenly fail.

What everybody has forgotten, and the press did not remind them, is that viewers get their first tube at cost price, or even less. As a consequence they have to pay extra on the replacement. To a slight extent it is like the safety razor blade holder—which is practically given you with the first three blades—except that the TV-tube normally gives a couple of years regular use.

It is the TV home-constructor who might claim to have the biggest grouse. He doesn't get his first tube cheap like the set purchaser. In fact, he has to subsidise the man next door so that he can buy his TV at a lesser initial cost.

Yet the constructor has enough good sense to realise that the present system grew out of a policy of mass marketing and the popularisation of TV. If someone can find a satisfactory way of equating the high cost of replacements, so much the better. If not, the constructor will simply put up with it, off-setting the extra expense against the many other economies he effects in the cost of his receivers and their maintenance.

Breakdown

Most viewers, if asked what they think it costs to make a cathode ray tube, will give some simply astonishing answers. Quite a lot seem to look on it as just a few bits of bent metal inside a big glass bottle, and imagine that thirty bob ought to cover it quite nicely. Even when one points out the lengthy and costly processes involved, they still feel there is a catch in it. Nor do they make any allowance for the research work that has been, and still is, done.

The most common failure in c.r.t.'s is cathode-heater breakdown. At least, without checking up, I think it must be. Perhaps I am influenced by my own experience of having this fault arise in two of mine, although in each case, I must admit after lengthy service. The symptoms, for those who have not encountered this trouble—the tube shows bright all over, and stays bright. Sometimes, if left switched on, the picture becomes normal for periods varying between a few seconds up to the rest of the evening. Our Editor, when he had this trouble, found it could be temporarily cleared by tapping the neck lightly with his finger. I found switching off for a few seconds, and then switching on again, would frequently temporarily restore normal working. I have never heard of other expedients to see you through until either you re-wire for grid modulation or acquire a new tube. If any reader has found a better way to deal with it, I should like to hear about it.

Recently I found a case of "tube failure" which turned out to be a transformer break down. The picture grew dimmer and dimmer over a period of two or three weeks. The owner, perhaps not unnaturally, thought the tube was "wearing out." He took quite a bit of convincing that it was old soldiers, not TV-tubes, that simply faded away.

Perfectly Clear

The last few months I have been keeping a watchful eye on the Crystal Palace site where the B.B.C.'s 640 ft. TV aerial tower is in the course of erection. At the moment of writing the crane used to hoist the sections into position still towers high above it, so I am not yet in a position to hand on any useful tips on how to tackle a job of this sort. I have a deep personal interest in this job inasmuch as I once, with a half-a-dozen others, helped in the erection of a 40 ft. lattice mast. We bolted it together on the ground and in turn nearly killed each other in our struggles to get it in the vertical.

However, I have collected a substitute tip which must serve for this month. Shavings of perspex were dissolved in acetone (or chloroform is a suitable alternative) until it became syrupy. It was then used for painting over panel names, etc., where it dries in a few seconds forming a perfectly transparent and hard coat which will stand any amount of rubbing.

Old timers will, of course, remember how we used to dope the stretched linen diaphragms fitted to balanced armature speakers, with celluloid dissolved in amyl acetate. This also makes a good protective and moisture proof varnish, but the perspex job is both clearer and harder.

CENTRE TAP *talks about* COLD SOLDER, TV TUBE PRICES, CATHODE-HEATER SHORTS

BOOK REVIEW

WOLF CUB BOOK OF PROFITABLE PLEASURE, published by Wolk Electric Tools, Ltd., Pioneer Works, Hanger Lane, London, W.5. Price 5/6.

This 100 page book, printed on fine quality art paper and stoutly bound in stiff card cover, is absolutely crammed from cover to cover with hints and tips on jobs to do and things to make. Some of the things covered are home repairs, handyman hints, fitments, furniture, toys, gifts, games, model making, wood turning, fretwork, etc., together with a host of other useful instructions. Divided into eight sections, each dealing with a separate subject, the book is well produced and good value for money. Section 1 deals with hints on the many uses of the Wolf Cub Home Constructor Equipment; Section 2 covers Joints and Jointing; 3 describes Household Jobs, Repairs and Maintenance; 4 features Fitments to Make; 5 shows Furniture to Make; 6 discusses Toys and Games to Make; 7 offers Gifts for Friends and 8 Model making. Each section is lavishly illustrated with simple and easy to follow drawings complete with suggested measurements, choice of wood and other details. The book is recommended to readers interested in doing all those odd jobs about the house and those, which includes most of us, who prefer to carry out these tasks ourselves. Available from Wolf stockists, it is also obtainable direct from the publisher at 5/9 post paid.

J.S.K.

