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MAY
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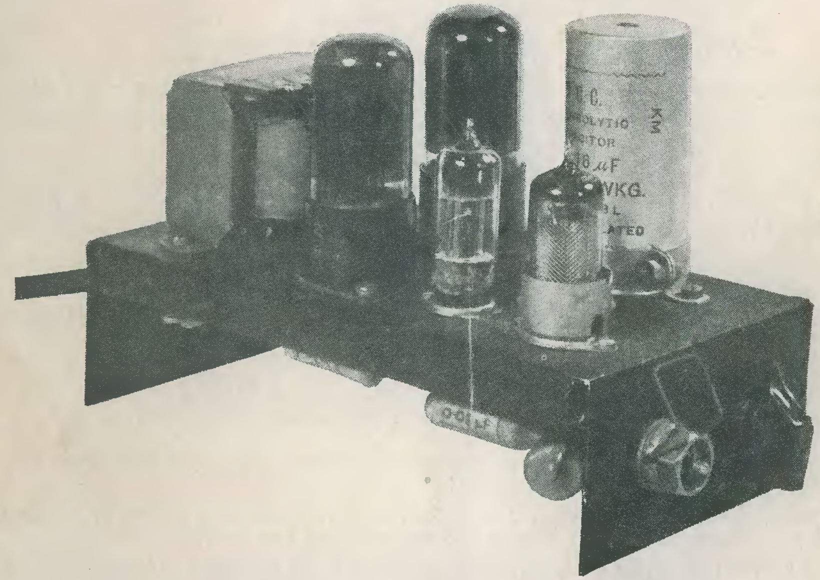

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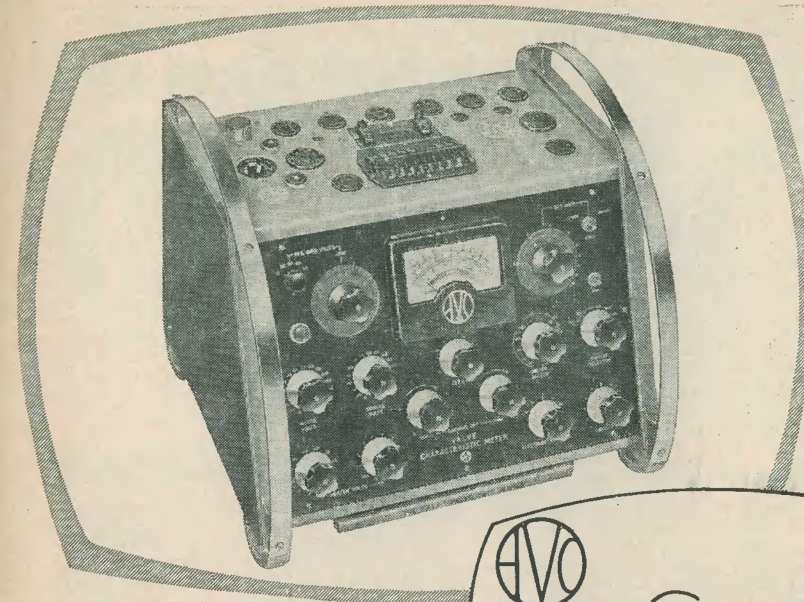

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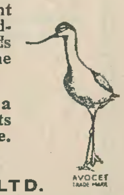

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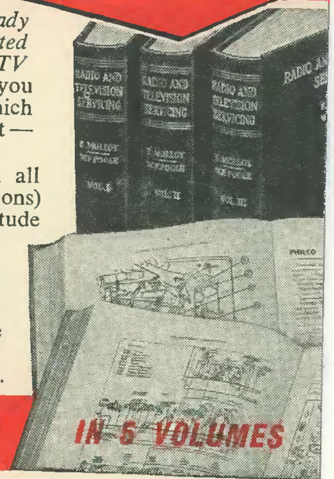

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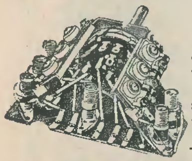

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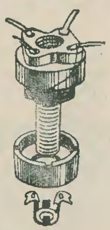

