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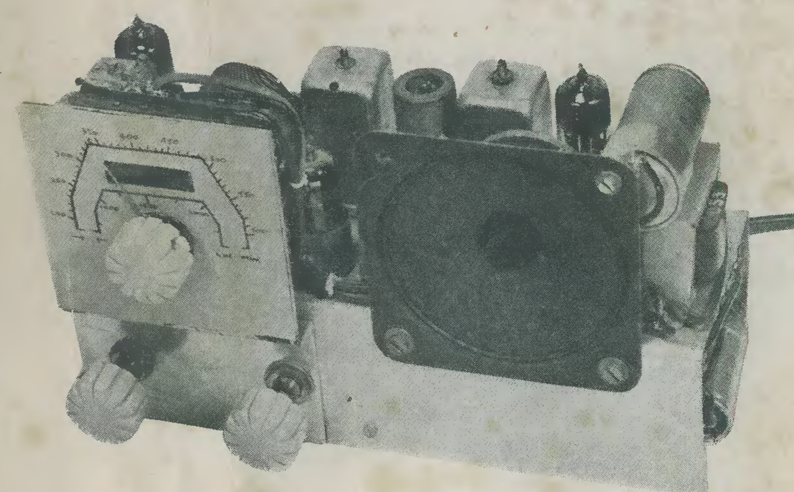
The
RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

Volume 9
Number 1
AUGUST
1955

MINIATURE



6-Valve SUPERHET

ALSO IN THIS ISSUE

1/6

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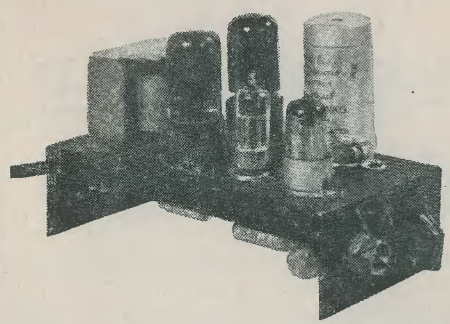

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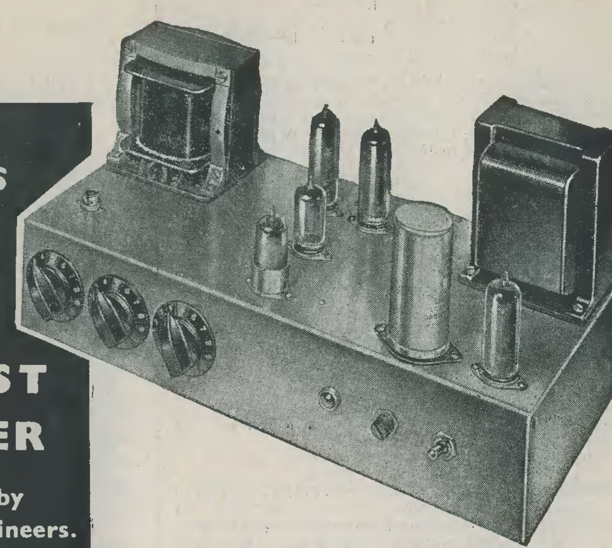

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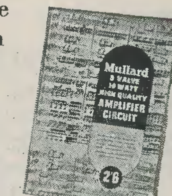

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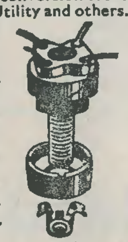

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The
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incorporating THE RADIO AMATEUR

VOL. 9 NO. 1
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AUGUST 1955

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CONTENTS FOR AUGUST

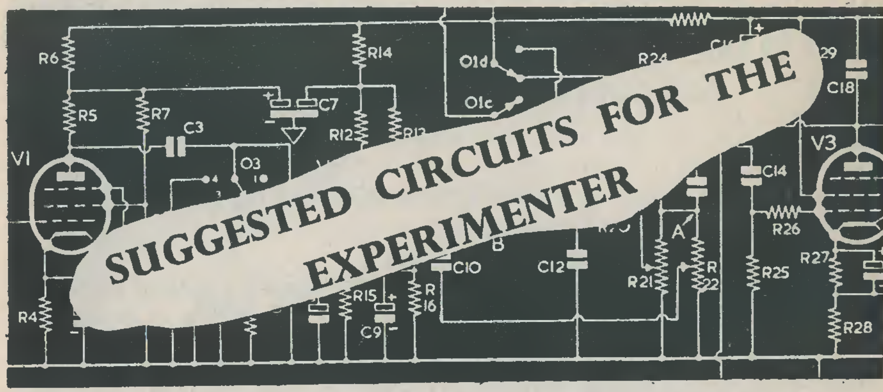
NOTICES

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

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

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

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR, 57 Maida Vale, London, W.9



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

No. 57: A SENSITIVE, DELAYED, VOLUME LEVEL INDICATOR

A POPULAR AND RELATIVELY INEXPENSIVE method of indicating the volume level of tape recorders and similar items of equipment consists of employing a tuning indicator of the "Magic Eye" type. Such indicators are liable to be rather insensitive, unfortunately, owing to the fact that their cathode-target circuits normally employ the full h.t. voltage available in the associated amplifier. Such operating voltages necessitate a variation in control grid potential of some 20 volts in order to effect a change from maximum to minimum shadow angle.

Furthermore, it is frequently desirable to have the volume level indicator function as a voltage delayed device. When this arrangement is employed normal volume levels do not affect the shadow display, but volume levels in excess of a given pre-set standard are intended to cause a rapid change of shadow angle. When a tuning indicator is employed in conventional volume level indicator circuits, the provision of a delay voltage usually necessitates the use of a potentiometer network connected across the h.t. supply; and this may be wasteful of power and components. Added to this is the fact that the low sensitivity of the device still does not allow sensitive changes in shadow angle, even after the delay voltage has been reached and passed.

In the device which is described this month, a tuning indicator is employed in a circuit which should give results that are at least three times as sensitive as are those given under conventional conditions. The circuit also enables delay voltages to be obtained without the necessity of connecting a potentiometer network across the h.t. supply.

The Circuit

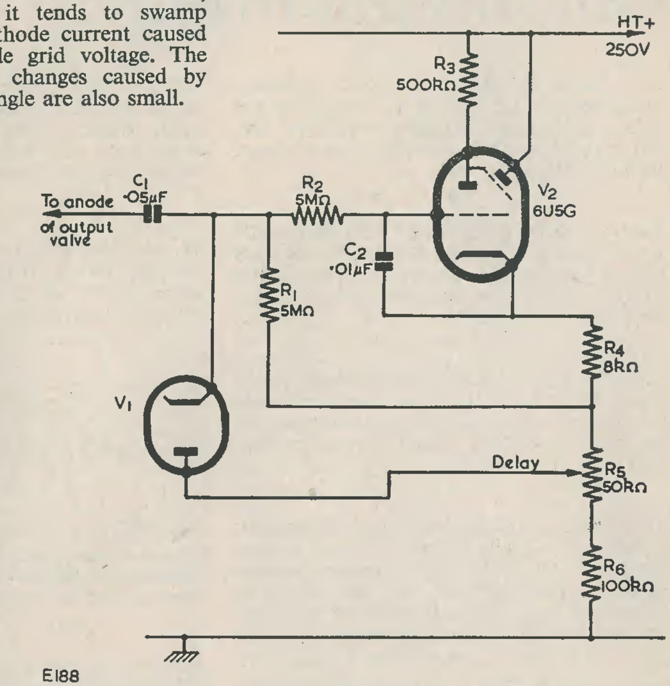
The diagram accompanying this article shows the arrangement employed. It has been designed around the 6U5G indicator; but it should cope satisfactorily with most other "Magic Eyes" having a single shadow display.

The circuit takes advantage of two facts in the characteristics of the 6U5G. The first of these is that the sensitivity of the indicator increases as the h.t. potential between its target and cathode decreases. Quoting from the Brimar Valve Manual, the variation in grid voltage required for maximum shadow angle change, with 250 volts cathode-target potential, is 22 volts. At 100 volts cathode-target potential, the change in grid voltage required is only 8 volts. (These figures assume that the indicator employs the recommended anode supply circuit). In the circuit shown here the tuning indicator has a cathode-target potential of approximately 100 volts.

The second fact of which advantage is taken is given by the relatively steady current which flows between cathode and target of the 6U5G, irrespective of its grid potential. The construction of the valve is such that the cathode-target electron stream is separate from the triode section. Also, the cathode-target current is much larger than the cathode current drawn by the triode section alone, with the result that it tends to swamp alterations in total cathode current caused by variations of triode grid voltage. The cathode-target current changes caused by variations in shadow angle are also small.

Due to these two characteristics, it is possible to obtain noticeably enhanced indicating sensitivity by feeding the cathode of the indicator through a dropping resistor. This allows the indicator to operate at a reduced cathode-target potential; and the voltage dropped across the series cathode resistor remains sensibly constant despite variations in grid voltage.

In this month's circuit such arrangements have been employed, the cathode resistor being given by R_4, R_5 and R_6 in series. The voltage appearing across these resistors is employed also for purposes of voltage delay.



Voltage Delay

To describe the functioning of the indicator and its delay circuit, it might be advisable to commence by assuming that the slider of R_5 is at the position of minimum delay. This is given when it is at the top of its track; i.e. at the end which connects to R_4.

Since the delay voltage obtainable in the circuit is negative, the Magic Eye is required to work in the opposite manner to that in which it is normally used. Thus, under conditions of zero signal from the anode of the output valve, the grid is connected, via R_2 and R_1, to the junction of R_4 and R_5, and has the same potential as that existing at this junction.

This point provides a negative bias of approximately 8 volts, which is just sufficient to cause the indicator shadow to "close." When a.f. is applied from the output valve anode to the diode V_1, via C_1, the diode rectifies and a positive voltage is built up across R_1. This is then applied to the grid of the tuning indicator, and causes its shadow to "open." Maximum shadow angle is given by a positive rectified voltage of 8 volts. Should the rectified voltage go further positive, the grid current of the 6U5G is limited to a safe value by the series resistor R_2. The negligible amount of grid current which flows will not affect the circuit to which the indicator circuit is connected.

The delay voltage is obtained, when required, by moving the slider of R_5 along its track. The diode will not then conduct until the applied a.f. voltage overcomes the voltage existing between the slider of R_5 and the top end of its track.

Whilst serving to limit grid current, the resistor R_2 also functions in conjunction with C_2 to decouple the grid of the tuning indicator. If this were not done, the shadow display would blur as the grid tended to follow the applied a.f. voltage.

Practical Points

This circuit should give very little trouble in practice owing to its simplicity. In cases when the required delay voltage is known, an economy may be effected by replacing R_5 with two fixed resistors of the requisite value. The current flowing through R_4, R_5 and R_6 is approximately 1mA, and this enables voltage calculations to be carried out very easily. (At this current 1kΩ drops 1 volt).

The diode V_1 may, of course, be replaced by a germanium diode.

Can Anyone Help?

R. J. Cole, of 26 Albert Road, Ledbury, Herefordshire, who needs the circuit of the U.S.A. Indicator Unit type BC.929A, and any information on its conversion to a 'scope. Willing to purchase data.

* * *

Brian C. Smith, "Katinka," 9 St. Margaret's Road, Westgate-on-Sea, Kent, who requests information on the conversion of the T1154 to cover 14 Mc/s and on a converter to extend the range of the R1155.

* * *

T. J. Jones, 19 Lauderdale Gardens, Bushbury, Wolverhampton, who needs information regarding the amplifying unit type 178, ref. no. 1OUB/185, also the receiver type 3206, ref. 1ODB/1332.

* * *

T. Harding, 112 Scales Road, Tottenham, London, N.17, who wishes to buy or borrow details of the CNA.46081 communications receiver, manufactured by the National Company, Inc. This is the receiver unit from the model RBJ4 Radio Equipment.

* * *

Bryan Hayes, G3JBU, 7 Western Terrace, Northampton, who wishes to buy or borrow details on the conversion of, and the manual for, the BC342N.

* * *

A. R. Williams, 24 Marlborough Road, Ipswich, Suffolk, wishes to purchase or borrow any details of the conversion of the T1154 for the Amateur Bands. (A G.P.O. licence is needed.—Ed.)

* * *

A. S. Burden, 1 Repton Manor Road, Ashford, Kent, requires any information on the ex-Army Wireless Set X42A; valve line-up, socket connections, power supplies, etc.

* * *

H. Bradshaw, 35 Bluebell Close, Hyde, Cheshire, wishes to learn the supply frequency and input voltage required for the Oscillator DP. No. 1 (ZC.8043) and any other particulars of mains power pack for this unit.

4011053 Sgt. Belton, W. J., Sgts.' Mess, Royal Air Force, Boscombe Down, Amesbury, Wilts., wishes to buy or borrow a manual or any information on the Hallicrafter AM/FM Receiver type R44/ARR5.

* * *

W. A. Finlayson, 1 Ravenscourt Close, Ruislip, Middx., wishes to obtain the circuit and valve types of the ex-Govt. receivers types R17 and R73.

* * *

W. Lowe, 28 Allenby Road, Cadishead, Manchester, wishes to obtain assistance in the way of aligning and otherwise putting in order his HRO Senior.

* * *

H. J. Gilson, 130 Garvary Road, Custom House, London, E.16, wishes to obtain the service sheet for the Portadyne CG68 radiogram, either on loan or sale.

* * *

W. A. G. Voss, "Watelea," 233 Daws Heath Road, Rayleigh, Essex, wishes to buy or borrow the circuit of the 10-valve 2 metres receiver ZC.8931, serial no. 31032.

* * *

Appreciation

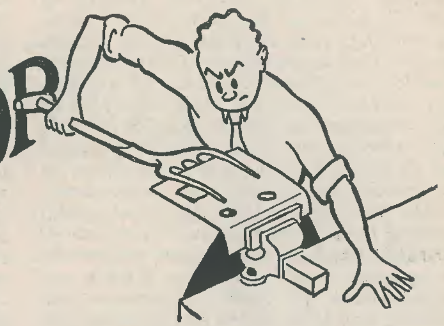
"Thank you very much for putting my requirements in the *Can Anyone Help?* section of your very excellent magazine. I was very pleased at the number of replies I received.

"It is very gratifying to know that fellow radio enthusiasts will try to help out, no matter how far away they are.

"I had quite a few letters giving me the specifications of the CV54 and also complete circuits and information on the Loran equipment, which was of great help to me.

"I have written direct to these Good Samaritans, but thought I would also like to express my appreciation to *The Radio Constructor*," S. Medford, VK7SF, 4 Mark Street, Hillcrest, Burnie, Tasmania.

In Your Workshop



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

One of the minor bugbears of amateur radio construction is represented by the domestic criticism to which the fruits of one's labours are so often subjected. It is fairly safe to say that such criticism is directed most frequently against the final appearance of a home-constructed piece of equipment. The female members of the average family are especially prone to shortcomings of outlook in this respect; and they are inclined to view with great suspicion any item of radio gear which is not stowed away in a nice, square, highly cellulosed, wooden cabinet.

Cabinets

Personally, I can appreciate to a certain extent the point of view which decides that a nicely finished cabinet goes some way towards enhancing the value of an amplifier or receiver. On the other hand, I cannot help but feel more strongly that a well-made chassis can look very attractive on its own. If the truth be told, the second view is probably due to an inherent laziness on my own part; because few of the things I have made at home have ever found their way into a cabinet. On the odd occasion that they have done so, this has usually been due to the fact that I have managed to persuade someone else to make the cabinet for me!

These words have been prompted by a survey of the sound receiver which I have rigged up during the last few days. I regret that the only part of this receiver which is housed in a box is the speaker itself. Nevertheless, the rig looks very nice as it stands: the amplifier is a Full-Tone, and feeding into it is an advance model of an f.m. tuner which is to be described shortly in *The Radio Constructor*. The whole assembly sounds, in my opinion, very fine indeed. It is possible that one day a cabinet may appear for the tuner unit and the amplifier, but, for the time being, I am more interested in the quality of reproduction than in the worth of the whole receiver as a piece of furniture.

This new f.m. tuner, incidentally, is called the "Challenger," and it has been designed by an old friend of *The Radio Constructor*. I refer to W. G. Morley, whose articles on home-constructed signal generators and valve testers caused a considerable amount of interest amongst readers some years ago. W. G. Morley does not produce a large amount of home-constructor designs, probably because he is a very busy man in his profession. Nevertheless, when he does design something for home-constructor use one can always be sure that it really is a "topline" article. Such an adjective certainly applies to this latest design of his; and I feel certain that it will prove to be a winner when it appears in print.

That Circuit

Believe it or not, but the letters still keep coming in about that Mystery Circuit. This first appeared in the September issue of last year. The circuit is supposed to give push-pull working, and many readers have written to explain why it does, or why it does not, do this. I have just received a particularly interesting letter from the Editor of our lively Australian contemporary, *Radio, TV, and Hobbies*, and I have much pleasure in reproducing it here:

"I was most interested to find in the March issue of this year reference to the 'Mystery' circuit and a number of explanations of its operation.

"You may be interested to know that this circuit was used in a receiver described in the Australian magazine Wireless Weekly *of April 17, 1935. It was credited to a local experimenter, Mr. A. Barnes, and became known as the 'Barnes Mystery Circuit' because it led to precisely the same train of 'explanations' as have apparently been submitted by your correspondents. It seems highly probable that the present reference to the circuit dates back to this publication, as the similarity of its description is hardly likely to be a coincidence.*

"The last reference to the circuit which appeared in our magazine was in the issue of April 1954 *which discussed various suggestions for push-pull circuits.* Wireless Weekly *was the progenitor of* Radio, Television and Hobbies, *and in its pages first appeared the plate-cathode phase-splitter often referred to as the 'Kangaroo' circuit because of its Australian origin.*

"I do not know whether the Schmit circuit was published before or after 1935, *but I thought you would be interested to know that the mystery was discussed 'down under' almost exactly* 20 *years ago.*

"With kind regards and congratulations on your highly interesting journal.

Yours sincerely,

John Moyle
Editor,
Radio, TV and Hobbies.

I really feel that this letter should now bring the whole Mystery Circuit business very satisfyingly to a close.

Ferrite Frames

Another subject which I mentioned last year, and one which also produced some letters from readers, dealt with "ferrite

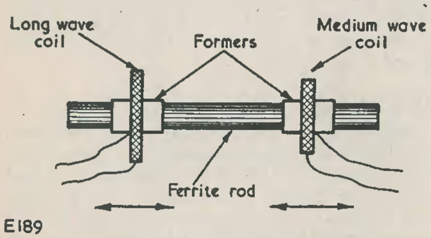


Fig. 1. *The basic construction of a typical ferrite frame aerial*

frame" aerials. Ferrite frame aerials have become commercially available to the amateur since that earlier reference to them in these columns, and I understand that quite a few constructors have had excellent results with these components.

Ferrite frames, as used in this country, normally consist of two coils mounted on a rod of magnetic material in the manner shown in Fig. 1. Usually, the magnetic material is Ferroxcube. The coils, on their formers, are free to slide along the rod; this enabling their inductance values to be varied.

Ferrite frames may be used in conjunction with almost any superhet or t.r.f. receiver, and they frequently improve its performance to a significant degree. The ferrite frame coils take the place of the existing medium and long wave coils which are fitted in the receiver chassis. If the set is an all-wave receiver, the short wave coils are left undisturbed.

Fig. 2 (a) shows the aerial coil switching circuits of the frequency-changer stage of a typical all-wave superhet. If a ferrite frame were fitted to this receiver, the aerial coil switching circuit would be modified to that shown in Fig. 2 (b), this diagram illustrating a typical ferrite frame application. As can be seen, the existing aerial coils in the receiver are now disconnected. They may, indeed, be removed from the chassis altogether, if desired. The short wave aerial coil is not affected, and this continues to work in its original manner. The method of fitting a ferrite frame to a receiver without a short waveband is, of course, exactly the same as that shown in Fig. 3 (b), since the short wave circuit does not affect the functioning of the receiver in any way on medium and long waves.

Practical Details

The mounting of a ferrite frame inside a receiver cabinet involves problems which are mainly mechanical. So far as possible, the ferrite frame should be kept clear of all metal parts, and especially of large metal areas such as the chassis. A clearance distance greater than one and a half inches is a useful figure to work from. The ferrite rod should be mounted with the aid of brackets made of an insulating material such as bakelite sheet, vulcanised fibre, and the like.