NOTES ON RADIO CONTROL

8: *Test Equipment*

by QUENCH COIL

A Test Panel

The writer's personal experience has shown that the most frequent cause of short circuits, with consequent burnt-out valves, damaged meters and ruined components, is to make temporary hook-ups of twisted wires and crocodile clips when testing out new circuits. The experimenter is strongly advised to construct a proper test panel, which will not only prove its worth on the bench but, if made portable, can be equally useful when conducting outside tests on transmitters and receivers.

Such a test panel can be quite simple in construction, or it can include any number of features which its builder may wish to incorporate. That made by the writer and described here, for example, includes a complete receiver, which has proved most useful when making outside range tests on transmitters. It obviates the necessity of taking the completed model on first transmitter tests. It also includes an arrangement whereby the relay actuating leads are taken to small plugs on the panel, so that various relays can be plugged in and checked and adjustments carried out for reliable contact operation, etc.

A further point, too, may be mentioned. One sees many radio control enthusiasts equipped with expensive multi-range test meters costing many pounds, carting these instruments around on flying fields and river banks. The reader will agree that such places are not the safest for equipment of this type. An inexpensive test meter should be available for field tests. An excellent test meter can be constructed from ex-service meters costing a few shillings only. It is, of course, possible to use one such meter only and, by means of shunts and switches, make it suitable for reading a number of ranges of current and voltage. Some means must be found in this case of re-calibrating the scale of the meter, which for many will present difficulties. As the ranges of current and voltage met with in radio control work are quite limited in their variation, the writer prefers to include three separate meters on his test panel, by means of which all the usual currents and voltages can be directly measured. Those found most suitable by the writer are a 0–5 mA meter for measuring receiver current. This may well be fitted with a shunt and switch enabling it to read 0–50 mA, a range useful for measuring transmitter current; otherwise a separate 0–50 mA meter can be fitted to the panel. An ammeter reading 0–20A is a useful meter to fit, as it will prove valuable for checking total battery current, electric motor consumption, and so on. And, finally, a 0–150 d.c. voltmeter should be fitted.

A suggested layout for the test unit is shown in Fig. 1. No constructional details are given as these will depend on the builder's requirements.

A Wavemeter

The next most important item of test equipment is the wavemeter. This is used for checking that the transmitter is working on the correct frequency. A suitable job is shown in Fig. 2, with details of construction, and in the photo illustrating this article; the wavemeter being the small unit shown to the left of the photo.

The coil is tuned by the variable capacitor to the correct frequency for the radio control band (27 Mc/s). When placed near a transmitter radiating at this frequency, enough current is absorbed to deflect the meter. This meter is a very sensitive one—reading 0–500 *micro-amps*. The current from the coil and capacitor combination must be rectified before it will work the meter, and this is done by the small germanium crystal diode.

The details of the coil are as follows: wind 18 turns of 24 s.w.g., D.S.C.E. wire on a polystyrene former 2″ long and ½″ diameter; wind tight and secure ends of coil through double holes. Dope finally with polystyrene liquid. Mount the coil on top of the case as shown, keeping connecting wires clear of metal case. Connect bottom end of coil to "earth" tag. The coil former must be rigid on the case. The components must be mounted on a metal panel or directly on the front of the case. Wire with 18 s.w.g. tinned copper wire. All wires must be kept short and rigid; this is most important as any movement will upset the accuracy of the meter. When complete, the meter must be tuned to 27 Mc/s. This should be done with

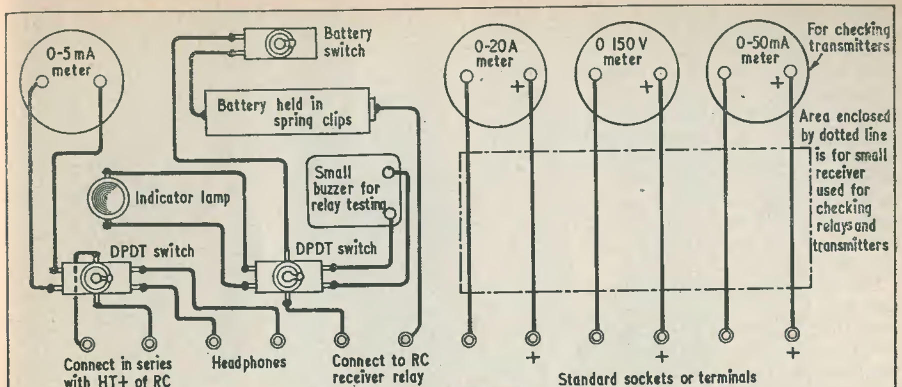


FIG. 1.

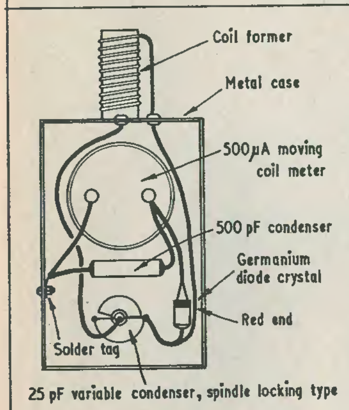


FIG. 2.