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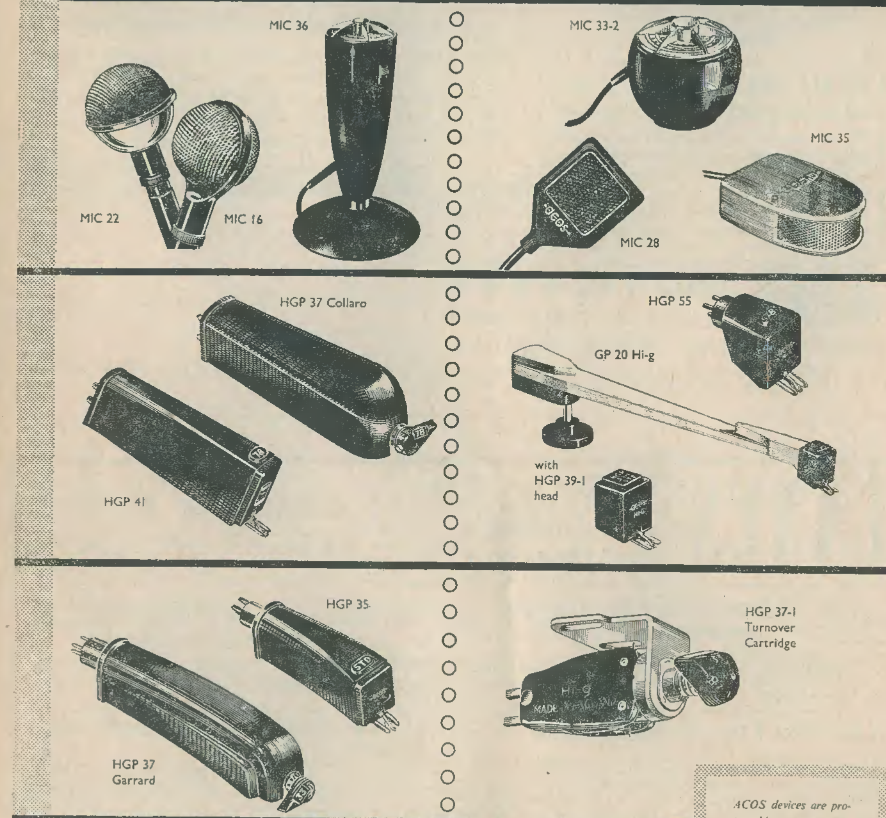

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VOL. 8 NO. 10

ANNUAL SUBSCRIPTION 18/–

MAY 1955

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CONTENTS FOR MAY

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.

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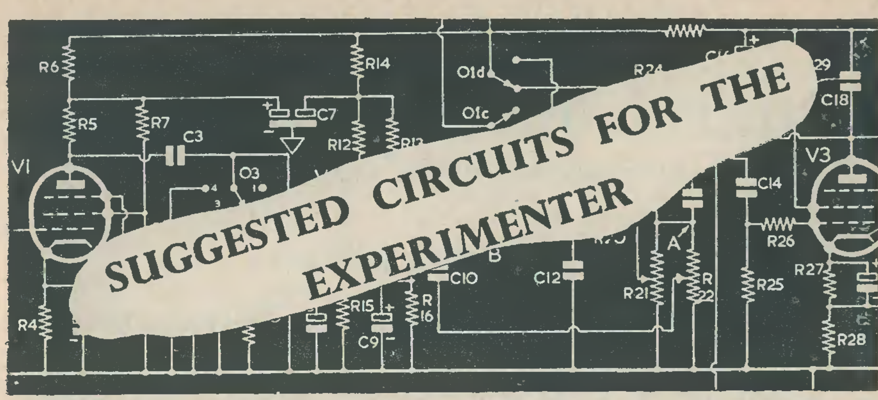


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 54: A TUNING INDICATOR FOR F.M. RECEIVERS

One of the more difficult problems to tackle in the design of f.m. receivers is that of accurate tuning indication. The situation is further complicated by the fact that such indication is even more necessary for f.m. reception than it is for a.m. reception. This is due to the fact that an f.m. receiver which is apparently correctly tuned, and which introduces no distortion at all at normal modulation levels, may give rise to considerable distortion when these levels are increased; as can occur during the louder passages of music in a symphony concert, for instance.

In this country, the most generally accepted commercial method of indicating the position of correct tuning of f.m. receivers consists, at present, of running a normal tuning indicator from the negative end of the discriminator stabilising condenser (possibly via a fixed potentiometer to reduce the voltages obtained). Whilst this process offers a simple and inexpensive solution to the tuning indicator problem it is not entirely satisfactory, since the i.f. response of an f.m. receiver is, ideally, flat; and recourse has to be made to "peaking" the i.f. transformers at the centre frequency in order to obtain a final, sharp, tuning indication. Unfortunately, i.f. transformer "peaking" cannot be carried too far without introducing distortion, with the result that the final "peaked" tuning indicator deflection is usually small compared with the initial deflection given by tuning in the station which is being received. Also, such "peaks" as are given are liable to drift away from the centre frequency with time, this being due to spread and deterioration in the i.f. valves, plus any accidental i.f. detuning which may result from knocks, heat, and similar causes.