From the radio point of view the only problem encountered with the ferrite frame is that of getting its coils to track with the oscillator coils in the receiver. To do this, it should first of all be ascertained that the oscillator coils are trimmed and padded accurately to the dial calibration. The receiver is then swung to the low-frequency end of the medium waveband and the medium wave ferrite frame coil moved along the rod until a position of maximum pick-up is obtained. The receiver is next set to the high-frequency end of the medium wave-band and the medium wave aerial trimmer (see Figs. 2 (a) and (b)) adjusted for maximum pick-up. The whole procedure is then repeated once

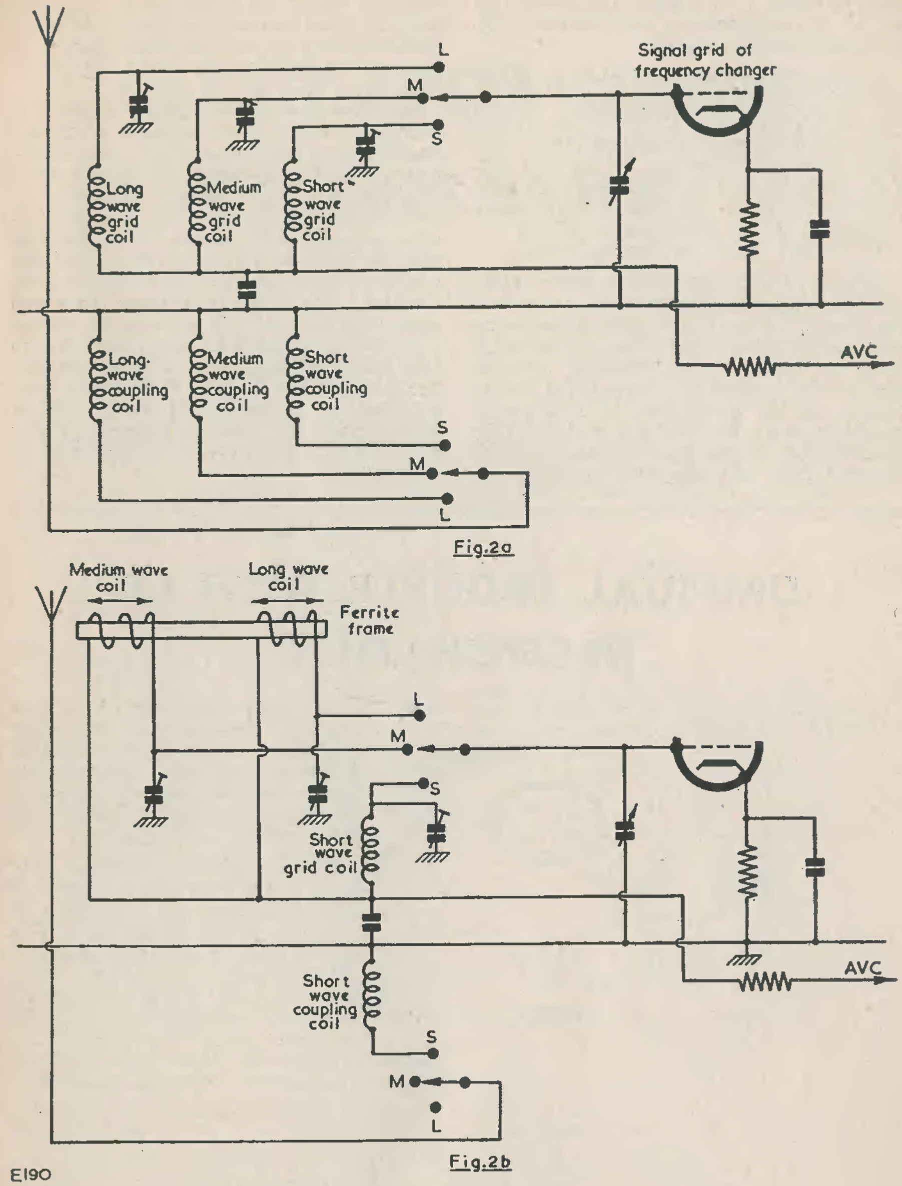


Fig. 2(*a*) *The aerial coil-switching circuits of a typical all-wave superhet.*

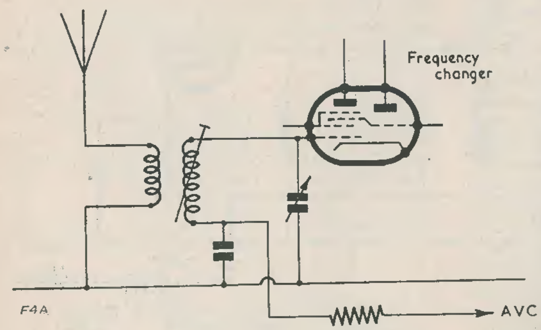
Fig. 2(*b*) *How the aerial coils may be replaced by a ferrite frame aerial* more to enable final small adjustments to be made. After this process, the long wave coil is aligned in similar manner.

It will probably be found best to set up the ferrite frame using broadcast signals. This is due to the fact that it is difficult to inject a signal generator satisfactorily into the circuit for purposes of alignment. It may also help if the coils are moved along the ferrite core with the aid of an insulated rod or similar instrument, since hand-capacity effects are liable to give slightly misleading results.

A t.r.f. receiver may have a ferrite frame fitted to it just as effectively as may a superhet, the ferrite frame coils replacing the aerial coils in exactly the same manner. However, it may be necessary to introduce a small measure of screening between the ferrite frame and the detector coils of the t.r.f. receiver, should any instability result from the modification. Normally, fortunately, the detector coils of most t.r.f. receivers are mounted below the chassis and, presuming that the ferrite frame is fitted above, adequate screening may be automatically assured in consequence without any additional alterations.

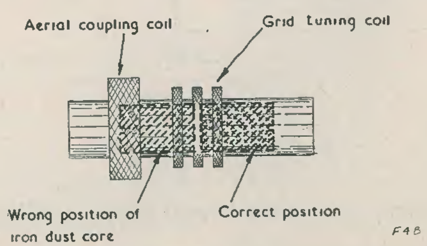
Although it is usually appreciated that the fitting of a ferrite frame converts a conventional receiver into a portable, it is not always realised that the new aerial can also cut down interference. This applies especially to mains-borne interference. This interference is often picked up by reason of the capacity existing between a receiver aerial and the mains wiring of the house in which the set is installed. The fitting of a ferrite frame can sometimes cut out this interference almost completely. Indeed, I have heard receivers in bad localities which were almost unusable because of interference, until they were modified to incorporate a ferrite frame. Afterwards, such receivers have reproduced signals which are almost entirely clear of background.

UNUSUAL TROUBLE WITH I.F. REGENERATION



The aerial input was of the conventional type shown in the circuit diagram, with a high impedance aerial coupling coil. The receiver was tracking properly, but burst into oscillation at the low frequency end of the Medium waveband.

Examination of the Medium wave aerial coil showed that the dust iron core had been set between the coupling coil and the grid coil. This caused an excessive increase in the inductance of the aerial coil, which now tuned near to the intermediate frequency; this was the cause of the trouble. Setting the slug in the correct position, as shown in the second diagram, completely solved the problem.



CALCULATED BRIDGE CALIBRATION

by **M.B.**

An L/C/R bridge is a most useful piece of equipment, and yet few home constructors possess one.

Fig. 1 shows the basic circuit of one class of bridge, which is simple to make, covers a very wide range of components and with care can be made accurate to within about 5%. Such a circuit forms the basis of most amateur bridges. The snag, apparently, is calibration.

The main trouble appears to be the lack of sufficient close-tolerance components to provide check points over the ranges; actually, a reasonably accurate calibration is possible with no extra components at all.

Referring again to Fig. 1, it is usual to take point P to the slider of a linear potentiometer, and R_1 and R_2 will then be the parts of the track to the left and right of the tapping. This is the arrangement we shall consider, since keeping one of R_1, R_2 fixed and varying the other requires that the resistance values be known; or even if sufficient components were available for an empirical calibration, it has a smaller coverage and is inherently less accurate.

Call the potentiometer's resistance R, and that of the resistor R_1, r. Then R_2 has a resistance R–r. For the moment suppose the standard is a resistor (giving a Wheatstone bridge) of resistance S; then at balance the usual formula gives

$$\frac{X}{S}=\frac{r}{R-r} \qquad \ldots\ldots(1)$$

where X is the resistance placed across the test terminals.

A linear potentiometer is one whose resistance is proportional to the angle of rotation, θ, and "proportional to" only means "equals a constant number times." Calling this constant K, then $R=K\theta$ ....(2) relating resistance to rotation.

Although we shall not need it, one could find K for any particular component. For instance, with a total track resistance of 15kΩ and a maximum rotation of 300°, K would obviously be 50Ω per degree.

Let us substitute (2) into (1):

$$\frac{X}{S}=\frac{K\theta_b}{K\theta_m-K\theta_b}$$

where θ_b is the angle of rotation at which a balance has been determined, and θ_m is the maximum rotation. If, as is usual, $\theta_m=300°$, then

$$X=\frac{\theta_b}{300-\theta_b} \qquad \ldots\ldots(3a)$$

or, by re-arranging,

$$\theta_b=\frac{300\,X}{X+S} \qquad \ldots\ldots(3b)$$

and the unknown is given in terms of the standard and the number of degrees through which the control was turned for a balance, and conversely.

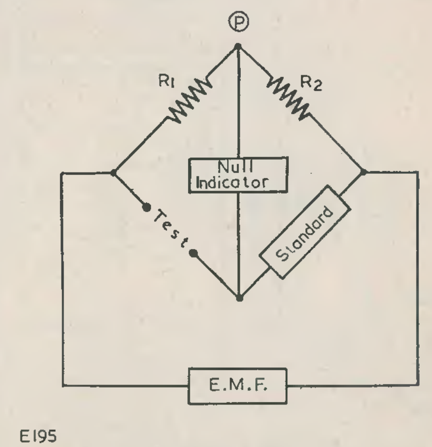
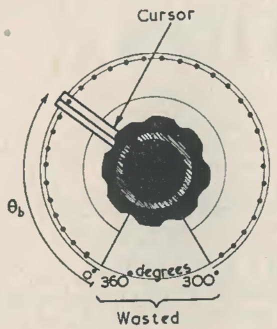


Fig. 1. *Basic bridge circuit*

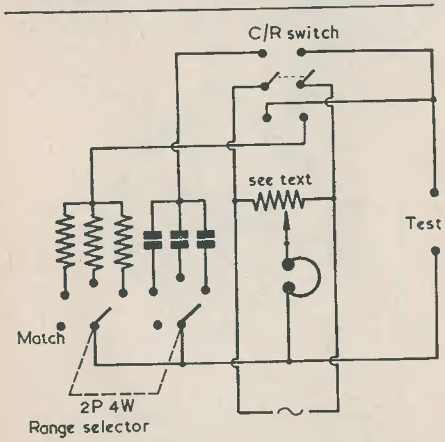
To measure θ_b, the dial can be made from a circular protractor. A suitable type is the Reeves No. 4, which is solid, about 5in. in diameter, and costs about 3s.

If the standard is one of capacitance, C (the circuit then being a De Sauty bridge) formula (3a) gives the balance angle for reactances, i.e. in terms of 1/C, and the formula should be inverted. This amounts to printing the same scale on the dial, but going the other way (anti-clockwise). However, this is not necessary, for a D.P.D.T. switch can be arranged to interchange the fixed potentiometer connections and this means only the one scale is needed.



E196

Fig. 2. The values for X are marked on paper under the celluloid protractor (different colours for resistance and capacitance)



E197

Fig. 3. R–100Ω; C–100pF (÷100)
R–10kΩ; C–0.01μF (X)
R–1MΩ; C–1μF (x 100)

Using formula (3b) one can find θ_b for the values of X in which one is interested, with a known standard. This is convenient with the resistance range, for one can mark the dial at each preferred value, e.g. with a 10kΩ standard, 68kΩ comes at an angle

$$\theta_b = \frac{300 \times 10}{10+68} \text{ or approx. } 262°.$$

Either side of 262° the scale can be marked to indicate within what limits, Δθ, a 68kΩ ±10% resistor might fall. And similarly for the other preferred values, the angular positions for which are given in the table.

The approximate angular spread for a tolerance of ±10% is given by

$$\Delta\theta \simeq \frac{60\ S/X}{(1+S/X)^2}$$

degrees, centred on each preferred value X. E.g. for 68kΩ ±10%,

$$\Delta\theta \simeq \frac{60 \times 10/68}{(1+10/68)^2} \simeq 7°.$$

Therefore as θ=262°, with a 10kΩ standard the scale from 258·5° to 265·5° could be marked 68kΩ ±10%.

The same marking holds for 680Ω ±10% with a 100Ω standard, and so on.

The standards 100Ω and 1MΩ can be marked "÷100" and "×100" on the selector switch.

The same scale (in pF rather than Ω) will apply to capacitors, but is not very useful because the same preferred values have not been given. However, a more convenient one can be made with the same formula; preferably marked in both pF and μF for convenience. With standards of 100pF, 0·01μF, and 1μF, one can cover 2pF to 0·005μF, 200pF to 0·5μF and 0·02μF to 50μF. The basic circuit is given in Fig. 3.

When using the bridge to measure small capacitors, it is first necessary to find the capacitance of the connecting leads and wiring. This is done by "zero-ing" the bridge with no component connected; this zero should occur well down the scale—say at 6pF. The unknown is then connected, the new minimum is noted—e.g. 13pF—and by subtraction the true capacitance of the component must be 7pF.

The potentiometer's resistance must not be too small or it will need to be of a high wattage to stay cool, and power requirements will be large. It must not be too large, or off-balance sensitivity falls and mechanical defects are more troublesome; but one has a wide choice (say 1kΩ to 50kΩ). The essential thing, if one is not able to give a direct calibration from a substandard resistance box, is that the potentiometer should be linear.

Three ranges are usually sufficient, as one can afford to lower the accuracy at the extremes. The standards should be ±2% or better.

X (*ohms*)	θ (*degrees*)	Δθ (*degrees*)
1,000	27	5
1,200	32	6
1,500	39	7
1,800	45	8
2,200	54	9
2,700	64	10
3,300	74	12
3,900	84	13
4,700	96	14
5,600	108	14
6,800	121	16
8,200	135	15
10,000	150	15
12,000	164	15
15,000	180	15
18,000	196	14
22,000	206	13
27,000	218	12
33,000	230	11
39,000	239	10
47,000	248	9
56,000	254	8
68,000	262	7
82,000	268	6

If a variable resistor is placed in series with the 1μF standard it can be calibrated in terms of power factor for the unknown; and it turns out that at the balance, which is obtained by rotating the two controls alternately for an absolute minimum, the power factor of the unknown equals that of the 1μF and series resistor combination:

$$PF = \cos \varnothing = \frac{\omega CR}{\sqrt{1+\omega^2 C^2 R^2}}$$

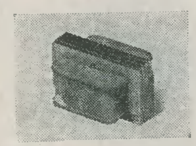
where R is the effective series resistance at bridge frequency ω/2 π in series with C=1μF. Using a good quality condenser here (e.g. oil-immersed paper type,) this is the series resistance setting at balance.

Alternatively, one can calibrate the phase-balance control in terms of what is usually called tan δ, where δ=90°–Ø. Tan δ=ωCR, which is the reciprocal of the Q of the condenser at angular energising frequency ω. For a 1μF standard, at balance, tan δ=ωR, and is hence proportional to the resistance inserted in series. The power factor is sin δ, and does not give a linear scale with a linear series resistor, whereas tan δ does.

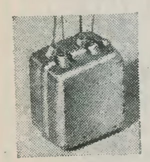
JOHN BELL & CROYDEN

117 High Street, Oxford.

This company have now marketed the type "F" transformers, specially designed for use in transistor circuits. The size of these units, $\frac{17}{32}$"× $\frac{5}{16}$", has been reduced to the absolute minimum consistent with the highest possible performance. The tiny size and low weight has been achieved by the use of very fine wire, light former and special nickel alloy high-mu magnetic core. The leads are flexible and colour coded.



Designed primarily for hearing aids in conjunction with transistors, these units are also employed in computer circuits, pocket radios, recorders and other applications. A mu-metal can has been designed to contain the "F" type transformers for application where screening is necessary.



The standard "F" range consists of one Output, two Input and two Interstage Transformers.

EVENING RADIO CLASSES

Brentford Evening Institute will again be holding classes in radio subjects during the session commencing on 19th September next.

The courses are:—

Radio Servicing I—No previous knowledge of the subject is assumed. The course covers theory of all circuits commonly met in commercial radio receivers and methods of locating faults. Some practical work is included.

Radio Amateurs—This class prepares students for the C. and G. examination for Radio Amateurs to be held in May. No previous knowledge of the subject is required. The class continues for several weeks after the examination.

Each class is held between 7 and 9 p.m. and on Mondays, Tuesdays, and Wednesdays respectively. Enrolment may be made during the evenings of 12–16th September inclusive. The fees are 10/– for any one course, or 15/– for two courses.

AERIALS FOR V.H.F. TELEVISION RECEPTION

by F. C. JUDD, G2BCX

PART 2.

Whilst the writer of this article is dealing with aerials intended for higher frequencies than those at present in use for t.v., much of the information given will be of interest to the constructor looking forward to Band III reception.

Some Designs Suitable for Broad Band V.H.F. Reception

Since this article is intended to be a survey of types of aerials suitable for v.h.f. t.v. reception, it is not concerned with giving complete details as to actual physical dimensions and construction, although some of the aerials described may be used with open 300 ohm twin flat transmission line. Others may require special matching, and much useful information on this may be found in the A.R.R.L. Antenna Handbook and Amateur Radio handbooks. Other references are quoted at the end of this article.

Fan Dipoles

These are the most simple of all v.h.f. dipoles and are suitable for wide band reception. The Fan dipole is constructed of two triangles of metal supported by a suitable insulator. Both triangles lie in the same plane and the transmission line is attached to each apex. Its characteristics are as follows: The aerial shows some gain over a thin dipole, and its directivity is normally similar. The patterns of Fig. 2 show a slight front to back ratio due to the presence of a supporting mast. The gain versus bandwidth graph (Fig. 1) shows a favourable gain between the test frequencies of 500 to 900 Mc/s. This type of aerial should be cut for the centre operating frequency. A diagram showing the general appearance is given as Fig. 3. Dipoles with triangular arms may be used with good effect as the driving elements in beam aerials, such as the corner reflector described later.

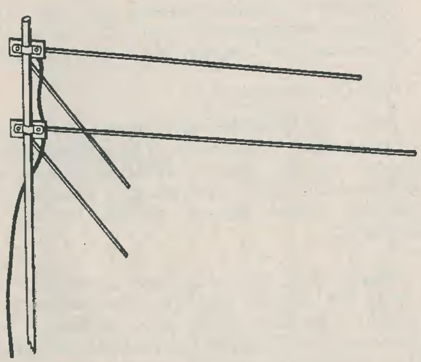


FIG.9.
THE STACKED 'V' AERIAL

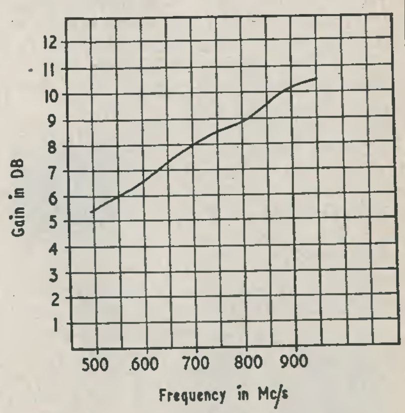


FIG.10.
THE STACKED 'V' AERIAL
Gain v Frequency

G179

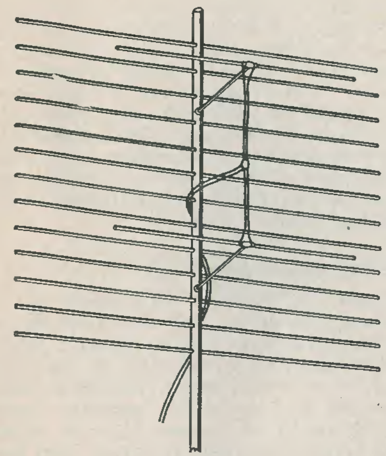


FIG.11.
SHEET REFLECTOR AERIAL

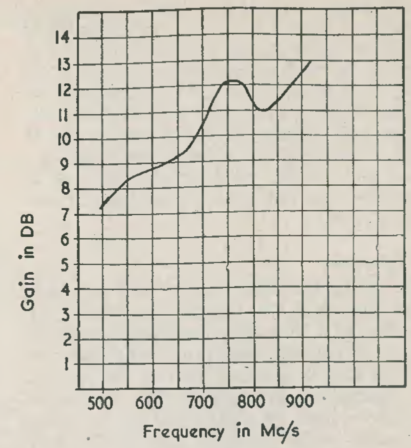


FIG.12.
CORNER REFLECTOR WITH FAN DIPOLE DRIVING ELEMENT (see text)
Gain v Frequency

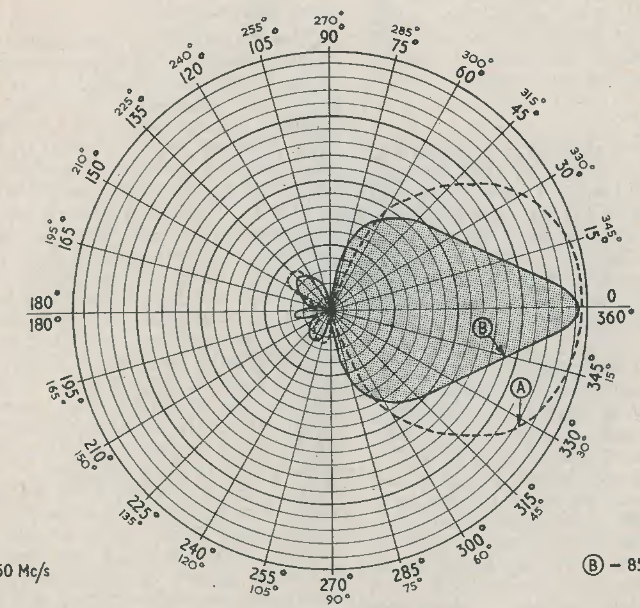


FIG.13.
THE CORNER REFLECTOR WITH FAN DIPOLE DRIVING ELEMENT

G180

Stacked Fan Dipoles

The simple Fan dipole may be stacked vertically as shown in Fig. 4. When properly phased, the gain of a two-stack Fan dipole is as shown in the gain versus bandwidth chart of Fig. 5. Although there is an increase in the vertical directivity, the horizontal polar pattern will remain as for a single dipole. The bandwidth is not quite so good as for a single Fan dipole, and is mainly due to frequency selectivity in the transmission and phasing lines.