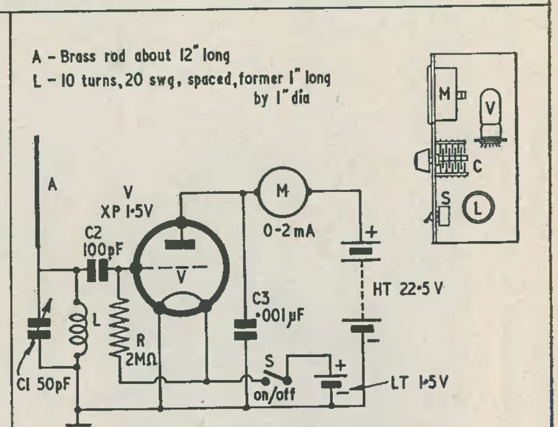


FIG. 3.

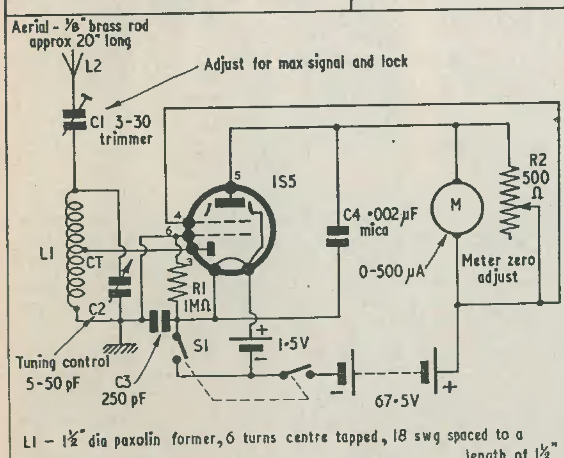


FIG. 4.

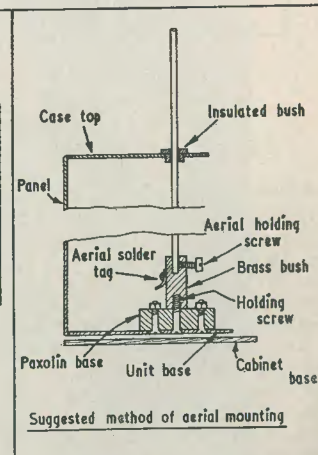


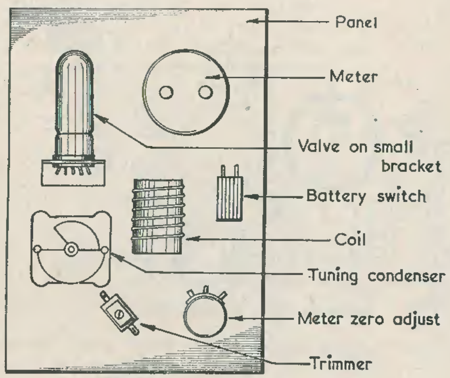
FIG. 5.

a signal generator covering the 27 Mc/s band or from another transmitter whose frequency is known to be accurate.

To operate, place the wavemeter close to the aerial of the transmitter, tune the transmitter condenser or trimmer until the wavemeter shows a peak reading, rotate past the peak reading and then back in order to accurately position the setting, It may be found that the tuning is very critical, but with some use it will be found that it is a simple matter to tune the transmitter to the correct frequency.

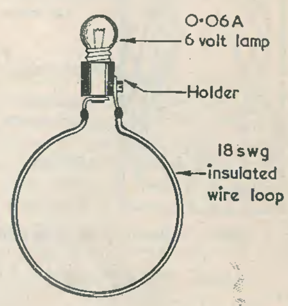
The wavemeter must be treated with great care, and it is a wise plan to have it checked from time to time with a signal generator. When tuning the transmitter it is most important to use an insulated trimming tool; under no circumstances must a screwdriver be used, as this will have capacity effect and the tuning will be inaccurate.

suggested arrangement is shown in the insert in Fig. 3, and in Fig. 6, which shows the position of the various components on the panel of the instrument. The general appearance of the completed meter is shown on the right of the photo illustrating this article. Assemble all components on the back of the panel; wire up with 18 s.w.g. tinned copper wire, keeping all wires rigid and short. The batteries should be located inside the case of the instrument and their leads kept short and twisted together. When once calibrated, neither the aerial length nor the valve must be changed. Should this be necessary for any reason, the meter must be re-calibrated. To ensure accuracy of the instrument it is wise to have it checked by a radio engineer or another radio control enthusiast possessing a signal generator covering the 27 Mc/s band. Details of the aerial mounting are shown in Fig. 5.