It is evident, that, for best results, some alternative method of tuning indication is required. This month's circuit suggests an accurate tuning indicator which may be fitted to f.m. receivers employing a balanced ratio discriminator stage.

The Discriminator

A typical discriminator of this type is illustrated in Fig. 1. In this diagram, the stabilising load resistor (Rl1 + Rl2) is centre-tapped, the tap being taken to chassis. The audio take-off point is taken from the tertiary winding of the discriminator transformer.

When the discriminator transformer is correctly adjusted and an r.f. signal is injected into its primary, a d.c. voltage appears across the stabilising condenser, together with another between either end of the stabilising condenser and the audio take-off point. When the injected signal is of the correct frequency the second voltage should be equal to exactly one-half of the first. Since the voltage across the stabilising condenser appears also across the load resistor Rl1 + Rl2, which is centre-tapped to chassis, it follows that the voltage appearing at the take-off point has a value which is zero with

respect to chassis. This is, in practice, what occurs. If, however, the injected frequency varies, the voltage at the take-off point varies also; becoming positive with respect to chassis for a change in frequency in one direction, and negative for a change in frequency in the other direction.

The d.c. voltage at the take-off point with respect to chassis provides a precise measure of tuning accuracy; the position of correct tuning being represented by zero voltage.

centre-reading 0–1 milliammeter. Zero voltage is represented by the centre reading of the meter.

As may be seen, the value of the circuit lies in the fact that the two triodes are balanced against each other. Because of this, variations in h.t. and heater supply voltages are largely cancelled out. Also, the fact that a double triode is used provides some insurance that shifting characteristics in the individual triodes due to age will lie closely together.

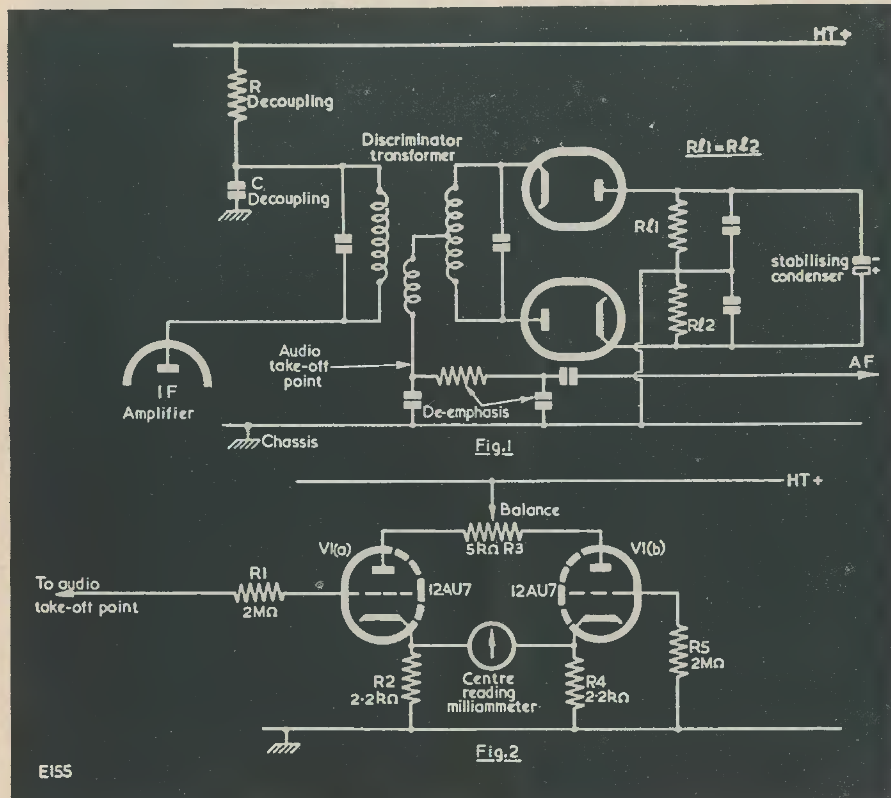


Fig. 1: Typical discriminator circuit

Fig. 2: Tuning Indicator circuit described in this article

Tuning Indicator

The tuning indicator which forms the basis of this month's contribution is illustrated in Fig. 2. It employs a double triode and gives its final indication by means of a

It will be noted that R1 and R5 both have the same value. This, again, helps to ensure balanced operation; it being assumed that the d.c. source impedance at the take-off point is very low compared with R1. For best results it would probably be advisable to have the values of the two cathode resistors, R2 and R4, within 5% of each other.