The Rhombic

The Rhombic aerial lends itself as being useful for v.h.f. t.v. reception, and is illustrated in Fig. 6. Rhombics are usually adjusted for uni directional operation and are terminated with a resistive load at the far end. The general characteristics are as follows: The gain is high, as shown in Fig. 7, making the aerial very suitable for fringe area reception. Directivity is good, and a polar diagram is shown in Fig. 8. It should be noted that while some minor side and back lobes are present, these should give no trouble except in very severe cases of reflection or multi-path reception. The bandwidth is good and shows rising gain towards the high frequency end of the band. This is a very desirable point. Rhombics may be stacked vertically one above the other, approx. 12″ apart,* and show a gain of 2 db over the entire band. Horizontal directivity remains approximately the same.

The Stacked "V"

This aerial is very popular in America and is normally constructed with thin elements as an ordinary v.h.f. aerial (Fig. 9). The gain is high, as shown in Fig. 10, and useful for medium and weak signal areas. It shows an increase in gain with an increase in frequency, which is useful in overcoming both propagation and transmission line losses, which also increase with frequency.

Sheet Reflector Type Aerials

There are many versions of these, most of which use dipoles as driving elements and a reflector constructed of sheet metal, wire mesh, or a number of metal rods (see Fig. 11). The corner reflector is another version of this type of aerial, and may use a fan dipole as the driving element. The construction of the reflector should be carefully considered with respect to wind and weather, and if metal rods are used they should be spaced a small fraction of a wavelength apart. This applies also to the openings in wire mesh, which should be only a small fraction of the wavelength square or round as the case may be.

The corner reflector with a Fan dipole has useful characteristics and the gain versus frequency is shown in Fig. 12. The Fan dipole should be folded at 90 degrees to conform to the shape of the reflector, which is also folded at this angle. It should be an extremely useful aerial for fringe areas. The directivity is shown in Fig. 13, and it should be noted that the low gain of the side and back lobes should reduce reflection and multi-path troubles to a minimum. The bandwidth is rather narrow, but considering the high overall gain, this should not prove too troublesome if a suitable size of reflector and the wide band dipole are used.

Parasitic Beams (The Yagi)

These aerials are very critical as to frequency coverage, and may have to be constructed to close tolerance if high gain is to be maintained. They may, on the other hand, be of small physical dimensions, light in weight, and useful for reception over a limited range of frequencies but where exceptionally high gain is required. They may be stacked to increase the gain, and horizontal directivity remains the same. The pattern of Fig. 14 was taken from a 3000 Mc/s model of an eight-element array.†

The Helical Aerial

This is another very useful aerial which has recently made an appearance in this country. It has broad band characteristics with high gain and directivity. It does, however, require careful matching if good results are to be obtained. The writer has quite successfully constructed several models for 3000 Mc/s (10 cms), patterns from which are shown in Fig. 15. Details of gain versus frequency are shown in Fig. 16. Helical aerials may be designed to give extremely high directivity, and may also be constructed as omni-directional aerials with considerable gain over a dipole. Such an aerial is illustrated in Fig. 17. A 3000 Mc/s model of this showed good all-round directivity with high gain, but proved a rather difficult aerial to match to a transmission line. This may, however, have been due to the very high frequency. No information as to measured gain (over a dipole) is at present available.

Also worth of mention is the slot aerial, which may be adapted in a variety of ways as a high gain aerial. Such aerials are fairly widely used in the U.S.A. for transmission of television signals. Slot aerials may be used in broadside or endfire arrays, and lend themselves as useful elements for omni-directional aerials of the slotted tubular type. Polarisa-

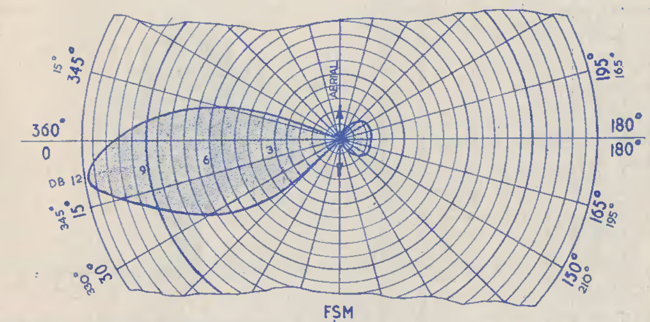
* Applies only to frequencies quoted.

† Measurements and Polar Patterns with Model Aerials by F. C. Judd (G2BCX), *The Radio Amateur*, Nov./Jan. '52–'53.

FIG. 14. EIGHT ELEMENT PARASITIC ARRAY

(Pattern from 3000 Mc/s model)

Gain over dipole approx 12 DB



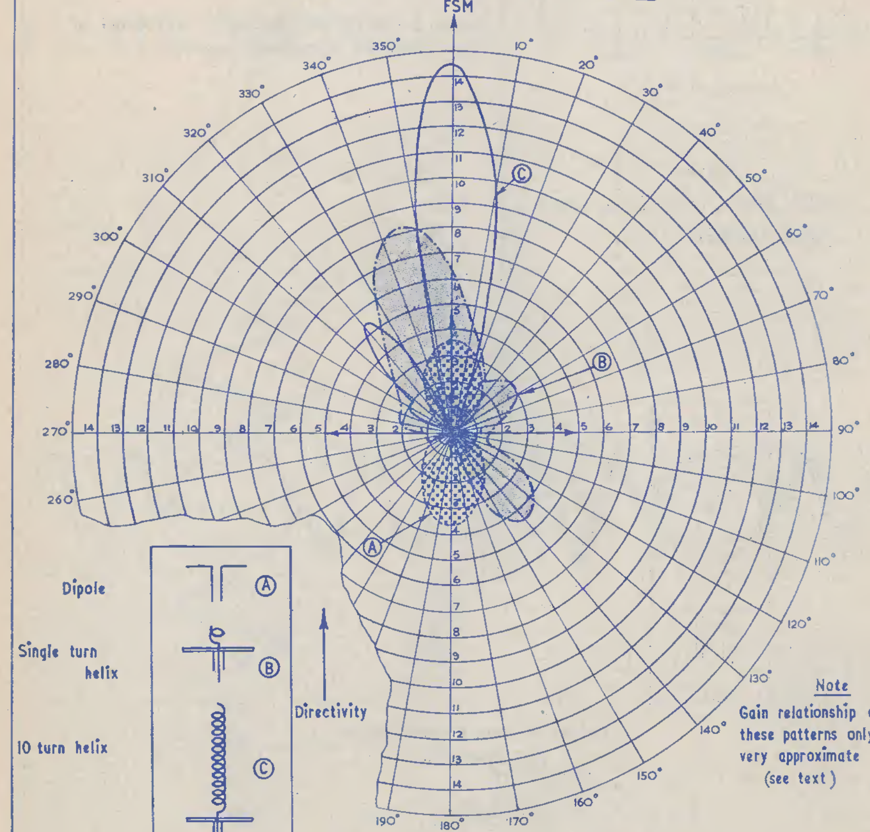


FIG. 15. VHF TV AERIALS

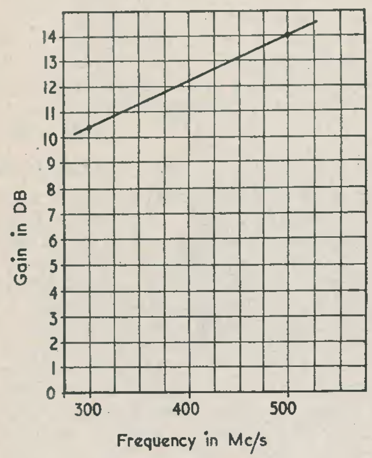
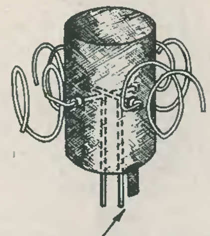


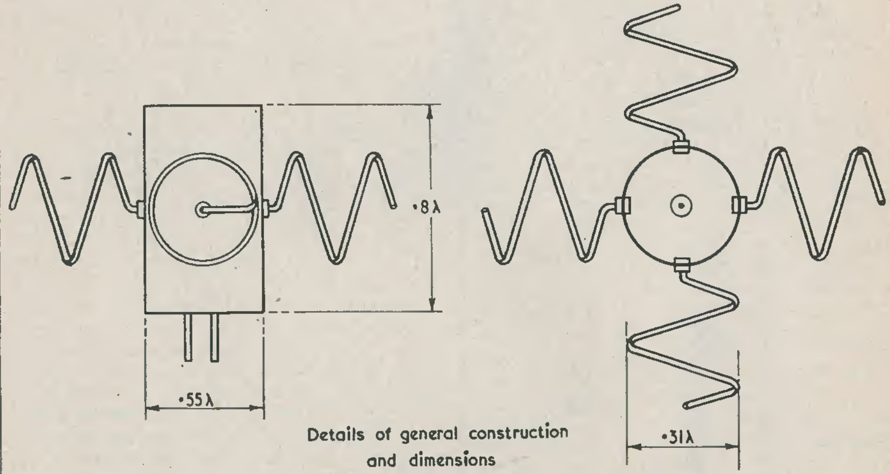
FIG.16.

THE HELICAL AERIAL (6 turn axial model)

Gain v Frequency



Sketch from a 3000 Mc/s model constructed by the writer for experimental purposes



Details of general construction and dimensions

FIG.17.

AN OMNI-DIRECTIONAL HELICAL AERIAL

tion is the opposite to a normal wire aerial; a vertical slot has horizontal polarisation. Refs. 2 and 3.

Transmission Lines

Transmission lines are an important part of the receiving aerial system. The best aerial performance can only be obtained by the proper choice and installation of the transmission line. Those listed below are suitable types not too greatly affected by weather, although the flat 300 ohm types show some loss due to moisture. Most of the aerials described in this article will work with 300 ohms flat or tubular transmission line, but may also be used with lower impedance co-axial providing suitable matching transformers and balancing networks are used.

TRANSMISSION LINE DATA

Loss—DB/100 feet

Type	100 Mc/s Wet	100 Mc/s Dry	500 Mc/s Wet	500 Mc/s Dry	1000 Mc/s Wet	1000 Mc/s Dry
1. 300 ohms flat line ..	7.3	1.2	20.0	3.2	30.0	5.0
2. 300 ohms tubular line	2.5	1.1	6.8	3.0	10.0	4.6
3. RG 59/U Co-ax. ..	—	3.7	—	9.6	—	14.5
4. RG 11/U Co-ax. ..	—	1.9	—	5.2	—	7.8

REFERENCES

1. **E. O. Johnson** *and* **J. D. Callaghan**, *Teletech*, Dec. 51. Receiving Antennas for U.H.F. Television.

2. **J. D. Kraus**, Helical Beam Aerial, *Electronics*, April 1947.

3. **J. D. Kraus**, *Proc. I.R.E.*, Oct. '48. Omnidirectional Helix.

CLUB NEWS

Details for insertion in this section should reach us not later than 7th of the month before publication.

QRP SOCIETY

The Society is extremely grateful to several well-known trade firms who have offered prizes for the Portable Amateur Radio Equipment Contest. Further contest entries are invited and need not be apparatus specially constructed for the purpose.

Society records show six affiliated clubs, and more U.S. members are reported.

GC2CNC, the Society's President, is officially credited with the world's record transistor QSO. This was with HB9T, on 1.8 Mc/s, over 532 miles.

Low-power enthusiasts are invited to write for details of membership. Hon. Sec.: John Whitehead, 92 Rydens Avenue, Walton-on-Thames, Surrey.

THE SLADE RADIO SOCIETY

Headquarters: The Church House, High Street, Erdington, Birmingham, 23.

Forthcoming Events

5th August, "Brains Trust." Questions submitted beforehand will be welcomed.; 19th August, "The Design of Transformers," by Mr. N. B. Simmonds (Member).

Direction-Finding Events

7th August, R.S.G.B. National D.-F. Contest, Edgware preliminary; 28th August, The fourth of the season's Harcourt Trophy Tests.

Club Station Programme

The Club Station at the Church House is open every day of the week for the use of Members. The following programme of instructional classes has been arranged: Every Monday evening at 8 p.m.: "Station Operation and Procedure." Instructors, Messrs. D. W. Morris, G3AYJ, D. J. Pye, G3EVC.

Every Wednesday evening at 8 p.m.: "Morse Practice and Equipment Design." Instructor, Mr. G. Nicholson, G3HKC.

Every fourth Friday at 8 p.m., on 1st July, 29th July, 26th August, 23rd September: "A Course of Instruction for Members intending to sit for the Radio Amateur's Examination." Instructors, Messrs. W. E. Lewis, and W. E. Merrill.

Full particulars of the Society and its activities may be obtained from the Hon. Secretary: Mr. C. N. Smart. 110 Woolmore Road, Erdington, Birmingham, 23, Visitors to the Society's Meetings, which commence at 7.45 p.m. prompt, and to the Club Station, are cordially welcome.

CLIFTON AMATEUR RADIO SOCIETY

The club librarian, D. Bennett, has been kept busy of late classifying the numerous magazines and books which have been donated to the Society. A comprehensive collection of post-war magazines and technical literature covering all subjects is available every week on loan to members.

Forthcoming Events: August 12th, Junk Sale; August 5th and 19th, Constructional Evening and Ragchew. September 4th, 3rd D.F. Contest; September 9th, Annual General Meeting.

Meetings are held every Friday at 7.30 p.m. at the clubrooms 225 New Cross Road, London, S.E.14, where new members and visitors will receive a warm welcome. Details of membership can be had upon application to the Hon. Secretary: C. H. Bullivant, G3DIC, 25 St. Fillans Road, Catford, S.E.6.

EAST KENT RADIO SOCIETY

The Society still meets fortnightly on Tuesdays, 8 p.m. at "The Two Brothers," Northgate Street, Canterbury. Many new members have been enrolled and one YL member. Many interesting lectures have been held, also raffles and sales. Morse classes are to be given by G2BBT and Transmitting Lectures by G3FCT have been arranged. New members and visitors are welcomed. Hon. Secretary: Mr. D. Williams, "Llandogo," Bridge, Canterbury.

WIRRAL AMATEUR RADIO SOCIETY

Meetings are held on the first and third Wednesday in each month at 7.45 p.m., at the Y.M.C.A., Whetstone Lane, Birkenhead. Visitors and Short Wave listeners particularly welcome. Hon. Secretary: A. C. Wattleworth, 17 Iris Avenue, Claughton, Birkenhead.

PROPOSED FORMATION OF A RADIO CLUB IN SWINDON

It is proposed to hold a meeting, with the object of forming a Radio Club in the town. Radio amateurs, short-wave listeners, constructors, in fact anyone interested in radio is invited to attend. Make this a date, please: 31st August, 1955, 7.30 p.m. at Connaught Cafe, 34 Cromwell St., Swindon. G3AYL es G31DW.

BAND III TELEVISION for the HOME CONSTRUCTOR

PART 2.

by **S. WELBURN**

The second of a series of articles describing the conversion of the Magna-View to Band I-Band III operation. The details given are largely applicable to most other home-constructor televisors

In the first instalment of this series we gave full details of the Valradio Tuner Unit type TP20P, this being employed for the Band I–Band III conversion described herein. We also gave a brief description of the method employed to couple the tuner unit into the Magna-View i.f. strip.

We may now carry on to give more explicit details.

Fitting The Tuner Unit

As was explained last month, the tuner unit takes the place of V_1 and V_2 in the original Magna-View. These two valves were the 6AM6 (or equivalent) r.f. amplifier, and the 12AT7 (or equivalent) frequency-changer. The valves employed in the Valradio Tuner Unit are cascode, triode-pentode types; and provide as much (if not more) gain on Band I than do the valves they replace.

We also stated that the tuner unit could be fitted, if desired, to the existing chassis in place of the original V_1 and V_2, together with their immediate components; but that we did not advise this course owing to the extensive chassis alterations required, coupled with the fact that the tuner unit spindle would not project at any convenient place, so far as cabinet layout is concerned. We advised instead that the tuner unit be mounted at a convenient point in the cabinet by means of its special mounting bracket; this latter being available as a separate item from Valradio, Ltd. The fitting of the tuner unit some distance from the receiver chassis proper is perfectly in order, since its i.f. output is at 75 ohms impedance, and interconnection may be carried out with the aid of co-axial cable.

It is important to make a note of the tuner unit type number—TP20P—just mentioned, as this tuner unit has been especially designed to feed into the i.f. strip (19.75Mc/s video, 23.25Mc/s sound) employed by the Magna-View. Also, this particular tuner unit has 6.3 volt valves designed for parallel operation, and thus conforms with the heater arrangement existing in the Magna-View.

Fig. 5 illustrates the manner in which the tuner unit is connected into the Magna-View circuit. It will be noted that this diagram gives all circuit details with the exception of the arrangements employed for the cathode of V_1 in the tuner unit (tag No. 4). The connections to this tag are discussed later in this article.

As will be seen from Fig. 5, the h.t. supply is fed to the tuner unit via tag No. 8. The h.t. supply is decoupled by means of a 500Ω 1 watt resistor mounted on the receiver chassis, and by means of a 0.05μF 350V wkg. miniature paper condenser mounted at the tuner unit tag-strip. This small amount of decoupling was found to be beneficial in practice in order to obviate a slight tendency towards peakiness in the video i.f. strip when the tuner unit was connected directly to the receiver h.t. supply.

The h.t. rail employed is that designated "B" in the original Magna-View circuit. This is the h.t. supply used throughout the Magna-View receiver and is that obtained after the rectified current from the h.t. rectifier has passed through the focus coil and the focus potentiometer network. In the original Magna-View, the oscillator h.t. voltage was obtained from the h.t. supply *before* the focus coil, thus obviating changes in voltage and, hence, frequency of reception, as focus adjustments were made. With this conversion the oscillator h.t. voltage is obtained *after* the focus coil. Because of this point, careful tests were taken to ensure that panel adjustments of focus did not cause any detuning. It was found that no noticeable detuning at all took place either on Band I or Band III due to focus adjustments, and it was decided that this part of the circuit was, in consequence, satisfactory.

The next supply leads to consider are those providing the heater voltage to the valves in the tuner unit, via tags 5 and 6. A conventional twisted pair of leads is employed, and it is advisable to use reasonably heavy wire for this purpose. This is due not only to the fact that it is desirable to avoid any volts drop in the heater supply to the valves in the tuner unit, but also because the earthy lead of the heater wiring also bonds the tuner unit and receiver chassis together. On no account should the i.f. co-axial lead "outer" be relied upon to provide this bonding and heater connection on its own; the additional lead "in parallel" is essential. Care should also be taken to ensure that the earthy heater supply from the Magna-View chassis is that which connects to tag No. 6 of the tuner unit. If the heater leads become reversed the heater supply from the Magna-View power supply will be short-circuited, with consequent damage.

No a.g.c. circuit is employed in the Magna-View. In consequence, tag No. 7 of the tuner unit is connected direct to chassis.

Tag No. 7 also provides an anchor for the "outer" of the 75 ohm co-axial cable carrying the i.f. output of the tuner unit. This cable connects to a special matching coil in the receiver (Denco type L3/3) which brings the 75 ohms coupling impedance up to that required at the grid of V_3 of the Magna-View. It is important to earth the co-axial cable "outer" at both ends. At the tuner unit this earthing is carried out as shown in Fig. 5. At the receiver chassis, the co-axial "outer" should be earthed at the same point as is employed for the earthy end of the matching coil. A suitable point is at the centre spigot of V_3 valveholder. The new matching coil takes up the position previously occupied by L3 in the Magna-View.

Finally, there is the aerial input connection. A balanced aerial coupling coil is available for 300 ohm inputs (tags 1 and 3); but it is likely that most constructors will employ 75 ohm co-axial feeder, in which

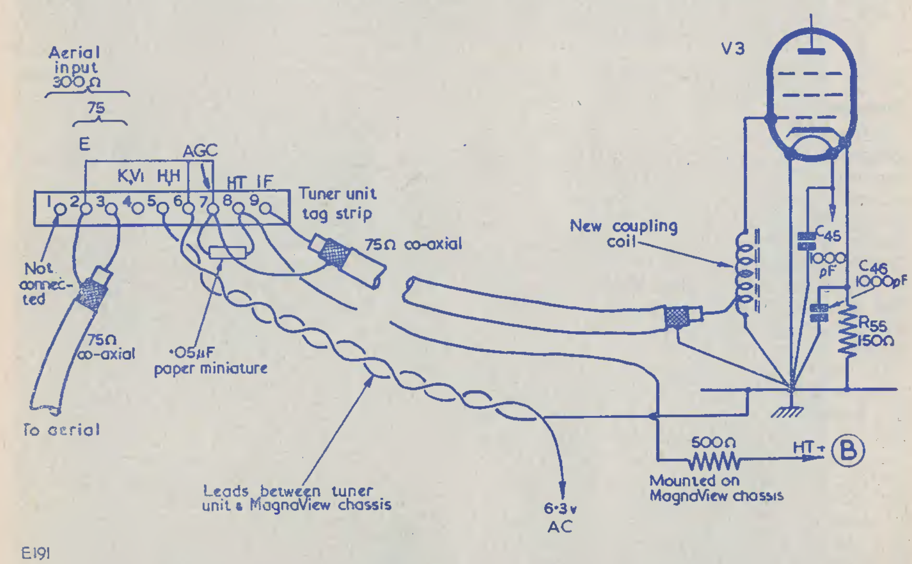


Fig. 5. Showing how the Band I–Band III tuner unit is connected into the existing Magna-View circuit. Care should be taken to ensure that the earthy lead of the heater wiring connects to tag 6, and not to tag 5, of the tuner unit. The numbered components are those already fitted to the Magna-View

case the aerial connection to the tuner unit should be carried out as illustrated in Fig. 5. There is only one aerial input available on the tuner unit and this is intended both for Band I and Band III.