ARRANGEMENT OF COMPONENTS

FIG.6.



FLASH LAMP TEST LOOP

FIG.7.

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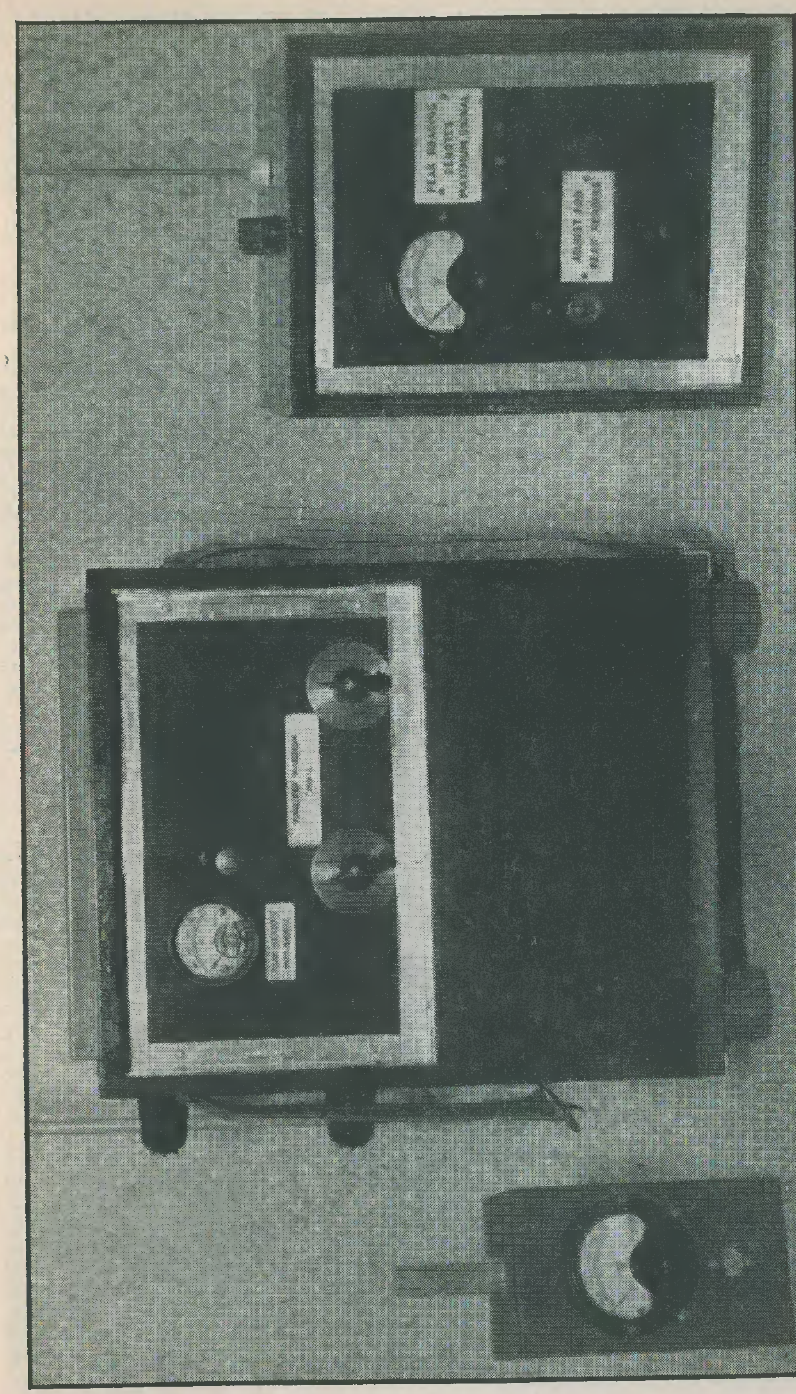
Field Strength Meter

The Field Strength Meter is used to indicate the relative intensity of the radiation from the transmitter under radiating conditions. It is most useful for the adjustment of directional aerials and to check the actual radiation of the transmitter in order to obtain the best results by varying aerial lengths, aerial coupling and so on.

Two circuits are shown, one using a triode valve, the other a pentode. Experimenters will, no doubt, like to build up both, but the less experienced constructor is recommended to start off with the triode version. The layout of the components is not critical, and a

When making tests, the positions of the transmitter and the field strength meter must always be the same distance and direction from each other. They should also be clear of buildings and damp ground. This is most important when making checks of relative strengths of different transmitters.

When the meter is switched on, it should show a full scale reading. In the circuit of Fig. 4, this can be adjusted by the variable resistor R_2. On tuning to the transmitter signal, the reading will drop. Tune the instrument carefully so as to get the lowest reading. Note the reading and then make the next test. In this way, comparative checks



Showing one of the writer's transmitters, the wavemeter and the field strength meter, the last two of which are described in the text.

can be made on the effects of adjustments to the transmitter, aerials and so on.