Setting Up

As shown in the diagram, the indicator will give full meter deflection for input voltages of 1.5 to 2 volts on either side of zero. If the receiver with which the indicator is to be used provides larger voltages, it will be necessary to insert a limiting resistor in series with the milliammeter. The value of this resistor should be found by experiment.

If the milliameter employed has very light damping, it is possible that its needle may flicker at high modulation levels. If this occurs, the tendency may be cleared by connecting a 0.01μF condenser between the grid of V1(a) and chassis.

The indicator circuit is finally set up by short-circuiting the audio take-off point to chassis and adjusting R3 to give a centre reading of the meter. This reading will then be that which corresponds to accurate tuning of the receiver.

CLUB NEWS

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

YORK AMATEUR RADIO SOCIETY

The Annual General Meeting was held on the 11th February, when the following officers were elected: Chairman, E. Warwick, G3GDE; Secretary, J. O. Yarker, G3GJY; Treasurer, L. Brown, G3HLT. Committee: G. F. Nottingham, G3DTA; P. S. Robson, G3FYP; A. Horner, G3FTS; P. Dekker. The meeting night has been changed to Thursdays at 7.30 p.m. The club room is in Fetter Lane facing rear entrance of Queen's Hotel. Lectures and demonstrations of radio equipment are a weekly feature. Morse lessons are now in progress each week. Prospective members and visitors are cordially invited. Hon. Sec.: J. O. Yarker, 14 Bewlay Street, Bishopthorpe Road, York.

* * *

EAST KENT RADIO SOCIETY

The Society meets fortnightly on Tuesdays at "The Two Brothers," Northgate Street, Canterbury. Nearly all radio and electronic subjects are covered. Raffles are held regularly, and lectures with demonstrations are given. New members are welcome, also visitors in the district. Hon. Sec.: Mr. D. Williams, "Llandogo," Bridge, Canterbury.

* * *

CAMBRIDGE AND DISTRICT AMATEUR RADIO CLUB

The Annual General Meeting was held on the 25th March, when the following officers were elected: President, Mr. C. H. Babbs, G5IG; Chairman, Mr. L. Gostelow, G2FOW; Treasurer, Mr. P. J. Broom, G5DQ; Secretary, Mr. F. A. E. Porter.

Meetings are held every fourth Friday at the "Jolly Waterman," Chesterton Road, and new members are welcome. The next meetings are on the 20th May and the 17th June (junk sale). A Morse practice class has been started for beginners. Hon. Sec.: F. A. E. Porter, 38 Montague Road, Cambridge.

THE SLADE RADIO SOCIETY

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

Forthcoming events: 8th May, first of the season's Harcourt Trophy tests; 13th May, "Amateur Radio Direction Finding," by N. B. Simmonds (member); 22nd May, R.S.G.B. National D/F Contest, Slade/Rugby preliminary; 27th May, "Past and Present in Amateur Radio," by E. G. H. Brown, G5BJ.

The club station at the Church House is open every day of the week for the use of members. Transmitting and receiving equipment is being installed and constructional facilities are available. Full particulars of the Society and its activities are obtainable from the Hon. Sec.: Mr. C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

* * *

EAST GRINSTEAD AND DISTRICT AMATEUR RADIO CLUB

At the time of writing the club has to share a hall with other clubs, which restricts activities, but it is hoped soon to obtain exclusive accommodation. The club transmitter is now under construction and it is hoped to be on the air this year. Morse classes are held weekly. New members are welcomed; full particulars can be obtained from the Hon. Sec.: Mr. R. A. Burnett, 19 Stockwell Road, East Grinstead, Sussex.

* * *

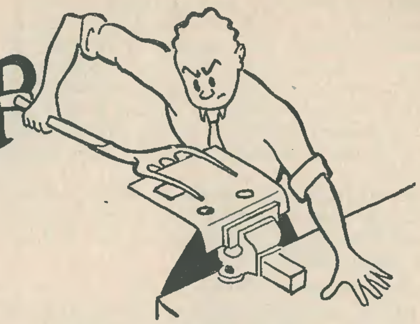
CLIFTON AMATEUR RADIO SOCIETY

The first DF contest in the 1955 series takes place on Sunday, 8th May in the vicinity of Farnborough, Kent. The club station, G3GHN/A, will be operating portable between 11.00 hrs. and 16.00 hrs. on a frequency of 3,504 kc/s and as only low power will be used reports and QSO's will be welcomed.