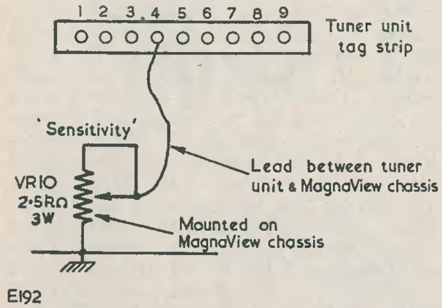


Fig. 6. In areas where Band I–Band III signal strengths are approximately equal, the simple Sensitivity control shown here is all that is required

Contrast

From the point of view of the writer, a somewhat unpredictable feature of the conversion is given by the difficulty of recommending the best contrast control arrangement to meet the differing conditions likely to be experienced by constructors. This is due to the fact that it is impossible to gauge the relative levels of the Band I and Band III signals for the individual localities at which existing Magna-Views are in use.

In the original Magna-View two gain controls were employed. One, VR_{10}, was the Sensitivity control, and it varied the cathode bias of the r.f. amplifying valve, V_1. The other, VR_{11}, was the Contrast control; and this varied the cathode bias of the second video i.f. amplifier, V_4. It was intended that under the conditions of reception given by single-station working the Sensitivity potentiometer be adjusted to give a coarse control of gain, after which the Contrast potentiometer would be employed to give panel control of contrast. However, under the conditions to be anticipated when receiving both Band I and Band III signals, it is possible that the range of control provided by the Contrast potentiometer on its own may not be adequate to cover both signals. This is especially true of anticipated conditions at Band III fringe areas. In such areas it is possible that a strong Band I signal may be received; whilst the Band III signal may be very weak. Conversely, of course, the Band III signal may be considerably stronger than the Band I signal in one or two alternative locations.

The best course to adopt is to find, after completion of the modification, what conditions exist in the particular district in which the home-constructor resides. If the two signals are sufficiently near to each other in strength to enable the existing contrast control to be employed, there is little point in altering the contrast control wiring already fitted. The existing sensitivity control may then be connected to the tuner unit as shown in Fig. 6, in which case it carries out the same function as it did in the original, unmodified, Magna-View.

If, however, the two signals are considerably differing in strength, two alternative plans may be employed. One plan would consist of allowing the panel potentiometer to have a far wider range of control than it has in the original Magna-View circuit. The other plan would consist of so treating the two signals that their effective input amplitudes to the frequency-changer were approximately equal, thereby allowing the existing contrast circuit, with its limited range, to be retained. The second solution is probably slightly more preferable, as it allows a finer control of contrast to be obtained; this being especially important in cases where the receiver is to be adjusted by non-technical viewers.

For the arrangement providing a wide range of panel contrast control, the circuit employed in Fig. 7 should be adopted. This means some slight modification in the receiver wiring. What now happens is that the original leads to the panel contrast control are transferred to VR_{10}, the Sensitivity control. VR_{10} then enables a pre-set control of the gain of the i.f. strip to be obtained. The Contrast potentiometer, VR_{11}, now varies the cathode bias of the cascode V_1 in the tuner unit and, in consequence, has a wide range of control. An additional 100kΩ 1 watt resistor is required for the circuit of Fig. 7, this connecting the top end of the Contrast potentiometer track to the receiver h.t. rail.

Maintaining Constant Level

The second solution, just discussed, of retaining the original contrast control is also quite easy to put into practice, although the method used may vary slightly under differing conditions.

It is anticipated that most readers will employ separate aerial input leads from their Band I and Band III aerials. If this is the case, these two inputs will have to be combined at the receiver in order to feed the single aerial input of the tuner unit. The

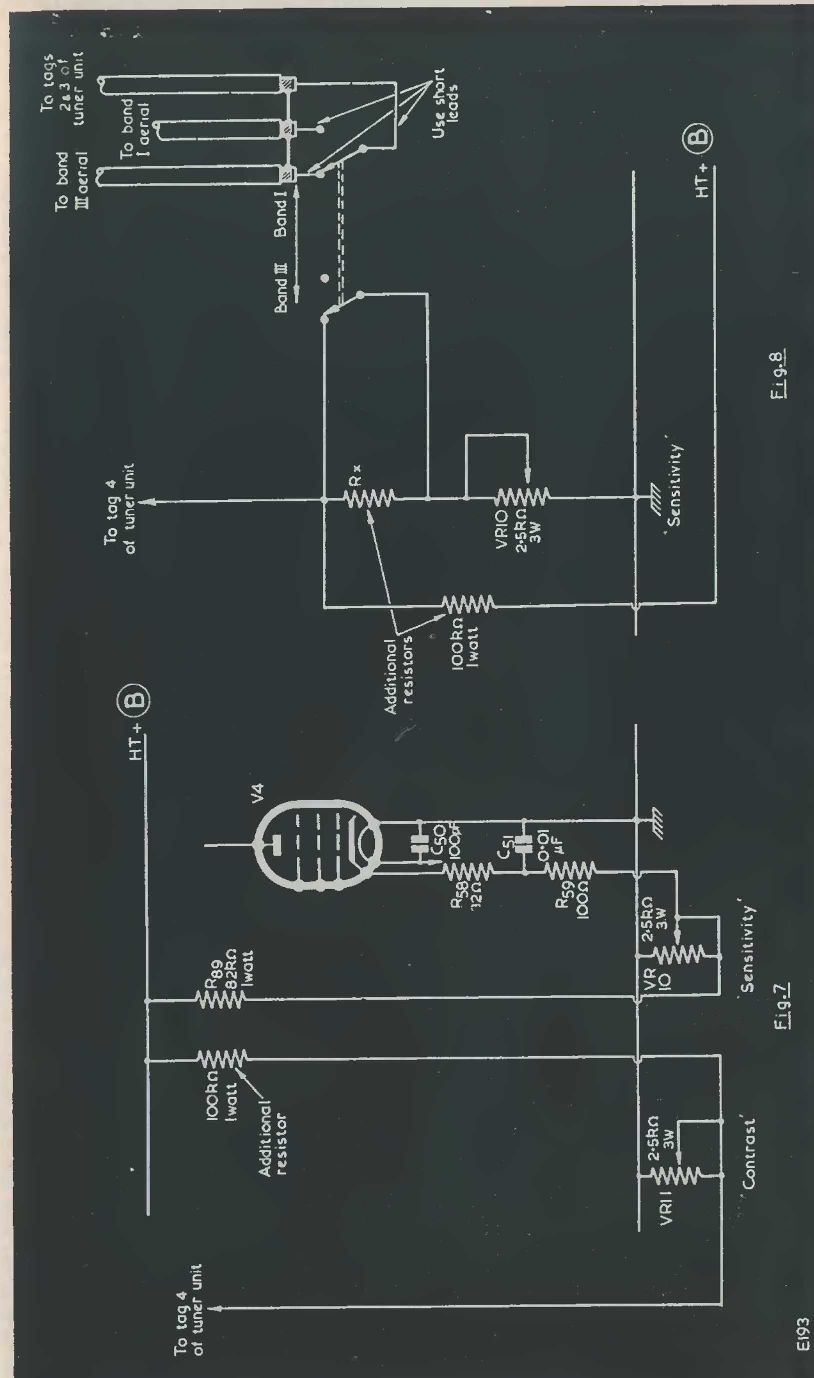


Fig. 7. If the Band I and Band III signals vary considerably in strength, a greater range of Contrast control will be given with this circuit

Fig. 8. Another circuit which allows for considerable differences in level between the Band I and Band III signals

simplest way of combining these leads, without losses, would consist of employing a simple change-over switch. This switch could then be employed also to maintain constant signal input amplitude to the frequency-changer over Band I and Band III.

The recommended circuit is shown in Fig. 8. In this diagram a simple two-pole two-way wafer switch connects the "inners" of the co-axial cables from the Band I and Band III aerials to the "inner" of the co-axial cable feeding the aerial input socket of the tuner unit. The change-over switch also varies the cathode bias of V_1 in the tuner unit. In the Band I position, where signal intensity is expected to be higher, the cathode of V_1 connects to the slider of the existing sensitivity control VR_{10} via a resistor, R_x. In the "Band III" position, where signal strength is expected to be lower, R_x is short-circuited. The value required for R_x will vary according to local conditions and it is best found by experiment.

(In the possible cases where the Band III signal is stronger than the Band I signal, R_x would be introduced in the "Band III" position of the change-over switch).

Practical Details

Before concluding this article, one or two details concerning practical points should be included.

Firstly, the modification should not be commenced until the constructor is satisfied that the existing i.f. strip is in good working order and that it is correctly aligned. After the modification has been carried out, the only core which should need adjustment is that fitted to the new i.f. coupling coil shown in Fig. 5. The i.f. core on the tuner unit will be set up by the manufacturer and should not normally require adjustment at a later date.

Secondly, after the modification has been completed, the circuitry around valves V_1 and V_2 in the Magna-View is no longer required and the components concerned may be removed altogether from the chassis.

Next month—the Teletron Converter

NOTES ON RADIO CONTROL

A Letter from Australia

One of our readers, Don Gilder, VK3AHG, of Victoria, writes to give us some information on his radio controlled model activities "down under." He writes:—

"I have a 3-foot model launch and have experimented with a number of transmitters and receivers in an attempt to get stability. I have used both the XFG1 and the 3A4 types of valve with fair success, but the present receiver uses a 3A5 twin triode and seems the most reliable of all. The circuit is a little unconventional, particularly the "split h.t." arrangement. However, the general idea is to use the first half of the tube as a normal super-regen and the second half biased to cut-off until reception of a signal, when it draws enough current to operate the relay with positive action. The circuit is shown in Fig. 1.

"The plate current drawn by the super-regen section through the potentiometer produces a negative voltage across the resistor, and so biases the second half of the 3A5 to cut-off. This can be adjusted by means of the potentiometer. On receipt of a signal, the plate current of the super-regen section drops and the voltage variation across the potentiometer overcomes the negative bias on the second half of the 3A5 and becomes a positive voltage. The tube conducts and draws plate current and actuates the relay. Battery drain is economical as the valve draws no current on no signal, due to the bias. The first half of the valve, operated in this manner, is much more sensitive as it does not have to be loaded up to provide enough current drop to operate the relay in its own plate circuit."

Don goes on to say: "If you have not tried this circuit you should do so, as I have found it extremely stable and it needs little retuning after long periods of not being used. The potentiometer is adjusted with the meter, for a low idling current of about 0.25mA. On a signal, the current should rise to about 3mA."

Describing his transmitter, Don writes: "In the interests of stability, I use a crystal controlled transmitter. One of the available filament voltage, but this is easily provided by a cycle lamp battery or a lightweight accumulator. About 120 volts of h.t. is needed for best results. The circuit is shown in Fig. 2. Coil data for your readers must be to suit your R/C frequencies."

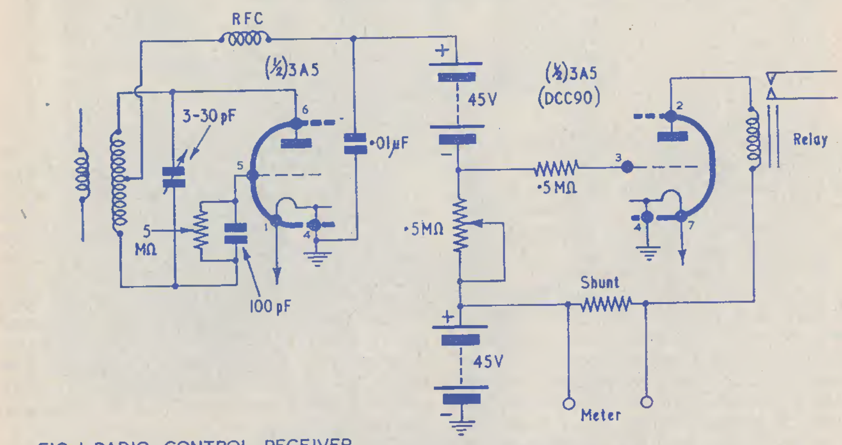


FIG. 1. RADIO CONTROL RECEIVER

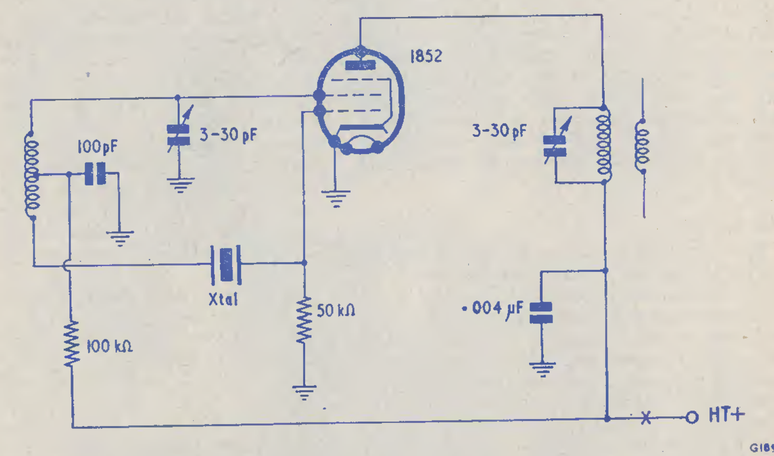


FIG. 2. RADIO CONTROL TRANSMITTER

radio control frequencies out here is 40.66 to 40.7Mc/s and this is the one I operate on. I use a crystal of 6,780kc/s and this trebles to 20.34Mc/s in the grid circuit, and then doubles to 40.68Mc/s in the output. An 1852 valve is used which requires 6 volts

We feel sure our readers will be interested in these two circuits and the methods they illustrate which are being used in Australia for R/C work. We gather that interest in this topic is just about as popular there as it is here in the British Isles at the moment.

A MINIATURE SIX-VALVE SUPERHET

by E. P. MEREDITH

THERE ARE MANY INTRIGUING ASFECTS TO the hobby of radio construction. One of the most fascinating of these is the construction of miniature equipment; this being also, indeed, a subject which is not given as much space in the technical press as, in the writer's view, it deserves.

This article describes, in some detail, the functioning and construction of a typical six valve superhet receiver using miniature technique. Nothing whatsoever has been sacrificed in its technical specification which would cause its performance to be below that of its much larger brother. This does not infer, however, that care has not been taken with the circuitry in order to reduce the number of components to a minimum. In fact, it is the writer's belief that those who are interested in miniaturised construction will find the circuit to be of most interest, and that they will be able to employ it to best advantage with those components which they may already have on hand, and in the layouts which they themselves think most suitable.

The Circuit

The complete circuit is shown in Fig. 1, and it would be worth while to touch on one or two points of interest contained in it.

As may be seen, the receiver covers medium and long waves, separate variable padders being used for these two bands. The negative voltage (with respect to chassis) which appears at the grid of the frequency-changer oscillator is applied to the potentiometer R3 and R12, causing a second, reduced, voltage to appear at the junction of these resistors. The reduced voltage is decoupled by C18, and is then applied, via R8, to the grid of the double-diode-triode; and to the a.v.c. network (and thence as a standing bias to the frequency-changer and i.f. amplifier) via R9.

This arrangement is known as an "oscillator bias" circuit and it offers considerable advantages.*

In the first place, it avoids the necessity of using cathode decoupling for the frequency-changer, i.f. amplifier and double-diode-triode, since the bias voltage for these valves is now obtained from the frequency-changer oscillator grid itself. The only components needed with the circuit are two resistors and a condenser; and yet they obviate three resistors and three condensers, one of which would need to be electrolytic. Secondly, the circuit simplifies construction since it allows the cathode of each valve to be connected direct to chassis in the initial wiring.

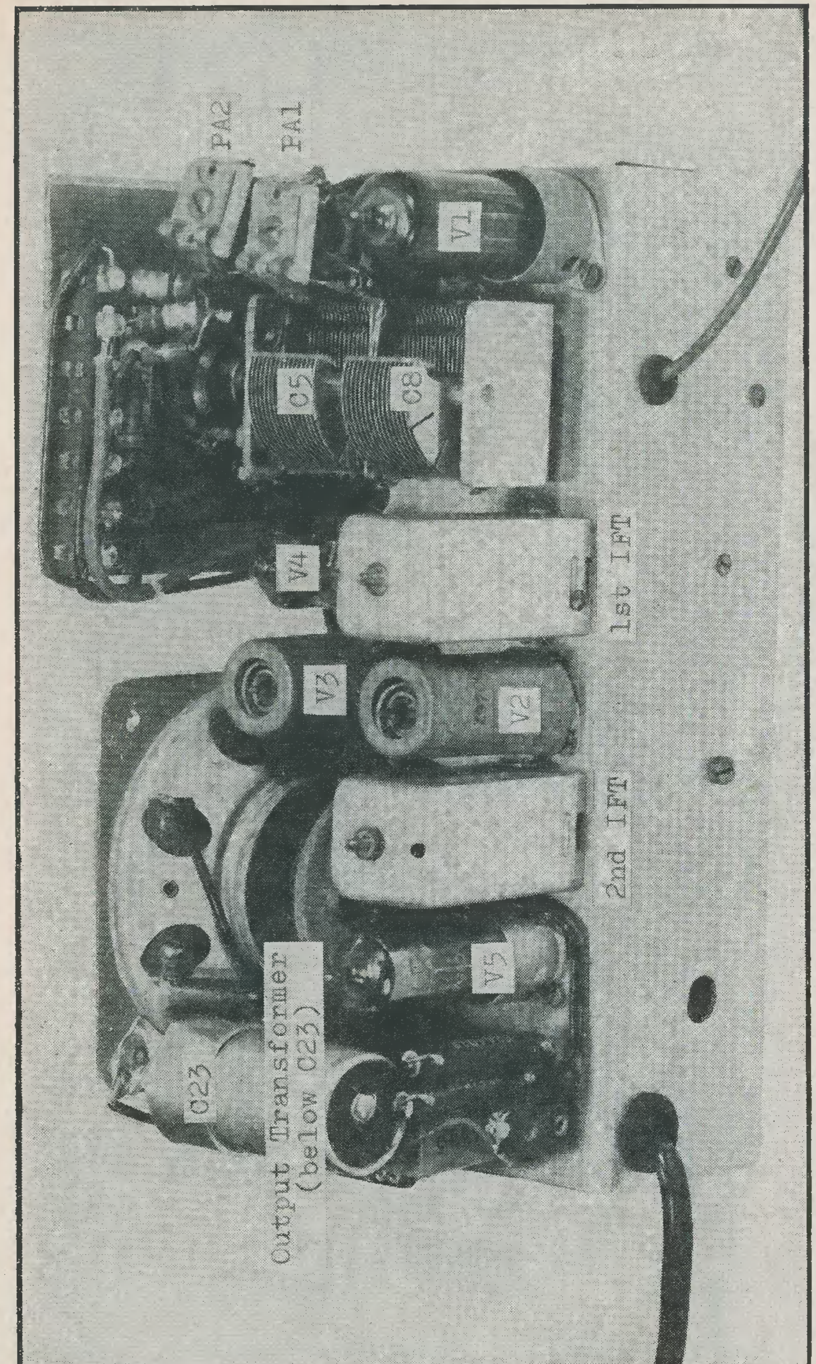
The "oscillator bias" circuit is shown separately in Fig. 2. It will be noticed that values which may at first sight seem rather low have been chosen for the resistors R3 and R12. These low values are used to prevent the a.v.c. voltage appearing at the top of R9 from building up an additional voltage across R12. If such a voltage were allowed to appear the standing bias would increase, whereupon the triode section of the double-diode-triode would be overbiased. Using the values shown, only one seventieth part of the a.v.c. voltage is added to the standing bias, with consequently negligible results.

Employing oscillator components having the values shown in Fig. 1, a negative potential (with respect to chassis) of approximately 13V appears at the oscillator grid when the set is switched to medium waves. On long waves this potential drops to approximately 12V. Thus, the standing bias given at the junction of R3 and R12 has a slightly varying value lying between the limits 1.6 to 1.7V.

Continuing with the receiver circuit, it will be noticed that a common screen-grid decoupling condenser, C6, is used for both frequency-changer and i.f. amplifier. This condenser is mounted at the frequency-changer valveholder. The use of a common condenser does not detract from the stability of the receiver.

There is little of note at the double-diode-triode save that the second detector circuit

* See G. A. French, *Suggested Circuits No.* 32, RADIO CONSTRUCTOR, August, 1953.



Rear view, showing location of components above chassis

COMPONENT LIST—Set out for easy reference to Fig. 1.