It will be found that as the battery supply drops off, the meter will not read full scale. This does not matter providing the reading is stable, as it is comparative readings which are needed, not the actual ones.

Finally, a word about a simple little test gadget which will be used as much as any other in the workshop (Fig. 7). It consists of a loop of stiff wire bent into a circle of about $1\frac{1}{2}''$ diameter. The two ends of the wire are soldered to the contacts on a 0.6A flash lamp bulb. When this loop is held over the tuning coil on the transmitter, it will absorb some of the radio energy and the bulb will light. As the loop is brought near to the coil, the transmitter meter reading will increase, thus indicating that the transmitter is loading up and is working properly.

LET'S GET STARTED—*continued from page 685*

At 10kc/s there is only one half the voltage present at 1kc/s.

2. An attenuator marked 10db is suspected of being faulty. In order to check it, the voltage loss must be found. If the test input voltage is 10 volts, what should the output voltage be?

This is a case of using the chart the other way round. First find 10db on the upper horizontal scale. Move vertically downward, until the diagonal line is reached. Read off on the "loss ratio" scale; in this case a little under 0.333. Now this is the ratio of the input to output voltage. We know the input to be 10 volts, so we can calculate the output voltage to be 0.333×10, or 3.33 volts.

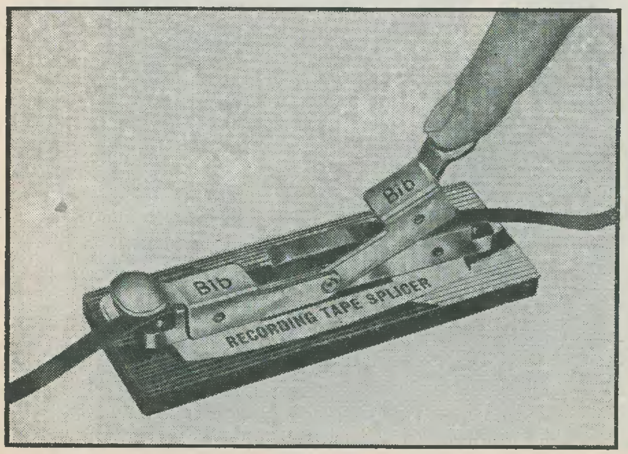
3. An amplifier has a voltage gain of 300 times. What is this in db?

Here the "gain ratio" scale is used. From the chart, 300 represents approximately 48db. Although primarily intended for voltage and current ratios, the chart may be usefully extended for use on power ratios. It is quite simple to effect. The db scale merely has to be divided by two. Therefore a gain ratio of 2 becomes 3db, instead of 6db.

Before leaving the topic, it cannot be stressed too strongly that the db is defined as the logarithm of the *ratio* of two currents, voltages or powers. One hears considerable misuse of the unit in this respect. Also, when dealing in voltage or current, the resistances involved must be equal, otherwise an incorrect answer is obtained.

Improved version of Bib Recording Tape Splicer

Multicore Solders Limited announce that an improved version of their Bib Recording Tape Splicer is now available. It is referred to as the Mark 2 and incorporates two tape retaining clamps which, in addition to having extensions on them providing an even easier releasing arrangement, are also fitted so that the clamp openings both operate identically towards the tape recorder. It is claimed that this makes tape splicing a quicker and simpler job without losing any of the virtually foolproof advantages of the original Bib product.



Multicore Solders Limited state that if an earlier model has already been bought and the user requires this latest modification, the work will be undertaken on receipt of the Splicer, properly labelled with the owner's name and address, and a postal order for 2/–.

TRF TV SOUND RECEIVER

JAMES S. KENT

At first sight, an article on a TV Sound Receiver may appear to be rather incomplete without a description of the rest of the televisor; but there are occasions when sound only is sufficient—notably to meet the needs of a blind person

Many readers will no doubt have in their possession television receivers constructed or converted from ex-Government surplus components or units. Those who have complete receivers of this type will probably by now be thinking of slowly converting their equipment to include new components, in which case the sound receiver would probably be the first item to be thus treated. For those who have surplus vision units and require the sound receiver, the present design offered here would be unit would suffice. These two units together with a suitable timebase and a 14-inch CRT have provided a satisfactory TV receiver for the London transmitter. (Our Data Book No. 4 *Inexpensive Television* provides conversion data for some of the surplus units to both vision and sound.—Editor).