Tape recording will be covered by Mr. L. Barnes on 20th May and the evening will comprise a demonstration and talk on the equipment being used.

Meetings are held every Friday at the clubrooms, 225 New Cross Road, London, S.E.14, at 7.30 p.m. Details of membership may be obtained from the Hon. Sec.: C. H. Bullivant, G3DIC, 25 St. Fillans Road, Catford, S.E.6.

IN YOUR WORKSHOP



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

I don't know why it should be, but it nevertheless seems to be an unassailable fact that as soon as anyone buys a television receiver these days they immediately assume a meanness of outlook which they never exhibited before. One would think that a person who buys a televisor would also be prepared to pay something towards its upkeep; but this does not seem to be the opinion of the set-owner. Whenever possible, he wants his repairs done on the cheap.

Bitter Experience

I think a number of readers will agree with me on this point; and I know quite a few technical people around London who have all had more or less the same sort of experience that I have had myself.

What usually happens is that the person who owns the televisor approaches any of his technical friends and informs him that some little thing has gone wrong with his receiver. "Some little thing" can, of course, be anything between the line-hold control out of adjustment to a nice, obscure, intermittent shorted turn or two in the deflector coils. However, the technician is assured that there cannot be much wrong with the set; and perhaps he would care to pop in one evening and just "have a look" at it. If that technician is mug enough to fall for that one he would quite probably end up by carting all his test gear around to the house and spending an entire evening wrestling with the dusty innards of a receiver which should have gone in for overhaul years ago. Furthermore, once he has touched the set, even if only to change a valve, he is "married" to that set for evermore. If it goes wrong at any later date he is the person who will be blamed for it.

I know I sound a little bitter about all this, but some television-owners have an almost incredible amount of neck. If one is "awkward" enough to get them to state why they won't take their set to a shop to have it repaired, one finds out eventually that they just don't want to fork out the money to have the job done properly. They would prefer to plague their acquaintances instead.

I know that some television repair bills are high, but that is mainly because television servicemen nowadays are skilled men who deserve every penny of the salary they earn. In any case, if the television owner wants to keep his repair bills down there are plenty of retailers who run maintenance schemes at very reasonable prices.

Alternatively, of course, it may quite simply be that I move in the wrong circle of acquaintances!

Caravan Dweller

I have recently received a letter from a reader who has just moved into a caravan. He is a short-wave enthusiast and naturally feels rather keenly the fact that he now has no mains supply available; especially so since this deprives him of the use of his R.1155 and all the gear he has made to go with it. He asks if it is possible to give some information on the construction of a communications receiver employing 1.4V B7G valves; the set to include a crystal filter, variable selectivity and a b.f.o.

Apart from the crystal filter and the variable selectivity, such a receiver should not be too hard to make. There are one or two important points to remember, however.

The first of these is that 1.4V battery valves are by no means as "lively" as are mains valves, and it is necessary to pay greater attention to circuit constants if the maximum amount of gain is to be extracted from them. Secondly, battery frequency changers do not oscillate as readily as do their mains counterparts. In consequence of this, it may be difficult to obtain a high value of conversion conductance (i.e., change in current, at i.f., at the anode of the frequency changer for change in voltage, at signal frequency, at the signal grid) all over a short-wave band whilst using the conventional 500pF tuning condenser. If one is looking for optimum results it would probably be best to use a tuning condenser of, at most, 350pF.

Apart from this, the use of battery valves does not raise too many difficulties. Indeed, it can introduce simplifications, as the following notes may show.

Battery Receiver

Fig. 1 shows the i.f. and a.f. stages of a practicable battery communications-type receiver employing valves from the current Brimar range (or their direct equivalents). There are several points of interest in this circuit.

Starting at the output stage in the diagram, it will be seen that either a loudspeaker or headphones may be used. The latter can be either high or low impedance and are plugged into appropriate jacks. The speaker may also be switched out, if desired. In order to obtain the maximum audio output, a speaker transformer having as close a ratio as possible to that specified should be chosen. It might be advisable to try and obtain a speaker transformer designed especially for battery output valves: such transformers often have a primary wound with a large number of turns (of finer wire) than is normally used in speaker transformers intended for general use.

A grid bias battery is employed in the circuit. Whilst a battery of this type is usually considered to be somewhat old-fashioned these days, its inclusion is certainly worth while in this instance. The reason for this is that if bias were obtained from the voltag dropped across a resistor in series with the negative h.t. supply lead (i.e., "automatic bias"), this voltage would be liable to vary considerably with a.v.c. voltage, since a large number of the valves in the set are a.v.c. controlled. Also, the requirement of an r.f. volume control necessitates having available a source of fairly high negative voltage, and it would be wasteful to obtain this from the h.t. battery with the aid of an automatic bias dropping resistor.