Condensers

C1	0.01μF 750V wkg
C2	0.1μF 350V wkg (T.C.C. Metal-mite)
C3, 4	60pF Trimmer
C5	500pF Tuning
C6	0.1μF 350V wkg (T.C.C. Metal-mite)
C7	300pF Miniature Mica
C8	500pF Tuning
C9	0.001μF Miniature Mica
C10	60pF Trimmer
C11	300pF Padder
C12	60pF Trimmer
C13	600pF Padder
C14	200pF Miniature Mica
C15	0.005μF Mica
C16	200pF Miniature Mica
C17	75pF Miniature Mica
C18	0.1μF 350V wkg (T.C.C. Metal-mite)
C19, 20	0.01μF 350V wkg (T.C.C. Metal-mite)
C21	12μF 25V wkg Electrolytic
C22	16μF 350V wkg ,,
C23	16μF 350V wkg ,,
C24	0.01μF 750V wkg ,,

Resistors

R1	22kΩ ¼-watt
R2	22kΩ ⅛-watt
R3	100kΩ ⅛-watt
R4	22kΩ ½-watt
R5	2.2MΩ ⅛-watt
R6	250kΩ Miniature Vol. Control (With Switch)
R7	22kΩ ⅛-watt
R8, 9	1MΩ ⅛-watt
R10	150kΩ ¼-watt
R11	250kΩ ⅛-watt
R12	15kΩ ⅛-watt
R13	680Ω ¼-watt
R14	1.2kΩ 3-watt
R15	500Ω ½-watt
R16	2.2MΩ ⅛-watt
R17	270kΩ ⅛-watt
R18	120Ω ±5% ¼-watt
R19, 20	50kΩ ¼-watt

Switches

S1, 2, 3, 4	Miniature 4-pole, 2-way wave-change
S5	On-off (combined with R6)

Coils

L1, 2	Wearite PA2
L3, 4	Wearite PA1
L5, 6	Wearite PO1
L7, 8	Wearite PO2

Valves

V1	Brimar 12AH8
V2	Brimar 6BA6
V3	Brimar 6AT6 or Osram DH77
V4	Brimar 6AM5
V5	Brimar 6X4 or Osram U78
V6	Mullard DM70

Other Components employed in the Prototype

Loudspeaker—Stentorian (W.B.) 3½in. (Maker's Reference S3.57)
Tuning Capacitor—Miniature 2-gang 500pF
Heater Transformer—6.3V at 1.5A
I.F. Transformers—Miniature, Type 160/120 Allen Components
Epicyclic tuning drive—Normal concentric pattern
Speaker transformer—Miniature (60:1)
Valveholders—B9A—1 screened
B7G—2 screened, 2 unscreened

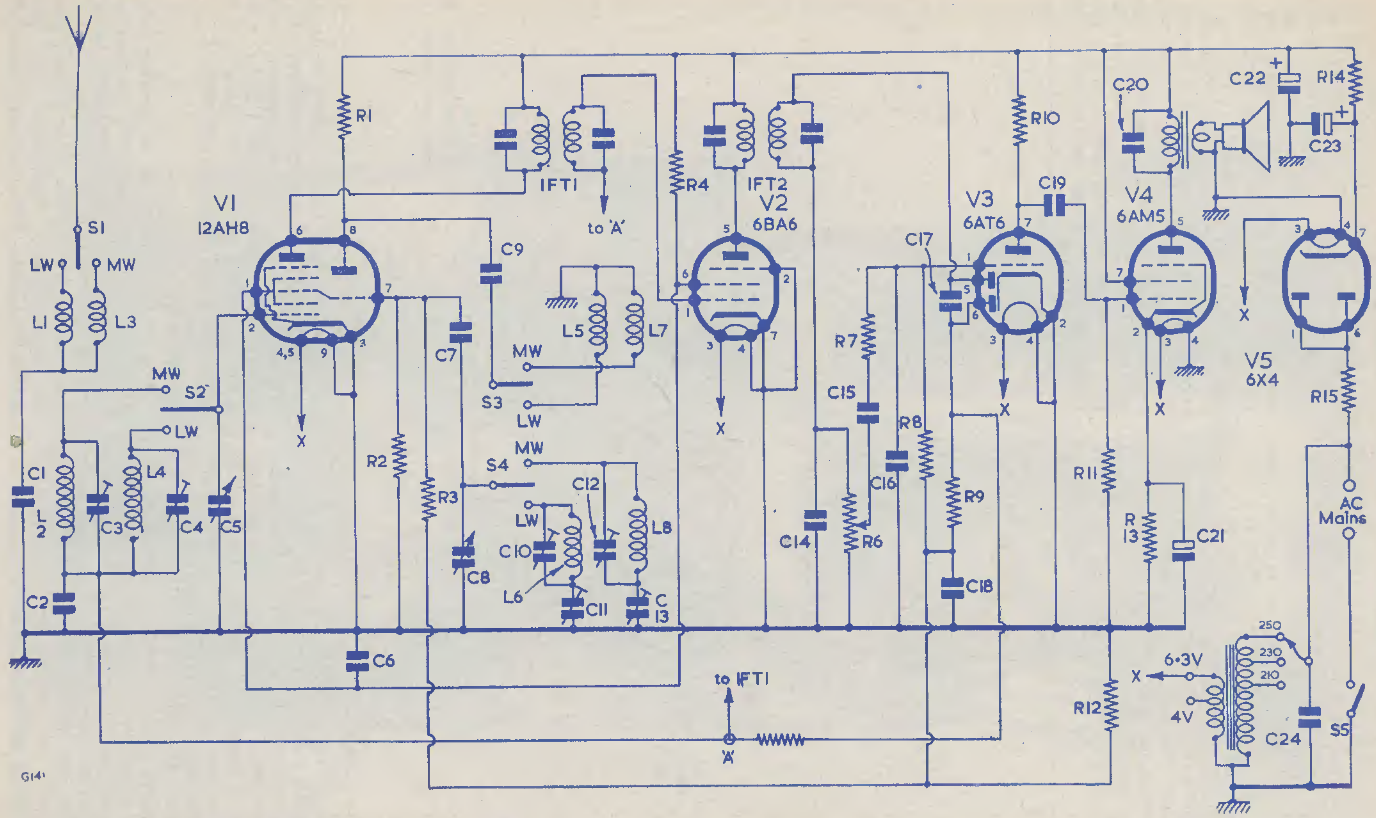


Fig. 1. *Theoretical circuit of the 6-valve Superhet*

is a little more comprehensive than is common with a miniature. This extra care in circuitry is well worth the slight trouble entailed in construction as it affords considerable protection against instability.

The power-supply circuit is quite conventional. A half-watt component is recommended for the limiter resistor, R15. In the event of an h.t. failure, this resistor should then burn out before any damage is caused elsewhere. An electrolytic condenser capable of carrying the ripple current is recommended for the reservoir position (C23). C22 is a smaller component intended for smoothing only.

Construction

A typical and very successful example of a receiver built to this circuit is shown in the photographs which accompany this article. As may be seen, the receiver is very compact, and the whole assembly is designed to fit into a small rectangular cabinet with hardly a cubic inch of space wasted.

The chassis on which this receiver is built is quite conventional, and is 3in. wide by 8½in. long. Its depth is 2¼in. A small cut-away is provided to enable the loudspeaker to be bolted flush to its front surface. A separate panel bolted to the main chassis is employed for the tuning dial and

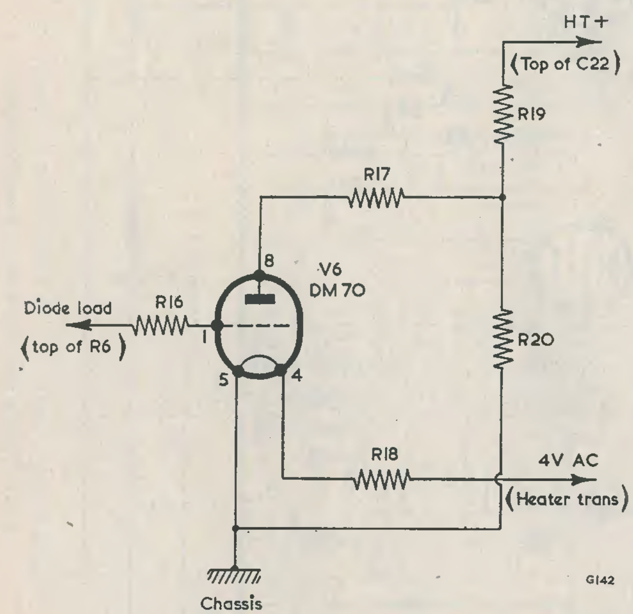


Fig. 1a. *Detail showing tuning indicator circuit*

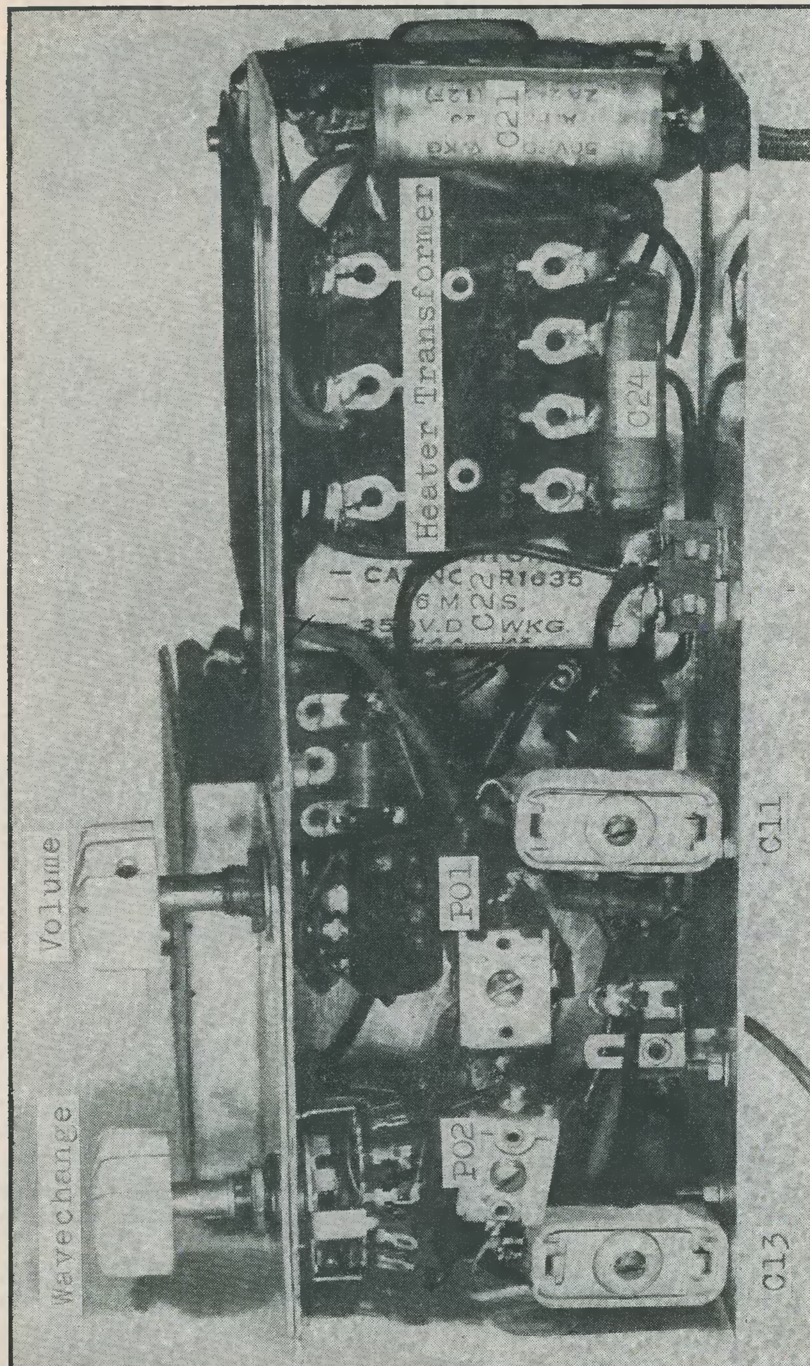
The tuning indicator control voltage is taken from the volume control, R6, and not from the a.v.c. line. This is because the latter carries a constant bias; with the result that, if it were used, the range over which the indicator could work would be reduced. Another point of interest lies in the fact that the 1.4V filament supply for the DM70 is obtained from a 4 volt tapping on the heater transformer (via a dropping resistor, R18), and not from the 6.3V tapping. If a heater transformer with a 4V tapping is not available, the DM70 filament may be run from the 6.3V tapping, a resistor of 220Ω ±5% being connected in series.

for mounting the DM70 tuning indicator and the components connected directly to it. The layout of the principal components employed is illustrated in Figs. 3 and 4, these giving a logical method of laying out the components without incurring feedback.

Precautions

The main precautions to observe when building a receiver as small as this are those of adequate heat circulation, voltage insulation and facility of servicing.

In the receiver shown in the photographs, all heat-producing components are fitted above the chassis with the exception of the



Under-chassis view showing main component layout heater transformer. This, being a component having a heavy mass of metal which is in good thermal contact with the metal of the chassis, has much of its heat conducted away. Despite this, however, it is advisable mains and h.t. connections have adequate physical spacing from chassis connections.

Facility of servicing can be achieved only by careful layout. The ideal to aim at is to so position the components that all con-

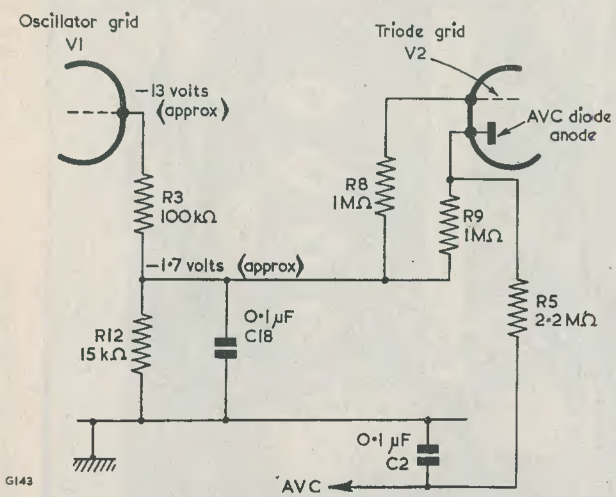


Fig. 2. Detail showing the "oscillator bias" circuit

to house a chassis of this type in a cabinet provided with feet or runners, and having several holes cut in the bottom to facilitate the circulation of air by convection.

Voltage insulation is also of some importance and care should be taken to ensure that nections are capable of being reached without the necessity of disturbing other parts. In this respect it cannot be too strongly emphasised that all solder joints must be well made during the period of construction in order to prevent trouble at a later date.

ERSIN MULTICORE SOLDER NOW AVAILABLE IN NEW 2/6 HOME CONSTRUCTORS' PACK

Multicore Solders Ltd. announce that they have supplemented their 6d. and 5/– retail lines, with a new 2/6 pack containing 20 ft. of high quality 60/40 alloy wound on a reel.

Multicore Solders Ltd. claim that with the increased interest in the construction of F.M. tuners and amplifiers by amateurs, a ready market will be found for this pack which is now being generally distributed. In addition to this the new 2/6 Home Constructors' Pack will satisfy the need for a larger and more economical supply of solder for home soldering purposes.

INCREASED RATING FOR MULLARD JUNCTION TRANSISTORS

The maximum permissible collector dissipation of Mullard junction transistors OC70 and OC71 has been raised from 6 mW to 25 mW. The original rating was deliberately made small in order to ensure adequate margins of safety. The increase reflects the experience gained by the practical application of these new devices.

The maximum DC collector voltage is 5V, and the maximum ambient temperature is 45°C.

The "FULL TONE" Amplifier

Reports from the Field

by **M. HARVEY**

Although it was described only as recently as in the May and June issues of *The Radio Constructor*, it appears that a considerable number of Full-Tone 8-watt amplifiers have already been made up successfully by home-constructors. In consequence, quite a few queries have been passed on to the writer, and he has been able to formulate an idea of how the amplifiers constructed have performed in the field.

In general there have been no complaints, although one reader was very critical of the fact that manufacturers' reference numbers were given for the various components. It is true that this makes it more difficult to buy some of the specified components at one's local shop. On the other hand, complete kits were put up by one advertiser; and another had ready-punched chassis immediately available. Also, the possibility of using alternatives was gone into at some length in the article in the May issue. Stated briefly, the situation is that it is not good engineering practice to design a chassis and circuit without also specifying the component types which may be employed in it. To take an example, in the case of a compact amplifier, such as the Full-Tone, condensers of small physical size are recommended. A model using bulkier condensers might, or might not, work just as well; but it would certainly be more difficult to build and would obviously not be a copy of the original prototype, whose specification and performance are known.

However, the writer feels certain that readers will use their own common sense on this matter and that the comments printed in the May issue clarify the position quite adequately.

Performance

There have been no complaints whatsoever about performance, but there have been several queries with relation to hum level. These have been investigated.

As is to be expected with a high-gain amplifier, hum can be quite a troublesome thing to clear up satisfactorily. With the Full-Tone, hum should be negligible, i.e. it should be inaudible against the slight background hiss given with the input terminals disconnected and the volume control turned to the maximum position. This implies the use of a conventional loudspeaker and the fact that the input socket is screened. The latter point will be mentioned again later in this short article.

The hum from which readers' models suffered could be divided into two categories. The first of these was hum originating in the amplifier and power-pack. The second was hum introduced by the equipment to which the amplifier was connected.

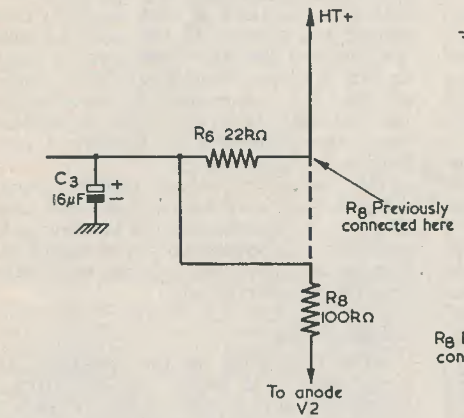
Amplifier Hum

Hum originating in the amplifier and power pack was largely due to errors in following out the instructions. Typical of these were the use of an unscreened volume control and an input jack socket instead of the recommended Pye socket. (So there *is* something to be said for specifying particular components after all!)

In practice the use of an input jack socket would be permissible in some cases if the chassis connections taken to the Pye socket in the original design were still retained at the same part of the chassis. However, the input socket *must* be a miniaturised bakelite component, and it might have to be screened. In the writer's opinion a lot of trouble would be avoided by using the specified Pye socket arrangement, which is known to be satisfactory. No other causes of hum in the amplifier itself were experienced.

Most of the remaining hum cases were caused by inadequate smoothing in the power packs employed. This was due to insufficiently large smoothing chokes or poor smoothing condensers. Fortunately, it is possible to overcome the effects of such power packs by a simple modification to the amplifier, at the expense of a very slight amount of gain. This modification is to be recommended as it will involve the constructor who experiences hum in less cost than would be given by the purchase of a larger choke for the power pack.

Fig. 1 shows the circuit details. All that happens is that R_8, the anode load of the phase-splitter V_2, is disconnected from the right-hand side of R_6 and re-connected to its left-hand side. In consequence, V_2 now has an h.t. supply which receives additional smoothing from R_6 and C_3. The loss in gain due to the lower h.t. voltage applied to V_2 is very small. Fig. 2 shows pictorially how the modification is carried out. This diagram should be studied in conjunction with Fig. 10 of the June issue.



E194 Fig.1

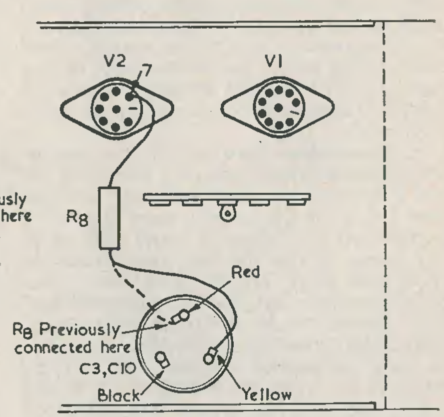


Fig.2

must obviously be picked up by the external circuitry.

So far as gramophone pick-ups were concerned, careful attention to screening cleared up most cases. Reversing the gramophone motor mains plug in its socket was also quite helpful. The trouble may also be caused by hum-loops. In such cases, all external earth returns should be taken to that at the Pye input socket via the screened input lead outer conductor.

Another difficulty was raised by an f.m. feeder unit which introduced quite noticeable hum when it was connected to the amplifier. This particular case was a little more difficult to solve but it was traced eventually to the fact that the feeder unit was employing the same power pack as that supplying the amplifier. The trouble was presumably caused by volts drop in the heater leads supplying both the feeder unit and the amplifier, this applying a small 50c/s voltage to the amplifier input. It is probable that the trouble could have been cleared by breaking the heater connection to chassis at the feeder unit, but unfortunately this could not be done in this instance. Nevertheless, it was found possible to clear the hum completely, this being done by supplying the feeder unit heaters from a separate 6.3 volt winding on the main power pack transformer, the "earthy" side being connected to chassis both at the power pack and at the feeder unit. The h.t. supply obtained from the power pack for both the amplifier and the feeder unit was retained, and gave no trouble.