Circuit

From this (Fig. 2), it will be seen that two RF stages are included and the output

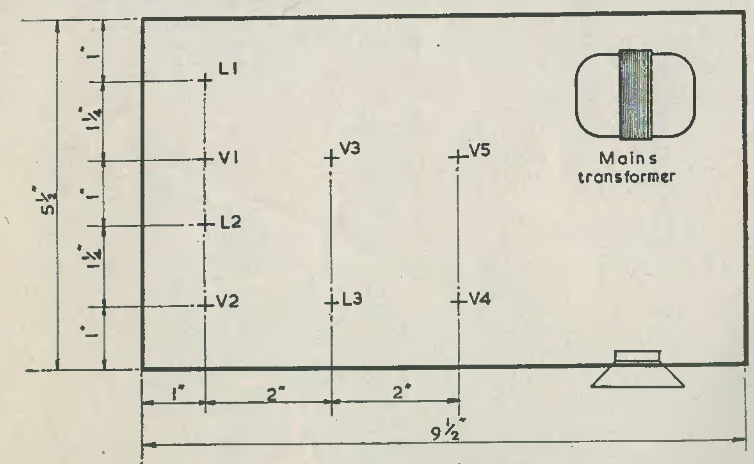


Fig. 1
Chassis drilling details

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particularly useful. It is for these readers that this article is intended, the writer using the prototype in conjunction with a converted RDF1 unit for vision on an experimental basis, although any surplus vision from these is fed into the combined detector and first audio amplifying stage, from which the resultant signal is passed to the output circuit. No AVC is included, although this could easily be incorporated should the reader desire to do so; the intention with the present design is to offer a simple straightforward inexpensive receiver. When correctly aligned an output of approximately 2.5 watts is achieved—quite adequate for the average room. The usual cut and try methods of coil winding have been eliminated, thus removing one of the major difficulties for the home constructor. The coils (see component list) may be obtained from The Teletron Co., and are produced to the writer's specification.

Construction

The chassis is of aluminium and drilling details for this will be seen in Fig. 1. The valve base spigots are connected to earth and each stage should have a single earthing point. In the prototype, it was found that a solder tag firmly bolted to the chassis, one to each stage, is a satisfactory earth—probably due to the use of modern miniature valves. Screening across the valve base is not required, the grid and anode connections being separated by the earthed spigot. The wiring is straightforward and the usual precautions with reference to short and direct wiring apply.

RF Stages

The Mullard EF42 valves are utilised here. This RF pentode has a slope of 9mA/V at an anode current of 10mA. The inter-electrode capacitances are small, the input capacitance being 9.4pF and the output capacitance 4.3pF. The EF42 is a most excellent wide band amplifier at TV frequencies and will, for those interested, serve in this capacity up to about 200 Mc/s. All the electrodes are connected to separate pins and therefore these should not be used for anchoring purposes. An internal metal screen is incorporated within the glass envelope and no external shielding is necessary.

The valve pins are numbered in the circuit diagram, and care should be taken to earth pin 3 and also to externally connect pin 4 to the cathode if instability is to be avoided.

The aerial connection may either be taken direct to the aerial or, should the constructor live in a fringe area, to a pre-amplifier. An alternative would be to incorporate a further RF stage ahead of the circuit shown, in which case the circuit would be as for V1 and associated components. The coil L1 peaks at 41.5 Mc/s with a secondary peak at 50 Mc/s. L2 and L3 tune over the range 35 to 44 Mc/s. Coil connections are given in Fig. 3. The chokes shown in the heater line are self supporting and are made by winding ten turns of 22 swg PVC covered wire on a ¼-inch diameter mandrel. All resistors are half watt rating and all capacitors are of the silvered mica type, except C9 and C10 which are ceramic.

The resultant gain from these cascaded RF stages was found to be sufficient to enable this receiver to operate satisfactorily at a distance of some 32 miles from the London transmitter.

Component List

R1	22kΩ ½ watt Dubilier
R2	270Ω ½ watt Dubilier
R3	3kΩ ½ watt Dubilier
R4	22kΩ ½ watt Dubilier
R5	3kΩ ½ watt Dubilier
R6	270Ω ½ watt Dubilier
R7	4.7kΩ ½ watt Dubilier
R8	100kΩ ½ watt Dubilier
R9	22kΩ ½ watt Dubilier
R10	250kΩ pot. with switch
R11	100kΩ ½ watt Dubilier
R12	2.2kΩ ½ watt Dubilier
R13	470kΩ ½ watt Dubilier
R14	270Ω ½ watt Dubilier
C1	3–30pF Trimmer (Philips)
C2	500pF Mica TCC
C3	500pF Mica TCC
C4	500pF Mica TCC
C5	500pF Mica TCC
C6	3–30pF Trimmer (Philips)
C7	500pF Mica TCC
C8	500pF Mica TCC
C9	50pF Ceramic
C10	22pF Ceramic
C11	0.01μF Tubular TCC
C12	150pF Silver mica TCC
C13	25μF Electrolytic 25V wkg.
C14	0.05μF Tubular TCC
C15	25μF Electrolytic, 25V wkg.
C16	16μF Electrolytic, 350V wkg.
C17	8μF Electrolytic, 350V wkg.
C18	0.05μF Tubular TCC
C19	500pF Mica TCC
V1	EF42 Mullard
V2	EF42 Mullard
V3	EBC41 Mullard
V4	EL42 Mullard
V5	EZ41 Mullard

Chassis—Kendall and Mousley

L1, 2, 3—The Teletron Co.