The diode-pentode stage is quite conventional, the single diode necessitating a common load, (R9), both for a.v.c. and sound detection. In consequence of this common load the a.v.c. has no delay.

The circuit around the r.f. volume control, R10, also merits some consideration. This control only becomes effective when a.v.c. is switched out, and it varies the potential of the entire a.v.c. line. The 9-volt bias voltage obtainable from a single grid bias battery should be sufficient to cause the receiver to be almost completely muted at the minimum setting of the r.f. volume control. However, should this not occur when powerful signals are being received, two grid bias batteries may be connected in series to provide a higher total negative control voltage. The bias supply is switched out of circuit when the receiver is switched off in order to prevent a continual discharge through the volume control. As is to be expected with a receiver of this nature, overloading at the diode detector, or at the last i.f. stage, will almost inevitably occur when the r.f. volume control is turned to its maximum setting whilst receiving strong signals.

B.F.O. Stage

A b.f.o. stage is provided with the receiver as well. This is only brought into operation when the a.v.c. circuit is cut out. Otherwise, it would be possible for the output of the b.f.o. to be rectified by the diode of V3, and thus generate a high a.v.c. voltage which would reduce the sensitivity of the receiver. The b.f.o. stage should be completely screened, and its trimmer, C13, may be brought out as a panel control. A Colpitts circuit is shown in the diagram. This circuit has the advantage of allowing a single, untapped coil (L1), to be used; untapped coils being readily available to the amateur from discarded i.f. transformers and similar components. The two condensers C15 and C16 should each have approximately the same value, their combined capacity, in series, being slightly less than that normally required by the particular coil chosen to resonate at the intermediate frequency. The trimmer C13 will then make up the requisite tuning capacity. The grid leak, R11, may require slight final adjustments in value in order to provide an oscillation which gives a pure tone free from squegging.

The b.f.o. is switched on and off by switching its filament supply. This is more economical on battery drain than would be the alternative method of switching the h.t. supply. The b.f.o. stage is coupled into the receiver capacitively; the coupling being provided by twisting its insulated output lead several times around the lead to the second detector diode. The resulting capacity (some 2 to 10pF) will then provide adequate coupling.

Variable Selectivity

A measure of variable selectivity is provided by the switch S1. This switch cuts out the last i.f. stage, V2, when it is required to use the receiver for normal broadcast reception. S1 should be fitted into the circuit with some care as, should any capaci-