All tests for hum in the amplifier should be carried out with the input terminal disconnected and screened. The latter is important, as the small pin projecting from the Pye socket may pick up hum in some installations. The input socket may be screened by fitting a dummy plug to it, or by temporarily covering it with a metal screen, such as a valve screen. Unscreened mains leads and similar wiring should not, of course, be allowed to pass underneath the amplifier chassis.

External Hum

Hum was also picked up externally in some instances. Such hum may always be detected by the fact that if hum does not occur when the input socket is "open" under the conditions just described, then it

Let's Get Started 26:

THE CATHODE RAY TUBE

by **A. P. BLACKBURN**

Over the past few years the importance of the oscilloscope has grown considerably. Although before the war it was in common use, the advent of radar and sundry other electronic techniques has led to rapid advances in oscilloscope design. The time is therefore ripe for a presentation of the basic purpose and operating features of the instrument.

The circuitry involved is of rather a different nature to that found in normal receivers and amplifiers. In fact, the principles entailed are often just the reverse of those connected with amplifier practice, where the object is to reproduce waveforms with the greatest possible accuracy. In timebase circuits, however, the object is often to produce highly distorted waveforms.

Objects

The purpose of the oscilloscope is to draw what is virtually a graph of regularly varying electrical quantities, such as voltage or current, against a horizontal scale of time. If, for example, we were to connect our oscilloscope to a point in a circuit where a sinusoidal signal existed, a picture of the sinusoid should appear on the screen of the oscilloscope. If the frequency of the signal were 25c/s, and the horizontal scale were ½ sec., 12½ cycles would be displayed. The vertical axis would normally represent voltage.

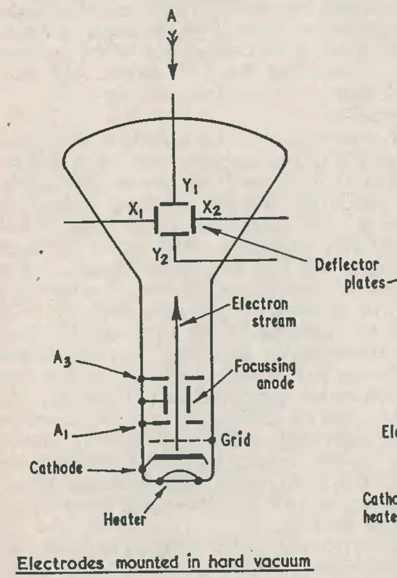


FIG. 1. (a)

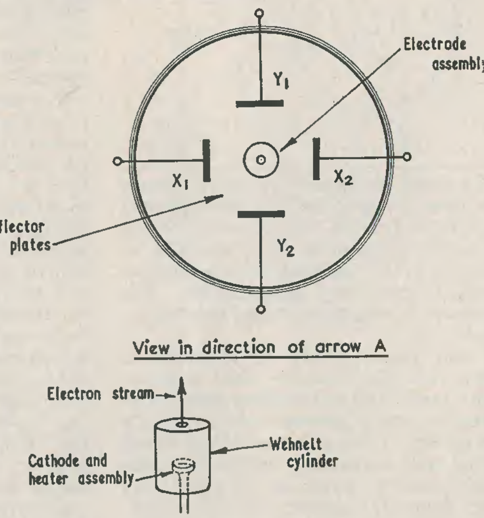


FIG. 1. (b)

G190

The Cathode Ray Tube

The heart of the oscilloscope is the cathode ray tube. This is the device which produces the picture, and therefore all the circuitry is designed around it. Fig. 1a shows an electrostatically deflected tube.

At the base of the tube there is a cathode heated in the same way as in an ordinary valve. This cathode therefore emits electrons, which are attracted away from it by the anode A_1. Between the cathode and the anode there is a "grid" consisting of a tube with a hole in one end, as shown in Fig. 1b. This is called the Wehnelt cylinder. By biasing this electrode relative to the cathode, a variation in the number of electrons passing through the hole may be achieved, as in the case of a normal valve. Beyond this electrode is an anode positively charged with respect to cathode. This anode is often in the form of a disc with a small hole at its centre. The electrons are attracted toward this electrode and stream through the hole at the centre. One or two further anodes may be situated beyond the first anode. These are of essentially the same mechanical form as the first anode, but they are connected to progressively higher potentials.

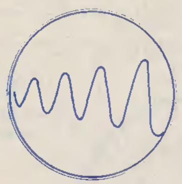


FIG. 2.

By the time the electrons have passed through these anodes, they are concentrated into a narrow beam. The potential of the second anode is normally made variable, so that focusing of the electrons into the narrowest possible beam may be achieved. The second anode is, therefore, called the "focusing anode."

The thin pencil beam of electrons is travelling at a high velocity when it leaves the final anode, and is therefore capable of traversing the space between the final anode and the screen. The inside face of the screen is covered with a material which fluoresces when the electrons strike it. A small spot of light, therefore, appears on the screen. The intensity of the light is controlled by varying the grid voltage as previously mentioned. So much for the production of the spot—now let's see how it may be moved around the screen.

Deflection

There are two main methods of deflecting the spot: (a) Magnetic and (b) Electrostatic.

Magnetic deflection is seldom used in oscilloscopes, but is almost invariably used in television receivers. As we are concerned with oscilloscopes here, magnetic deflection will be dealt with very briefly. It is worth noting that the focusing system described above is electrostatic, that is, it is controlled by the potential of the second anode. Focusing may be achieved magnetically, if required, and is frequently used in TV receivers.

The operation of magnetic deflection is quite simple. If a magnetic field is brought near to the electron beam after it has left the final anode, the beam will bend. This deflection of the beam from the straight path it was originally following causes the spot to take up a new position on the screen, because the electrons strike the screen at a different point. Variation of this field will, therefore, vary the position of the spot on the screen. To achieve this, coils are placed outside the tube envelope, and a current passed through them. Variation of this current will change the field, and so deflect the spot.

Electrostatic deflection is, however, achieved by means normally contained within the tube. Returning to Fig. 1a for a moment, we see that two sets of flat plates are placed either side of the electron beam. The set which will deflect the beam horizontally are called the "X" plates, and those deflecting in a vertical direction the "Y" plates.

The method by which deflection is achieved is similar to the magnetic case. If a positive potential is applied to one of the plates, the electrons will be attracted toward it, that is, the beam will be deflected. The spot will, therefore, take up a different position on the fluorescent screen. If a negative potential is applied, the electrons will be repelled by the plate and the beam will be deflected in the opposite direction. If, therefore, a regularly varying voltage were applied to one of the plates, the spot would move backward and forward across the face of the tube. If the rate of movement were sufficiently rapid (i.e. the frequency of the applied voltage were high enough), the eye would be fooled into believing that a continuous straight line were being drawn across the tube.

Clearly, then, the application of the appropriate voltages to the deflector plates enables us to move the spot to any position on the screen. As usual, however, there are one or two limitations to the cathode ray tube which make life difficult for the user.

Distortion

From the simple explanation of cathode ray tube operation given above, one would expect the spot to remain the same size at whatever position it occupied on the tube face, because focusing of the electron beam was carried out well before the deflector plates were reached. However, it has been found that the application of deflection voltages to the plates brings about defocusing of the beam. The effect worsens as the spot moves further from the centre of the screen. This may be overcome by what is called "symmetrical deflection." This merely means that if 10V positive have to be applied to one plate to move the spot a certain distance, then +5V on one X plate, say, and –5V on the other X plate would produce the same deflection but with less deflection defocusing. For example, a push-pull amplifier might be used, with the anode connected to a pair of X or Y plates.

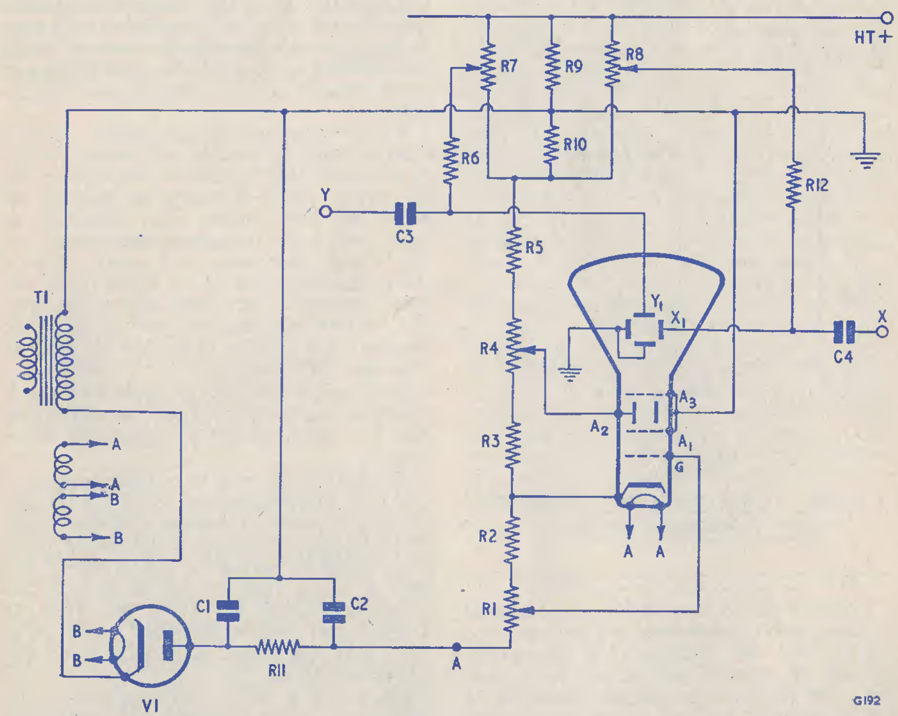


FIG. 3.

Another form of distortion is astigmatism. This means that focus may be obtained in, say, the vertical or Y direction, but not in the horizontal or X direction. Tubes are usually internally corrected for this defect to a certain degree, but circuitry can be devised to minimise it even further.

Trapezium distortion which results in a rectangular picture on the tube becoming a trapezium is virtually absent in many modern tubes, but the effect is illustrated in Fig. 2, where a sine wave of constant amplitude appears to grow in amplitude at one end of the trace.

So much for the tube itself. The most important thing to discover now is how to operate it.

Power Supplies

Fig. 3 shows a typical power supply for a cathode ray tube. T_1 is the mains transformer and V_1 a high voltage rectifier. The transformer must produce 1kV to 5kV, depending upon the tube used. We will assume an average tube working at 2.5kV. C_1, C_2 and R_{11} form a ripple filter, the output side of which is 2.5kV negative with respect to earth. The CRT operating potentials are derived from the chain of resistors, R_1 to R_5.

The cathode is connected to a point some 40 or 50 volts positive from the point A, and the grid is returned to the slider of R_1, which varies the potential of the grid relative to cathode. This, therefore, is the brilliance control. In practical circuits, A_1 and A_3

are connected together as shown. A_2, the focusing anode, is connected to the slider of R_4. This electrode is nominally at about +200V from the point A, but sufficient variation is allowed by the use of R_4 to achieve optimum focusing. A_1 and A_3 are connected to earth.

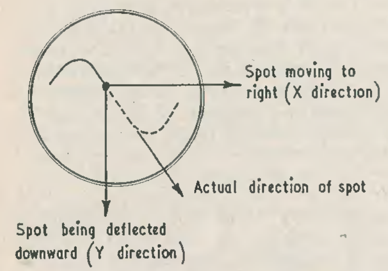


FIG. 4. G193

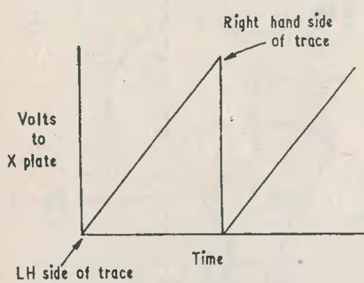


FIG. 5.

X PLATE VOLTAGE WAVEFORM TO DEFLECT SPOT TO PRODUCE FIG. 4. G194

Deflector plates Y_1 and X_1 are connected to the "shift" potentiometers R_7 and R_8. These vary the potentials of the plates positive or negative with respect to A_1 and A_3. The spot may be placed, therefore, at any convenient position on the face of the tube. When, for example, R_7 and R_8 are half way along their tracks, the potentials of X_1 and Y_1 will be the same as that of A_1 and A_3, and the spot will be central. This assumes that R_9 and R_{10} are equal in value, which would normally be the case. Y_2 and X_2 plates are shown connected directly to earth.

R_6 and R_{12} are the deflector plate leaks. If a signal, let us say, a sinusoid, is applied to C_3, the signal will swing symmetrically either side of the voltage at which R_7 is set. The spot will be disturbed, therefore, either side of its set position, in the Y direction. A line of light will, therefore, appear vertically on the face of the tube.

The question now arises, what is the use of applying a sine wave to the tube when it merely draws a straight line? Surely one would expect to see the picture of a sine wave. Quite true . . . And the mechanism by which this is obtained is to apply a linearly changing voltage to the X plates. This forms a "timebase."

Sweeping

Suppose for a moment that the sine wave applied to the Y plates were of a low frequency, just a few cycles per second. At the same time, the X shift potentiometer is rotated at a regular rate, so that the spot is deflected smoothly from the left hand side of the tube to the right. The spot would now fall under two influences. It would be moving up and down sinusoidally and linearly from left to right.

It is easy to simulate this effect. Place a sheet of paper on a table, and move a pencil in a straight line backward and forward on the paper, while someone is moving the paper smoothly away in a direction at right angles to the pencil movement. A very rough sine wave will result. Fig. 4 shows the effect on the CRT. When the spot reaches the right hand side of the tube, one picture is complete, and it must be returned very rapidly to the left in order to start another picture.

If we graph the voltage applied to the X plates during this operation, we will obtain Fig. 5. This is called a "saw-tooth waveform."

This waveform must be produced regularly and at a frequency equal to, or an integral (i.e. whole number) number of times slower than, the applied frequency. If, for example, our sinusoidal signal on the Y plate had been at 50c/s, then the saw tooth must run at 50c/s, or 25c/s, or 16.6c/s, etc. If it ran at 50c/s, one sine wave would appear, if at 25c/s two sine waves, at 16.6c/s, three sine waves, and so on.

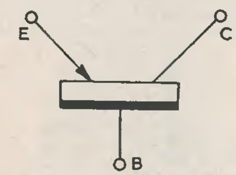
Obviously, it would be inconvenient, not to say impossible, to waggle the shift potentiometer about at these speeds, so we have to resort to more subtle means. These means open up a vast field of circuitry. The basic device for producing the sawtooth of Fig. 5 is called a timebase, and may take many and varied forms.

Many types of the circuits involved are rather different to those we have already met in conventional radios and amplifiers, and some of these will be discussed next time.

Introducing THE TRANSISTOR

by **B. H. JAY**

CONSIDERABLE EXCITEMENT EXISTS IN amateur radio circles over the Transistor. In some quarters the doom of the valve is already heralded, while in others the transistor is regarded as a novelty of little immediate interest. The truth, of course, is somewhere between these two points of view, and a few of the misconceptions regarding transistors may well be dealt with.



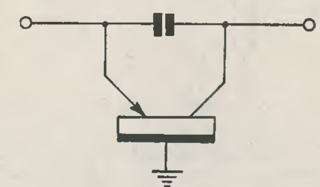
G195

Fig. 1. Transistor Electrodes
E=Emitter
B=Base
C=Collector

First of all there are an almost unlimited number of *types* of transistor. This does not just mean different sizes of the same thing, but actual types of fundamentally different operating conditions. However, while there are many such variations of transistor, the only two of interest are the junction transistor and the point transistor. That is of interest to the radio constructor, for these are the only types readily available commercially. Without undue technicalities, the point transistor consists of two closely spaced points on one side of a thin slice of germanium and a flat connection on the other (Fig. 1). By appropriate treatment the device becomes the so-called crystal triode. The "emitter" roughly corresponds to the grid of a valve in its controlling action of the current flowing in the "collector" circuit, which corresponds to the anode of a conventional triode. In the junction transistor the same amplifying action is obtained by using the "junction" between two differently treated pieces of germanium. However, the action is roughly the same.

From the point of view of types available to the private radio experimenter, the point types on sale will operate up to a megacycle or so as oscillators and amplifiers, while the junction types are confined to low frequency amplifying applications. The point types are also more delicate and "ticklish" in operation and manufacture, although they are the ones capable of reasonable high frequency operation. The junction types are stable and relatively robust and an easier manufacturing proposition. The usual h.f. limit of available point types is about a megacycle, but some samples may go to 2 or more megacycles, so selection is usually necessary for h.f. work, even as a top band QRP transmitter!

It must be clearly understood that this limitation *only* applies to transistors generally on sale. Transistors of various types can be induced to do almost anything, even to oscillating and amplifying at over 100 megacycles. The snag lies in mass producing reliable standardised transistors of high performance. These snags are being overcome, and in a year or so junction transistors of good h.f. performance are expected to be generally available.



G197

Fig. 3. The input and output circuits are in phase, so that a single capacity can cause regenerative feedback

The transistor is roughly analogous to a triode, and thus Fig. 2 gives the valve equivalents of possible transistor connections.

Considering the point transistor generally available, however, this analogy is a dangerous half-truth at the best. Thus there is no phase reversal between the "collector" and the "emitter," so that unlike the valve, the input and output signals are in phase. Thus no phase reversal is needed to cause oscillation, and in many cases a condenser from collector to emitter will cause positive regeneration (Fig. 3).

This lack of phase reversal also means that "cathode" bias obtained by putting resistance in the "base" return to earth causes positive regeneration and not negative feedback as with a valve. While a bias resistor in the base earth return could be bypassed with a condenser this still leaves d.c. feedback, which may still cause instability.

The above factors do not offer any insuperable barrier, however, but unfortunately there is more to come. We are so used to the very high input impedance of a valve, that we take this for granted. With a valve, the grid under conventional operating conditions takes no current. The grid is virtually a "voltage operated" device. However, the emitter circuit of a transistor has an input impedance of around 300 ohms or so. Thus it draws appreciable current. But we are not really concerned with increasing this input impedance . . . we should be very glad if it were even smaller . . . even zero! The low impedance emitter is in fact a "current operated" device. If it were of zero impedance, a current flowing through it would lose no power, so that we could connect the transistor in series with a High-Q tuned circuit for efficient amplification (Fig. 4). This would be the exact converse of the ideal valve which consumes no grid current when a voltage is applied to the grid. The valve is so close to this ideal, that we do connect it directly in parallel with High-Q tuned circuits with no ill effect.

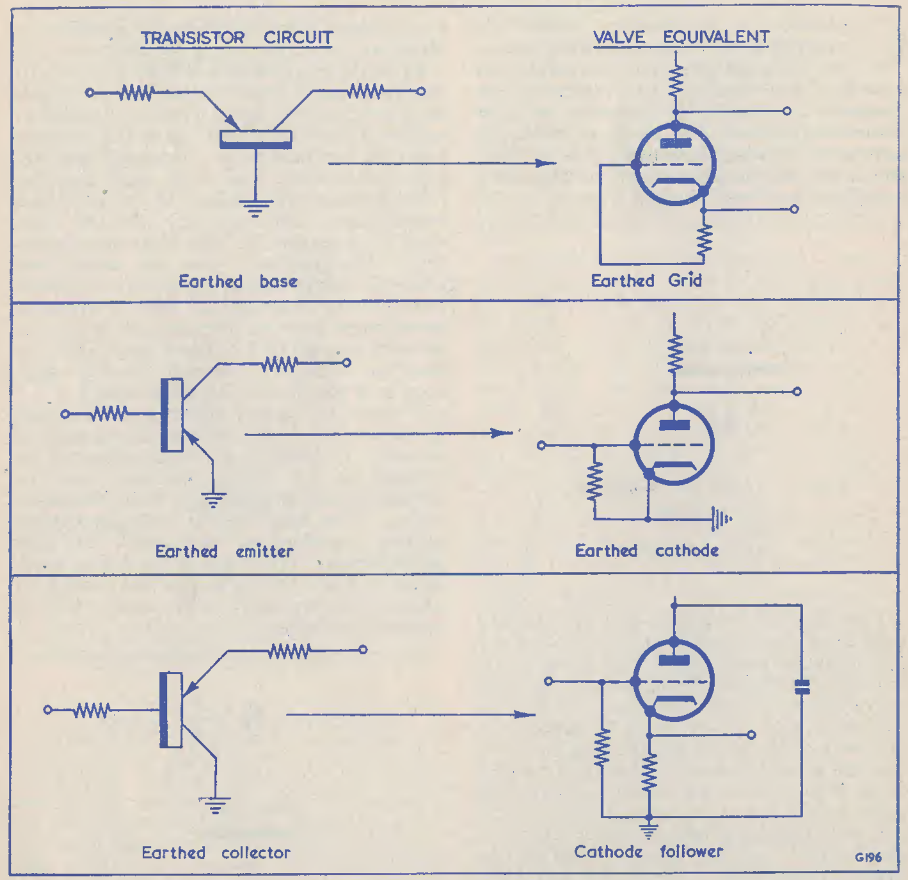


Fig. 2. Valve-Transistor Duals

Unfortunately the transistor, although of low input impedance, is not quite so ideal, and is usually matched into a tuned circuit. In transistor deaf aids operating from a crystal microphone, the high impedance microphone is actually matched by a step-down transformer into the low impedance transistor "emitter" (Fig. 5). It is also to be noted that the collector has an output impedance of some 20,000 ohms, roughly equivalent to a high impedance triode anode circuit. Thus this has also to be matched into the load, which may be a pair of phones, or even a loudspeaker.