LF Choke—10H, 60mA

Mains Transformer—Ellison Type MT162, 250–0–250V, 60mA; 6.3V, 3A; 5.0V, 2A.

Speaker—Goodmans Type 74/243

B8A Bases—McMurdo

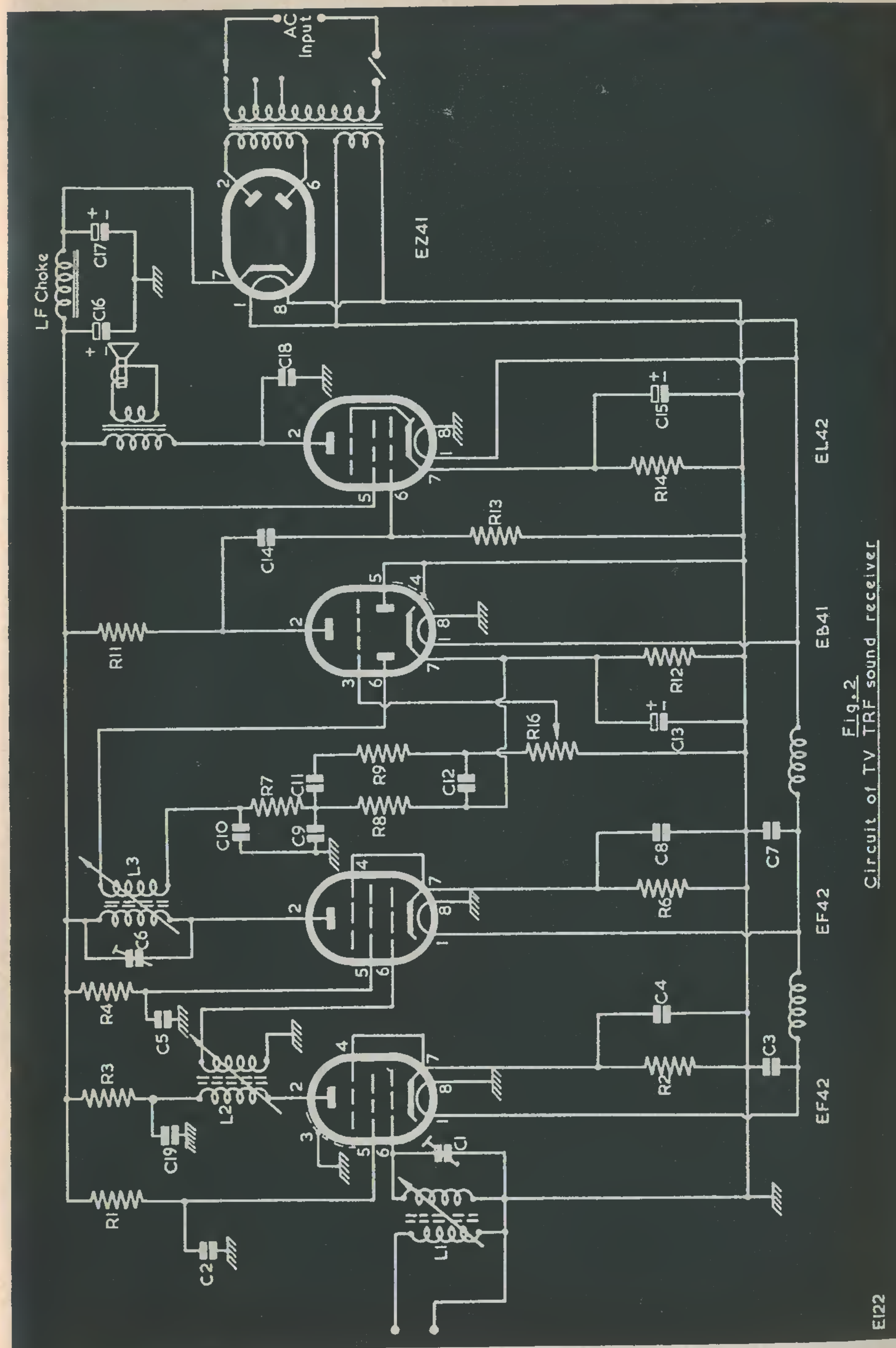


Fig. 2 Circuit of TV TRF sound receiver

Detector

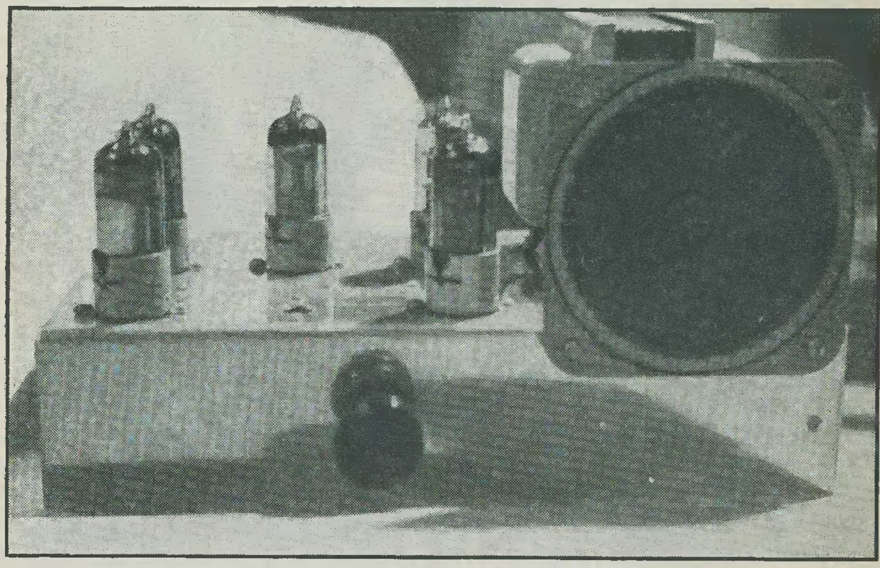
The EBC41 is used to good advantage here in a perfectly straightforward arrangement that should present no difficulty to the constructor. Those living in the London area would probably benefit from the inclusion of an AVC circuit to avoid overloading, in which case it could easily be included in the usual manner.

Output Stage

In a perfectly conventional audio amplifier stage, the EL42 delivers a satisfactory output. Coupled to the small 3½-inch speaker seen in the illustration, the resultant audio is sufficient for most purposes.

Operation

The only tuning required is the adjustment of the coil slugs for maximum volume. Once this has been obtained, a small quantity of wax, taken from an old condenser, should be poured into the top of the coil, thus obviating any movement of the slugs subsequent to lining up. Provided the layout of the chassis as shown in Fig. 1 has been closely followed, the coils will be found to tune into the sound channel with little or no trouble. Any departure from the layout will of course affect the stray capacitances present in the circuit, and thereby alter the tunable frequencies for which the coils were designed.



General view of the TRF TV Sound Receiver. The valves are as follows:—Left rear, 1st RF Stage; Left front, 2nd RF Stage; Centre valve, Detector; Right front, Output and Right rear, Rectifier. The control is Audio Gain combined with On/Off Switch. The position of the coils will be seen from Fig. 1