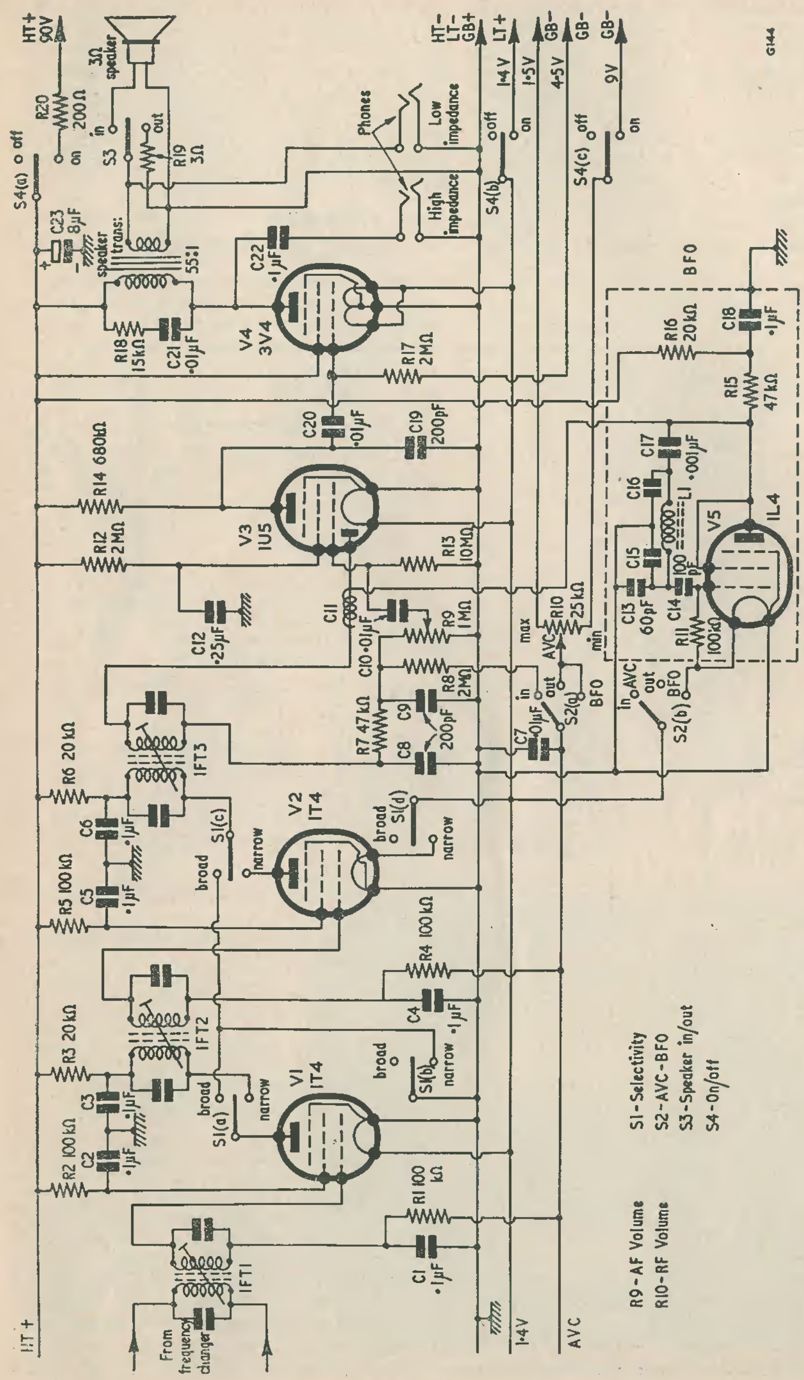


Fig. 1. The i.f. and a.f. stages of a battery communications receiver. Where condenser values are not shown, they are discussed in the text. C11 is a "twisted pair"

tive coupling exist between the two sections S1(a) and S1(c), V2 may go into oscillation when switched in. The best method of preventing such coupling cosists of screening the sections S1(a) and S1(c) from each other. When the i.f. stage is switched in for the "narrow" bandwidth condition, the lead linking the two sections is earthed by S1(b) to prevent any capacitive r.f. feedback occuring along this route. A suitable procedure for constructing the i.f. stages would consist of getting them to function satisfactorily primarily without having S1 in circuit at all. This switch can then be fitted, whereupon any instability it may introduce can be tracked down and cured more easily.

In a receiver of this nature, considerable care has to be taken with regard to the layout of the i.f. stages. This is due to the fact that the greatest degree of amplification in the receiver exists in these stages, and they are consequently most prone to instability. To obviate such instability, all grid and anode leads must be kept as short as possible, and all decoupling components placed very close to the circuit they bypass. It would be preferable to provide the two i.f. amplifying valves, as well as the diode-pentode, with screening cans,