However, it will be noted that a current of, say, one milliampere flowing in the low impedance emitter input circuit represents a substantial *power* gain if it causes a change of one milliampere in the output current of the collector circuit in an impedance of 20,000 ohms. Thus if the input circuit were 200 ohms due to the emitter impedance, into the 20,000

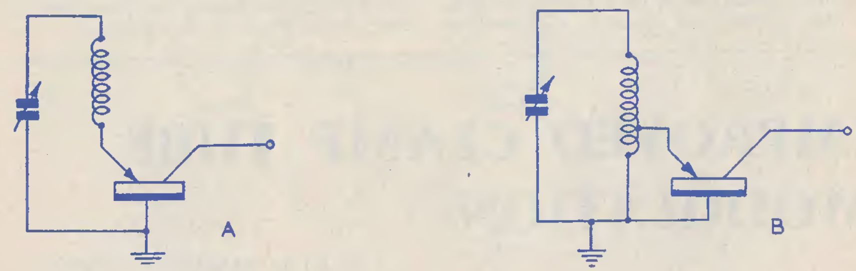


FIG.4.

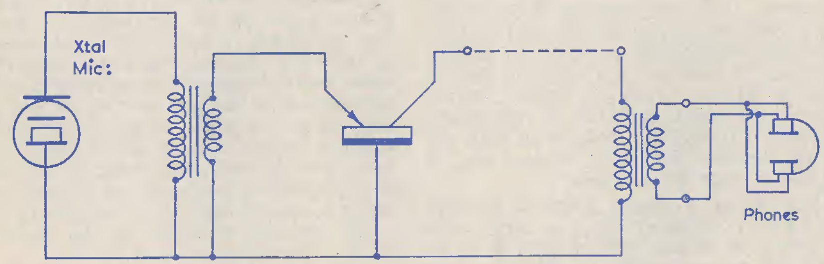


FIG.5.

Fig. 4. A perfect "zero input impedance" transistor could be included in series with a High-Q tuned circuit for high gain amplification (A).
Actual transistors have a low but appreciable input impedance of about 300 Ω, *and are tapped well down a tuned circuit for matching (B)*

Fig. 5. A crystal microphone has to be matched by a step-down transformer into the low impedance input of a transistor.
Similarly, a pair of phones may be transformer matched into the high impedance collector output circuit

ohms impedance of the collector we should have a *power* gain of 100 times, or some 20 db. However, an actual *current* gain can be achieved, so much so that a three-stage junction transistor amplifier may have a gain of 90 db.

Due to the "current" operated nature of the transistor, the gain is actually expressed in terms of the "current multiplication" factor or "alpha," which plays much the same role as the mutual conductance of a normal valve. Moreover when considering transistors, it is as well to forget any analogy with valves, and consider the operation on a transistor basis. In this respect, the signal is a fluctuating *current*. The "emitter bias" is so many microamps of current and *not* voltage . . . even though we may be interested in the emitter voltage we would plot output in the collector against various fixed values of emitter current! Needless to say, also, the output current is reversed as compared with a valve and we have to be careful about not stacking up the negative h.t. voltage!

These alarming glimpses of the vagaries of transistors should not frighten one away from these interesting gadgets. There are many rewards for their peculiarities, and many simple flea powered receivers, amplifiers and even transmitters can be produced.

IMPROVED CLAMP TUBE MODULATION

by **D. M. MALLETT, G3HUL**

Of all the systems of efficiency modulation, clamp tube modulation is about the simplest. In the usual form, the clamp tube is unbiased and holds the carrier to about one third of its maximum c.w. level. Only the negative swing of the audio cycle on the clamp tube grid is used, and this modulates the carrier in an upward direction. According to some, this should result in all manner of distortions, but in practice the signal radiated is reasonable. However, although passable, even with the use of negative feedback, diodes, etc., it still leaves much to be desired.

After seeing a circuit using a clamper tube to vary the input of a p.a. stage from full power to almost nothing (150 watts to about 10) the possibility of using this for linear modulation became apparent and the circuit of Fig. 1 was devised.

This enables the clamp tube to work under Class A conditions and the p.a. input to be at about two thirds maximum c.w. level. The p.a. can be any normal tetrode such as an 807 or TT11, etc., utilising the drive power to bias it. R_1 is calculated to provide correct bias. R_2 acts as a voltage divider to bias the clamp tube to any value of negative voltage from maximum p.a. grid voltage to zero. The value of R_4 depends on the p.a. tube used and should be the same value as for normal c.w. ratings, but it must also be able to handle the extra current used by the clamp tube. Audio is applied to the clamp tube via C_5, R_3 acting as the grid load resistor.

Setting Up

R_2 should be set with the slider towards C_3 and the r.f. choke, and the Tx should be loaded up for maximum c.w. operation. R_2 should then be turned in the opposite direction and the p.a. anode current should then go down to a low value. R_2 is then set half-way between maximum and minimum anode current. The audio gain is then advanced until the p.a. needle just starts to kick on speech peaks. If R_2 is set too low, the p.a. anode current meter needle will kick upwards, and downwards if too high. It is possible to modulate quite deeply with the p.a. needle absolutely stationary, but more "punch" is added to the carrier if the p.a. needle just flickers.

If the p.a. current will not go to a low value, try altering the resistor R_4, or if it will not rise to a maximum c.w. level, with the clamp tube in, check drive voltage. This should be more than enough to bias the clamp tube to cut-off.

A variation, shown in the circuit of Fig. 1, can be used if it is desired to increase the modulation even deeper. R_5 is arrived at experimentally and then the screen supply to the driver is also controlled by the clamp tube. When correctly set up, the drive to the p.a. will vary proportionately to the p.a. input and 100% modulation can almost be achieved without fear of breaking up the carrier through overmodulation.

The audio amplifier shown in Fig. 2 can be used, and with a deaf aid crystal microphone unit will fully modulate a 100 watt input transmitter.

The circuit of Fig. 1 is used on the writer's Top Band V.F.O./P.A. transmitter, and although modulation depth on the oscilloscope is 80% it appears quite fully modulated enough on the air. The oscilloscope trace of the waveform is perfectly linear. The clamp tube in the writer's transmitter is a 6J5 with a TT11 as the p.a. valve. In the writer's high power rig, two 807's in parallel are modulated by this system by a single 6L6 as the clamp tube. For rigs up to 60 watts input, a 6V6 does very well. Reports on quality are always very good to excellent, even from critics of the clamp tube system of modulation, although they do alter their opinion after being informed that clamp tube is being used!

Points to remember are to use screened wire on all leads carrying audio, including the lead from the clamp anode to the p.a. screen and also to the screen of the driver if used. R_3 and R_4 should be wired as near to the clamp tube as possible.

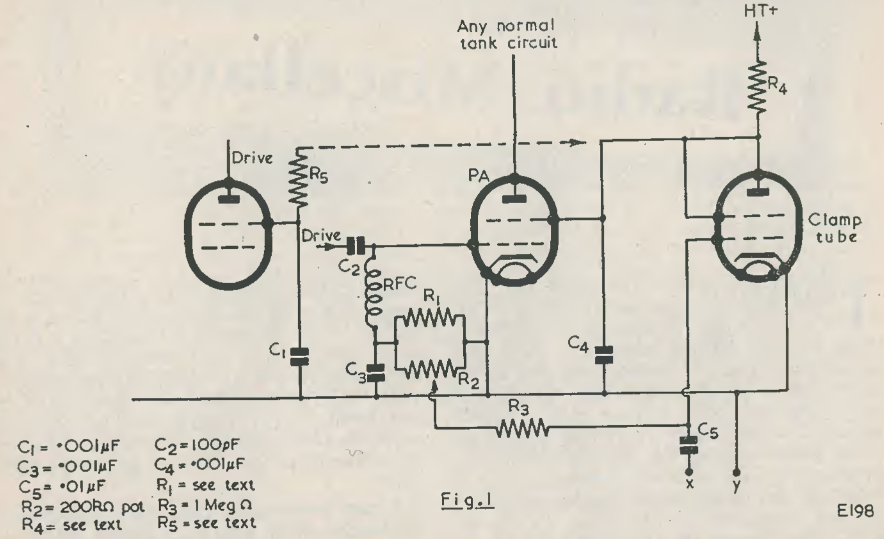


Fig. 1

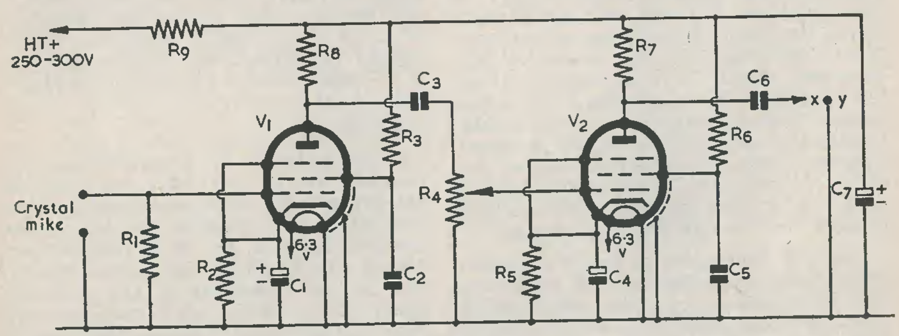


Fig. 2

R1 = 2MΩ
R2 = 2kΩ
R3 = 1MΩ
R7 = 470kΩ
R4 = ·5MΩ pot
R5 = 2kΩ
R6 = 1MΩ
R8 = 470kΩ
R9 = 30kΩ
C1 = 25µF 25V
C2 = ·1µF
C3 = ·01µF
C4 = 25µF 25V
C5 = ·1µF
C6 = ·01µF
C7 = 8µF 500V
V1 = 6SH7
V2 = "

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Radio Miscellany

The recent news item about the man who built a portable t.v. receiver for use in his car leaves one wondering if there are any others who have built sets for similar use. It would not be at all surprising if there were several others not yet come to light. There are frequent instances where more than one enthusiast have been working on similar ideas quite unknown to one another. Perhaps I should mention, for those who missed the news (it also appeared in Childrens' TV News-Reel) that the set fits into the boot of the car and can only be used when stationary, and not like a dash-board sound radio.

Recently I saw an extremely neat steam radio fitted to the handlebar of a motor-scooter. It was about the size of a large breakfast cup and of similar shape. A telescopic aerial extended from the top to a height of about 20 inches gave an adequate signal, the whole thing fitting on a shock-proof mounting with the speaker at the large end of the "cup," facing the rider. For simplicity it was powered by a dry battery tucked away in a neat satchel. Incidentally, there is an equally compact continental commercial model built on these lines. They are obviously in greater demand there on account of their more settled summer weather and warmer evenings.

It is unfortunate that so few of the interesting pieces of home-designed equipment one hears about get fully described in print. For my own part, I have several times induced builders of novel items to get down to the problem of writing a constructional description of them. Usually, after an earnest start they seem to grow discouraged and perhaps, after one or two more fitful attempts, give it up. It is admittedly not always easy for people unaccustomed to writing to express their ideas fluently on paper—even experienced writers often re-write several times before they get things to their liking or are satisfied they are conveying the right idea. Then there is the matter of photographs. Close-ups are not easy with a snap-shot camera, and it is expensive to have it done professionally—until you are certain the result will be published. Yet it is the writing which seems to be the chief difficulty—but it should never be allowed to become an insurmountable one.

I can only hope these few words will encourage those who have found preparing a written description a tedious business, to keep trying. Editors are invariably helpful with advice on material which shows promise. In fact, *The Radio Constructor* provides a special pamphlet to help those without previous experience. Yet here again we find a similar state of affairs. Lots of those who apply for a pamphlet seem to give up too easily or else keep putting it off. Yet if the idea is good they can be assured of sympathetic consideration, and if necessary, helpful guidance in making it suitable for publication.

Complimentary

Quite a batch of correspondence this month—I fear I shall never get around to answering it all. One letter begins "Dear Madam—" so I suppose the writer must consider I am a bit of an old woman! Maybe that is all to the good. When I first saw a melodrama it had a goody-goody hero and a dim ever-so-trustful heroine, both deadly boring. The villain of the piece, however, was absolutely magnificent. The audience got no end of a kick out of booing and hissing him. T.V. Panel Games seem to prove very much the same thing. Throw in a Gilbert Harding and you will attract a bigger audience. Half of them like to see him and the other half settle down in front of their screens to enjoy a jolly good hate. From everybody's point of view it is far better than being ignored.

CENTRE TAP *talks about* ARTICLE WRITING C.R.T. PRICES C.R.T. AILMENTS

Reasoning on these lines, I feel it is nice to have a letter now and again beginning "Dear Twerp—"—at least one can feel that one is not boring the customers.

Money Matters

Two interesting letters have come to hand regarding my comments in the June issue on the price of t.v. tube replacements. The first comes from Mr. Wm. Buckley of Knoll Rise, Luton, who has for some time actively campaigned for British manufacturers to slash prices. He suggests I should be guided by American prices as a yardstick. This, by direct comparison, would not be quite fair. A bigger production, while the overhead costs remain sensibly constant, can make an enormous difference to the selling price and, of course, the American "jobber" system of marketing is greatly different from that prevailing over here.

However, I was not trying to justify the cost of British tubes, but simply trying to be fair and point out that because of the way in which t.v. has developed it is no longer simply a matter of production cost plus a reasonable profit. From a personal angle I am all for a re-distribution of costs, so that the set purchaser would not get a preferential price over the replacement buyer and home constructor.

The other comes from J.T. of Sheffield who not only says that tubes are "too dear" but quotes the case of a neighbour whose dealer charged an extra 25s. for merely fitting the tube into the set. This practice is far from unusual, although sometimes the charge (often a lower figure) is made in a disguised form. After all, accidents when fitting tubes are by no means uncommon. Thus some of it has to be set off as a form of insurance. When there is a breakage the dealer has to bear the whole of the cost of the second tube. Customers cannot be expected to pay for the tube somebody else breaks in the fitting! Pushing the neck through a tight fitting magnet, or bolting down on an awkwardly shaped chassis when a turn too much on one of the threads can easily result in fracture, as well as the risks of handling and delivery, all add to the chances.

Again I am quoting only the dealer's (not the customer's) viewpoint, and remember there is no profit on purchase tax. I believe most of them point out to the customer, when it comes to a matter of simple tube replacement, that there may be incidental charges as well as the cost of the tube. If an "accident" occurs once only in a few hundred times, somebody has to pay for the odd one and it is not entirely unfair when the risk is spread as an "insurance."

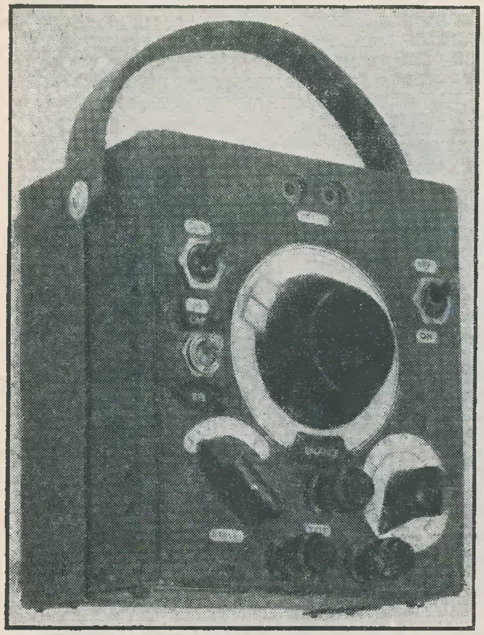
First Aid

When I wrote recently of temporarily restoring t.v. tubes developing cathode-heater shorts to a workable condition (until such time as a permanent modification could be made) I asked for ideas other than the expedients I mentioned. So far I have not heard of any, but several readers have been good enough to write about the trouble and the frequency of its occurrence.

As Mr. David Edmund (of Exeter) points out, a special low capacity isolating transformer is the most convenient method when the use is limited to a.c. mains. Mr. H. Templeman (of East Ham) also suggests, for sets operated on d.c. mains, reducing the heater voltage on the tube by using the highest value resistor which will clear the fault. He is a service engineer and, he says, expects to see a few raised eyebrows in reporting that he has known many cases where grid-cathode shorts in tetrode tubes have been cured by re-wiring them as triodes.

Mr. F. Pack (Clapham Park) and Mr. S. G. Spiegler (Lancaster Gate) were also good enough to write describing their experiences with conventional remedies.

Finally a letter from Mr. G. T. Fernyhough, Jr. (of Liverpool 20) deplores the quality of both t.v. tubes and modern valves. He has been the victim of repeated failures in certain types—they just live out the guarantee period and then fold up. He wonders if this is due to the manufacturers nowadays working to minimum standards, especially as he has a PM2DX of 1930 vintage still in daily use in his home-built steam radio. He is now beginning to feel he has been sentenced to spend his life working hard just for the sake of keeping his (commerical) televisor in running order!



A SELF-CONTAINED RESISTANCE-CAPACITANCE BRIDGE

by S. M. STOVES

The bridge described in this article was constructed with two main objects in view: the first being the need for a reliable but inexpensive measuring set, and the second to have a really portable instrument at hand.

The Bridge

The bridge is of the usual null-point indicating type, and is energised by a simple battery operated valve oscillator, the null-point being detected on a pair of head-phones.

A total of eight ranges is available, covering from 1Ω to 10MΩ on the four resistance ranges, and from 10pF to 100μF on the four capacitance ranges. Provision is also made (by the use of terminal 3 and switch S_3, Fig. 1), for comparison of components against an external standard.

The Circuit

The theoretical circuit of the bridge is shown in Fig. 1. S_1 and S_2 form the range selector switch, which is a 2-pole 4-way yaxley type. By means of switch S_4, which sets up the instrument for capacitance or resistance, the arms of the bridge are reversed, so that only one scale is needed for all measurements. This is quite a useful point, for calibration as well as operating.

In this particular model the main calibrated potentiometer VR_1 has a value of 7.5kΩ, but any value between 5kΩ and 20kΩ will be found to give equally good results. The potentiometer should, of course, be a wire wound type with a linear characteristic.

The variable resistance VR_2, which is also wire wound, has a value of 300Ω. This is operative only on capacitance ranges 3 and 4, and is used to balance out the resistive component in condensers of poor quality, thus enabling a sharp null point to be obtained on the main potentiometer.

With the exception of C_3 and C_4, the "standards" can be purchased with an accuracy of ±1% of their stated value. To obtain C_3 (0.1μF) and C_4 (1.0μF) the best plan is to find a tolerant "spares dealer" who will measure a few good quality paper condensers from his stock, until the required values are found having reasonable accuracy.

The eight ranges available are as follows:

Range Switch	*Resistance*	*Capacitance*
Position 1	1Ω—10kΩ	10pF—0.1μF
Position 2	10Ω—100kΩ	100pF—1.0μF
Position 3	100Ω—1MΩ	0.001μF—10μF
Position 4	1kΩ—10MΩ	0.01μF—100μF

It may be thought that the overlap is too great from one range to the next, but in the writer's opinion this is an advantage, as it enables measurements to be made on the central position of the scale where the accuracy is much better than at the extremes.

The Oscillator

The energising voltage for the bridge is obtained from a simple battery-operated audio oscillator, the circuit of which is shown in Fig. 2. A miniature 1S5 diode-pentode valve is made to oscillate by means of the grid-anode coupling provided by the transformer T, which is an ordinary inter-valve type, ratio 3:1.

"Drymax" 514 H.T.—L.T.). With careful use, such as switching off the oscillator when not actually measuring, this battery should—in the view of the exceptional low h.t. current drain—give upwards of a year's service. The l.t. side of the battery may not, however, last quite as long as the h.t., and so a space has been reserved in the battery compartment for fitting a small 1.5V dry cell, which should be wired in parallel with the existing l.t. if and when the latter fails. After four months continuous use, it has not yet been found necessary to do this.