THE BRITISH INTERPLANETARY SOCIETY

12 Bessborough Gardens London SW1

We feel that quite a number of our readers may be interested in the above Society.

Whilst its objects are primarily those of space travel, much of a radio nature concerns the Society, particularly in the realms of radio control. Rocket propulsion as applied to guided missiles and high altitude exploratory rockets is another of their interests, and their Journal enables its readers to keep up to date in this sphere.

The list of books and publications available from the Society shows just how comprehensive are its interests, and we would recommend those of our readers who would like to know more of this latest scientific study to write to the Secretary and obtain further particulars of membership.

G2ACC offers you

AERIAL WIRE. 14 s.w.g. hard drawn copper enamelled, cut to any length, 4d. per yard

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COAX CONNECTORS. Belling Lee L734 plug, 1/3; L604 socket, 1/2. L616 Line Coupler, 1/6

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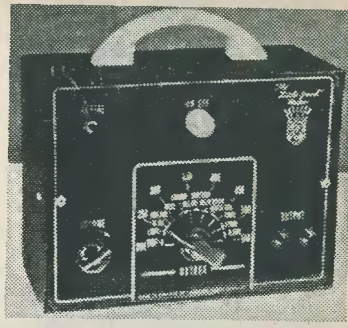

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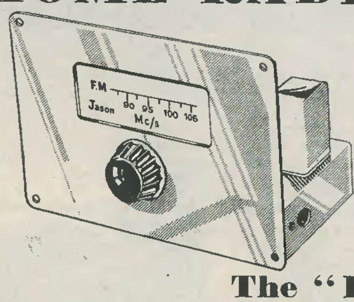

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[continued on page 703

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continued from page 701]

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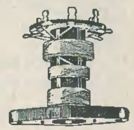

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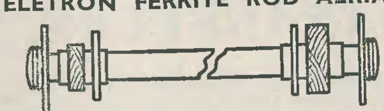

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