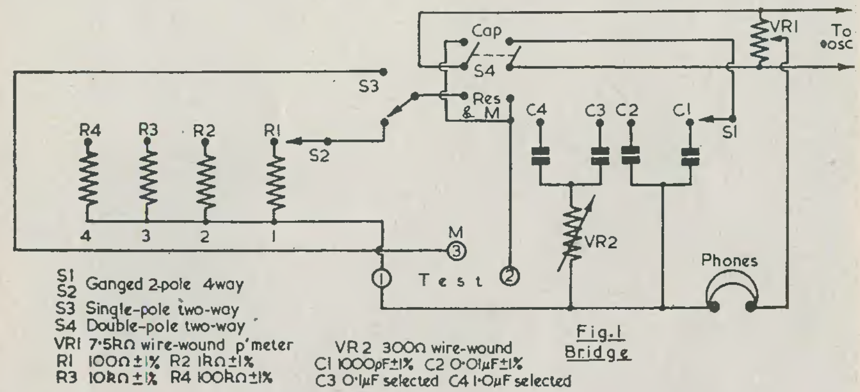


Fig.1 Bridge

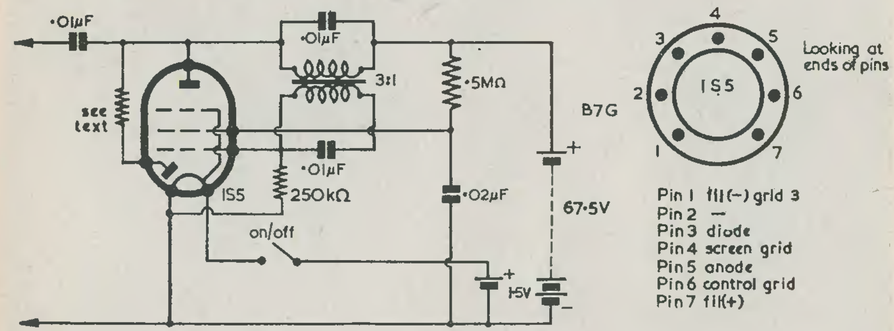


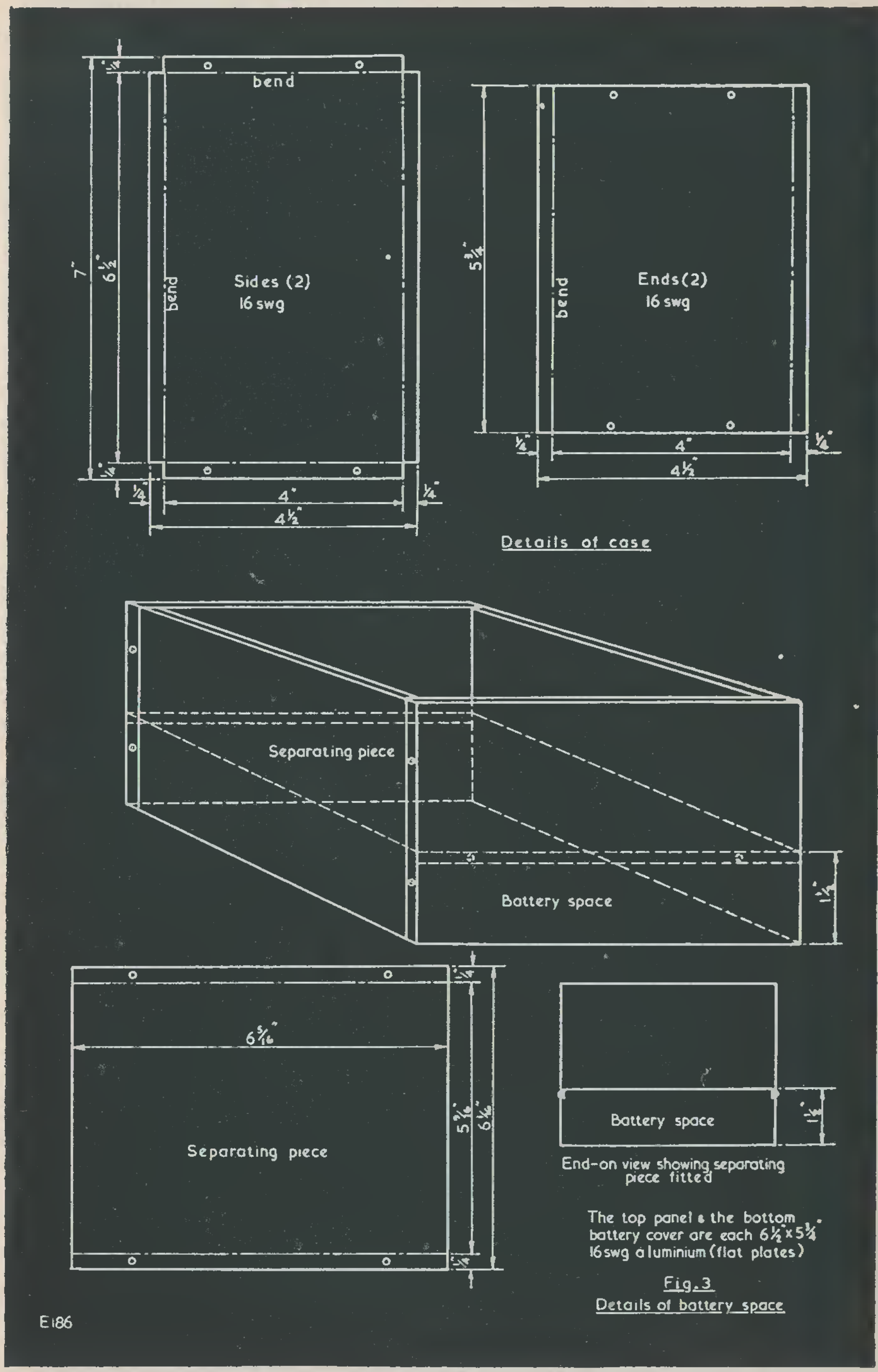
Fig.2
Oscillator & connections for 1S5

E185

By altering the value of the diode anode resistor R_1, Fig. 2, the pitch of oscillation may be varied quite appreciably, and it should be adjusted to suit individual requirements. For the sake of h.t. economy, the value of this resistor should not be made lower than around 250kΩ, the h.t. current for the circuit shown being only 0.7mA, which ensures a long life for the battery. The latter is of the layer type (Drydex

Case and Panel

The whole instrument, including batteries, is housed in a case 5¾in. by 6½in. by 4in. deep. This case was made from 16s.w.g. aluminium, and details are given in Fig.3. To facilitate construction, the four sides were made separately and then riveted together.



Details of case

Fig. 3
Details of battery space

The control panel and the base are each secured by four self-threading screws. The whole was given a black crackle finish, and, to complete, four rubber feet and a leather handle were fitted.

Calibration

The procedure for calibrating the instrument is to connect a known quantity across the terminals, adjust VR_1 for balance (null point in phones) and then mark the scale accordingly.

For the most accurate results a decade resistance box should be used for this purpose, but if this cannot be obtained a number of ±1% resistors may be used. If the values of these resistors are suitably chosen only a few are needed to cover the entire scale.

For instance, if a ±1% 1kΩ resistor is connected across terminals 1 and 2 and the range switch set to position 1 (1Ω–10kΩ), the main potentiometer is adjusted for balance, and this setting gives the calibration point to be marked "1,000." The range switch should now be set to position 2 (10Ω–100kΩ) and VR_1 again adjusted for balance. This setting should be marked "100." With the range switch in position 3 (100Ω–1MΩ), the calibration point "10" can be found. Range 4 (1kΩ–10MΩ) will give the calibration point "1."

By using two 1kΩ resistors a total of 11 points may be calibrated as follows: single, 1,000, 100, 10, 1; parallel, 500, 50, 5; series, 2,000, 200, 20 and 2. With a third 1kΩ resistor the points (series) 3,000, 300, 30, 3 and (series-parallel) 1,500, 150 and 15 may be found. On these lines the whole scale may be calibrated without undue cost. This method cannot, of course, be said to give first rate accuracy, but it provides one way out of the difficulty of calibration when more accurate facilities are lacking.

General

Owing to the switching arrangements employed, the self-capacitance of this bridge is fairly high. The exact value of this may be found by adjusting VR_1 for balance when the instrument is set to range 1 on capacitance with the test leads disconnected. The value obtained should be subtracted from readings below, say, 1,000pF; above this value the self-capacitance may be ignored. In the original model it was around 40pF.

No part of either the bridge or oscillator circuits is connected to the metal case,

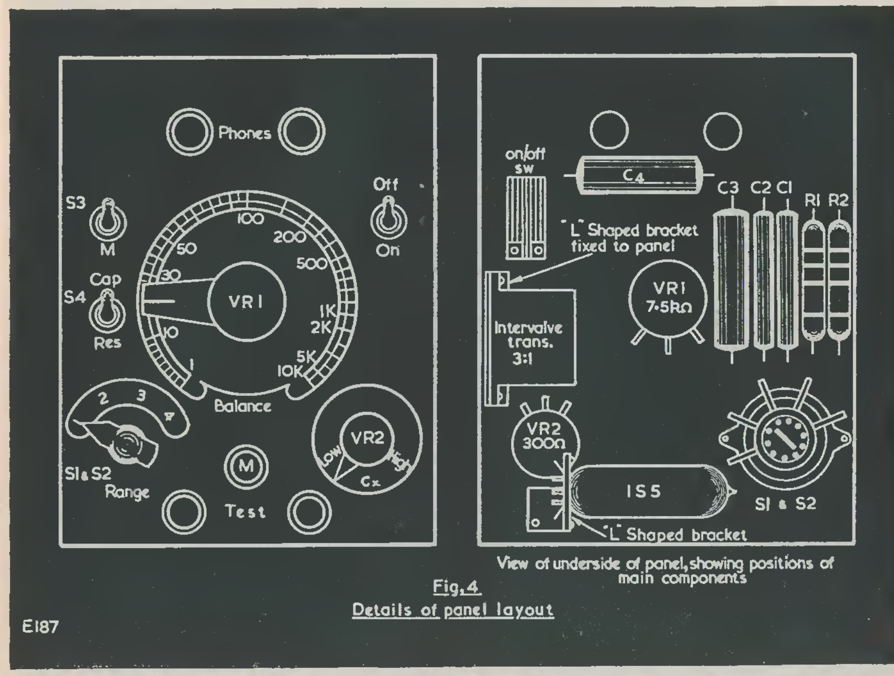


Fig. 4
Details of panel layout

which may be earthed to give a sharper null point when measuring high impedance components.

When using an external standard for comparison purposes, S_3 should be set to position M, and S_4 set to "Res"; terminal 1 then becomes a common connecting point for the standard and the unknown.

Apart from the obvious uses of this instrument, a useful source of a.f. is available; this may be used for checking the l.f. stages of receivers (by injecting into the p.u. sockets) for testing loudspeakers, and for modulating r.f. signal generators, etc.

In conclusion, it should be stated that if a little care and patience is exercised in the construction of the instrument, the trouble taken will be amply rewarded by the possession of a handy and reliable piece of workshop equipment.

DYNAMOTORS

by E. G. BULLEY

SUCH PIECES OF EQUIPMENT ARE AVAILABLE upon the surplus market, and are best described as combined motor generators which have two or more separate armature windings, but with a common field.

One of these windings is energised from a d.c. source, whereas the other or others, as the case may be, act as the d.c. generator. As will be seen from Table 1, there are quite a number of dynamotors, many of which have been stripped from Government surplus equipment. The range is quite wide and is suitable for many uses.

The d.c. output voltage can be reduced by reducing the input; or to clarify this point, it is best to state that by reducing the excitation of the primary, the secondary output voltage will likewise fall.

The d.c. output requires filtering if used with radio receivers or transmitters—this is necessary to eliminate the ripple, etc. However, such generators are useful for car radios, not forgetting of course, one's workshop, or in fact anywhere where a d.c. voltage is required. Before using a dynamotor it is advisable to run it for a while without load, especially if it has been standing in a surplus shop for a long period. This procedure will, of course, ease the shaft and bearings and thus provide smoother operation when put into regular service.

	D.C. Input		D.C. Output	
Type	*Volts*	*Amps*	*Volts*	*Amps*
3X059	19	3.8	405	.095
POSX-15	14	2.8	220	.08
DA-7A	28	27.0	1,100	.400
DM33A	28	7	540	.250
B-19	12	9.4	{ 275	.110
			500	.05
DA-3A	28	10	300	.26
PE73CM	28	19	1,000	.350
BD69	14	2.8	220	.08
DAG-33A	18	3.2	450	.06
DM25	12	2.3	250	.05
PE94	28	10	300	.26
DM40	14	3.4	172	.138
DM32A	28	1.1	250	.05
DM34D	12	2.8	220	.08
DM35D	12.5	18.7	625	.225
DM36	28	1.4	220	.08
DM37	25.5	9.2	625	.225
DM53A	28	1.4	220	.08
PE73C	28	20.0	1,000	.350
PE101C	13	12.6	400	.135
PE94A	28	10.0	300	.200
PE94C	26	10.0	300	.200
PE103	6		500	.16
PE98	14	21.0	300	.20
PE36	28	1.25	250	.06
PE135AX	24	12	500	.20
BD77	12		1,000	.350
135A	6	1.8	135	.030
180A	6	2.2	180	.03
210A	6	6.3	200	.100
220A	6		200	.200
251A	6	9.0	250	.100
301A	6	9.7	300	.100

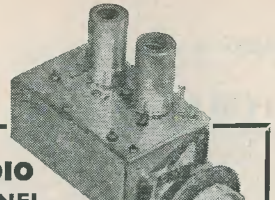
VIBRATOR DATA

PART 1. *Compiled by* E. G. BULLEY

Radiart	*ATR*	*Turner*	*Delco*	*Electronics*	*James*	*Mallory*	*Meissner*	*National Union*	*Utah*	*Oak*	*Wearite*	*Volts*	*Max. load (amps)*	*Frequency c/s*	*Remarks*
2742	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	4	115	NS
2743	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	4	115	NS
2747	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	4	115	NS
2819	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	4	115	NS
2864	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	4	115	NS
2867	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	4	115	NS
3223	325	T4S	8511	—	PJ4	298	442	—	NP6	—	—	6	5	115	NS
3225	—	—	—	—	—	—	—	—	—	—	—	32	1.0	115	NS
3226	—	—	—	—	—	—	—	—	—	—	—	6	5	115	NS
3227	305	—	—	—	—	—	—	—	—	—	—	6	5	115	NS
3260	340	T3SP	8523	1703	—	859	405	404	NP476	V5105	NSB6	6	6	115	NS
3261	325	T6S	8512	—	PJ4	298	449	—	NP61	V5495	NSB6	6	6	115	NS
3262	340	T3SP	8524	2605	—	859	415	406	NP476	V5105	NSB6	6	6	115	NS
3263	325	T4S	8513	—	PJ4	298	442	—	NP65	V5495	—	6	6	115	NS
3264	324	T3	8508	—	PJ3	294	403	—	NP481	—	—	6	6	115	NS
3283	503	T55	8618	—	PJ55	270B	705	—	SP50	—	—	6	6	115	S
3290	—	—	—	—	—	—	—	—	—	—	—	6	4	115	S
3299	325	T19S	8513	—	PJ19	298	452	—	NP63	V5495	—	6	6	115	NS
3300	303	T1A	8507	—	—	292	400	—	NL3	—	—	6	4	115	NS
3302	325	T19S	8513	—	PJ19	298	452	—	NP63	V5495	—	6	6	115	NS
3308	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S
3313	303	T1A	8507	—	—	292	400	—	NL3	—	—	6	6	115	NS
3315	550	—	8602	—	PJ50	222	—	—	—	—	—	6	6	115	NS
3317	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S
3318	—	—	—	—	—	—	—	—	—	—	—	6	4	115	S
3320	324C	T1	8522	—	PJ1	507P	407	—	NP41	—	NSB6	6	6	115	NS
3356	325	T14S	8513	—	PJ19	298	452	—	NP65	V5495	—	6	5	115	NS
3375	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	6	115	NS
3395	2324	32T3S	8706	—	32PJ3S	F294	571	—	32NP42	—	—	32	1.4	115	NS
3397	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	NS
3398	303	T1A	8503	—	—	292	400	—	NL3	—	—	6	4	115	NS
3399	324	T12	8506	—	PJ15S	294	409	—	NP481	—	NSB6	6	6	115	NS
3407	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	NS
3417	324	T3	8504	—	J22	253	403	—	NP4	—	NSB6	6	6	115	NS
3442	—	—	—	—	—	—	—	—	—	—	—	6	6	115	NS
3443	—	—	—	—	—	—	—	—	—	—	—	6	4	120	NS
3444	—	—	—	—	—	—	—	—	—	—	—	6	4	120	NS
3445	—	—	—	—	—	—	—	—	—	—	—	6	4	115	S

Radiart	ATR	Turner	Delco	Electronics	James	Mallory	Meissner	National Union	Utah	Oak	Wearite	Volts	Max. load (amps)	Frequency c/s	Remarks
3460	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	NS
3461	508	T54	8621	2682	J54	273C	704	—	SP51	—	—	6	6	115	S
3462	—	—	—	—	—	—	—	—	—	—	—	32	1.0	120	NS
3463	—	—	—	—	—	—	—	—	—	—	—	32	1.0	115	S
3481	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	NS
3503	—	—	—	—	—	—	—	—	—	—	—	32	1.0	115	NS
3588	—	—	—	—	—	—	—	—	—	—	—	32	1.0	115	NS
3607	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	S
3608	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	NS
3651	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	S
3679	521	T60	8612	—	PJ60	245C	714	—	SP55	—	—	6	6	115	S
3741	340	T15S	8523	2605	J23	500P	495	404	NP41	V5105	NSB6	6	6	115	NS
3782	340	T15S	8524	2605	PJ15S	501P	450	406	NP44	V5133	NSB6	6	6	115	NS
3786	—	—	—	—	—	—	—	—	—	—	—	6	6	115	NS
3789	523	T59	8615	—	J59	247	708	—	SP6	—	—	6	6	115	S
3806	340	T15S	8542	2605	PJ2	507P	495	406	NP46	V5179	NSB6	6	6	115	NS
3815	324	TU3S	8508	—	PJ3	294	409	—	NP47	—	NSB6	6	6	115	NS
3818	340	T15S	8527	2605	PJ16	508P	495	406	NP476	V5193	NSB6	6	6	115	NS
3842	324	T11	8508	—	PJ12	294	409	—	NP489	—	NSB6	6	6	115	NS
3848	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S
3850	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S
3865	340	T15S	8529	2605	PJ18	850	495	406	NP485	V5359	NSB6	6	6	115	NS
3880	303	T1A	8503	—	J1A	503	400	—	NL3	—	—	6	4	115	NS
3883	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S
3883-12	—	—	—	—	—	—	—	—	—	—	—	12	4	115	S
3888	340	T15S	8534	2605	PJ18	853	495	406	NP485	V5745	NSB6	6	6	115	NS
4251H	324	T12	8508	—	PJ12	—	403	—	NP489	—	NSB6	6	9	115	NS
4253	—	—	—	—	—	—	—	—	—	—	—	6	9	115	NS
4253-12	—	—	—	—	—	—	—	—	—	—	—	12	6	115	NS
4253-32	—	—	—	—	—	—	—	—	—	—	—	32	1.4	115	NS
4254	—	—	—	—	—	—	—	—	—	—	—	6	10	115	S
4254-12	—	—	—	—	—	—	—	—	—	—	—	12	6	115	S
4254-32	—	—	—	—	—	—	—	—	—	—	—	32	2.5	115	S
4255	—	—	—	—	—	—	—	—	—	—	—	6	10	115	S
4255-12	—	—	—	—	—	—	—	—	—	—	—	12	6	115	S
4255-32	—	—	—	—	—	—	—	—	—	—	—	32	2.5	115	S
4255H	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S
4256	—	—	—	—	—	—	—	—	—	—	—	6	10	115	NS
4256-12	—	—	—	—	—	—	—	—	—	—	—	12	6	115	NS
4256-32	—	—	—	—	—	—	—	—	—	—	—	32	2.5	115	NS
4257	—	—	—	—	—	—	—	—	—	—	—	6	5	180	S
4257-12	—	—	—	—	—	—	—	—	—	—	—	12	4	180	S
4257-32	—	—	—	—	—	—	—	—	—	—	—	32	2.5	115	S
4258	—	—	—	—	—	—	—	—	—	—	—	6	10	115	S

* S = synchronous. NS = Non synchronous. *(to be continued)*



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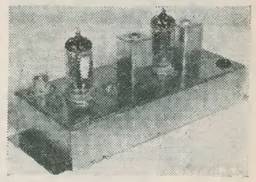

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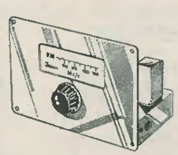

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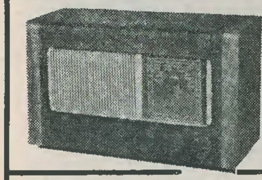

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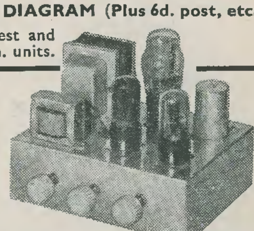

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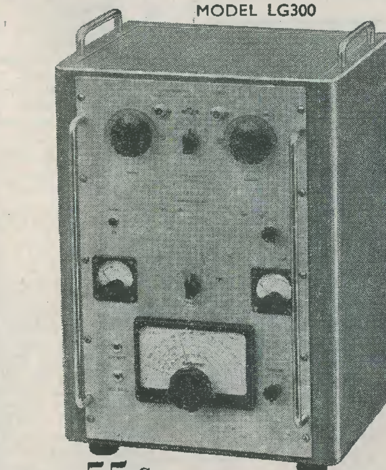

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[*continued on page 63*

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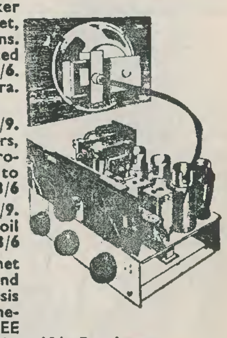

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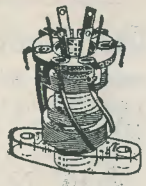

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continued from page 61]

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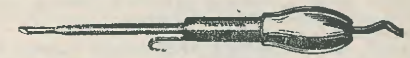

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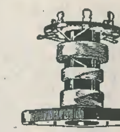

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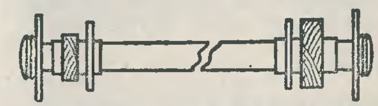

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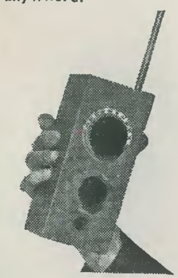

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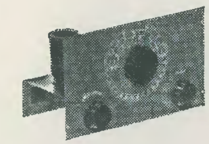

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