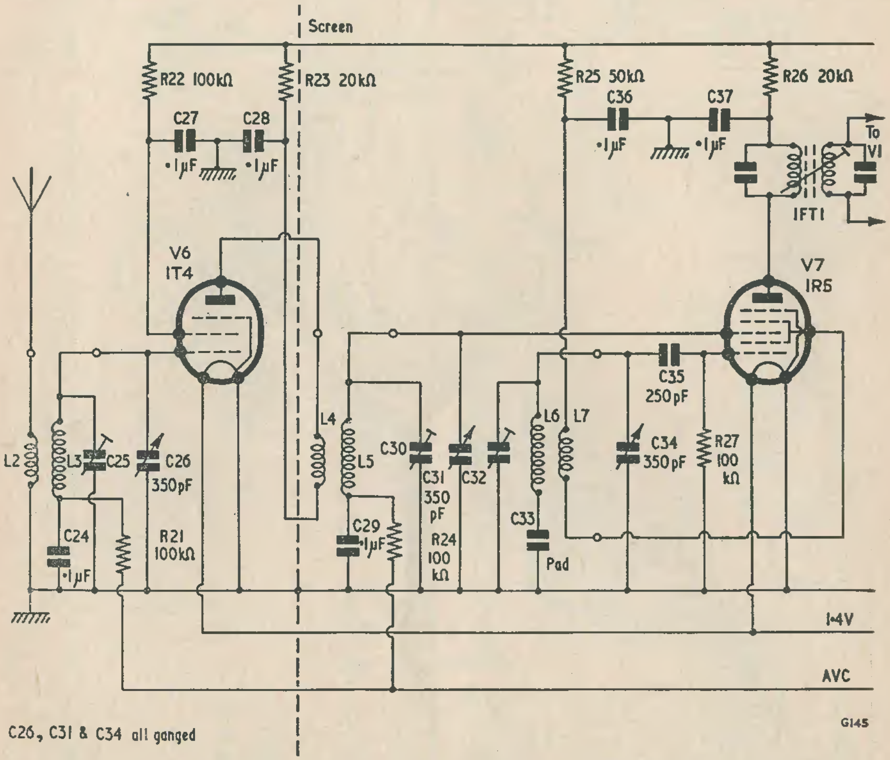


Fig. 2. The r.f. (optional) and frequency changer stages of the battery communications receiver described in the text. Range switch contacts would be inserted at the points where the circuit lines are broken by circles

The R.F. Circuits

A typical frequency changer and r.f. amplifier circuit is illustrated in Fig. 2. The r.f. amplifier is optional, of course. Should it not be desired, the aerial and earth may be connected to the coupling coil, L4; deleting all components to the left of the screen in Fig. 2. This diagram illustrates the conditions required for one range only. If range switching is employed, the switch contacts should be inserted at the points where the circuit lines are broken by circles. Alternatively, a coil turret may be employed.

Many constructors would prefer to use a coil-pack for this part of the circuit. If this is the case, they should first of all ensure that the coil-pack chosen is intended specifically for battery valves; and they should study the manufacturer's suggestions for its incorp ration into the circuit. In some instances, manufacturers may recommend, for their particular product, grid leak and condenser values which differ slightly from those shown in Fig. 2.

Once again, careful attention has to be paid to decoupling and layout; this being especially true of the frequency-changer stage. It must not be forgotten that, although the signal and oscillator grids of the frequency-changer are not tuned to the i.f. their circuits are still capable of picking up any radiation from i.f. components and wiring; resulting, thereby, in possible i.f. instability. It is necessary to emphasise this point, since the receiver described in this article has greater i.f. gain than that normally given in conventional superhets. A further important point is that the second detector stage should be kept some distance away from the r.f. and frequency-changer stages. This is not only on account of instability, but also because i.f. harmonics are liable to be generated at the second detector, and these may cause whistles with received stations.

"Postage Stamp" Rectifiers

Just as I was on the point of completing this month's contribution, a friend of mine lent me some samples of a new series of h.t. rectifiers introduced by Westinghouse. These rectifiers carry out exactly the same functions as those of the ordinary metal rectifiers with cooling fins which we know so well. The only difference is that they are about one-sixth of the size!

To gain an idea of the dimensions of these rectifiers, one, which is intended for use in television receivers (250 volts at 300mA, half-wave rectification), is only 6 in. long, by 2in. wide, by ⅜in. thick. Another, which would be ideal for normal sound receivers (250 volts at 60mA, half-wave rectification), is 1⅝in. long, by 1½in. wide, by ⅜in. thick. The baby of the bunch (250 volts at 20mA, half-wave rectification), has the same thickness, (⅜in.), and is so small that it can almost be completely hidden under a postage stamp. I understand that this latter is already being used in commercial record-players employing an ECL80 in a two-stage amplifier. The three rectifiers just described are, of course, only typical types chosen from a wide range.

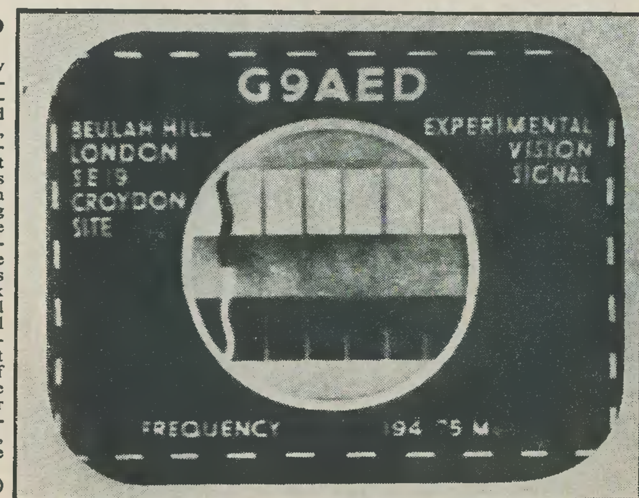
These little components are designated "Contact-Cooled Rectifiers," and their name gives the clue to their small size. They are intended to be mounted flat against the metal of the chassis in which they are fitted; whereupon the heat dissipated in the rectifier is conducted away by the chassis itself. The chassis also, of course, provides a large surface area for subsequent radiation and cooling by convection.

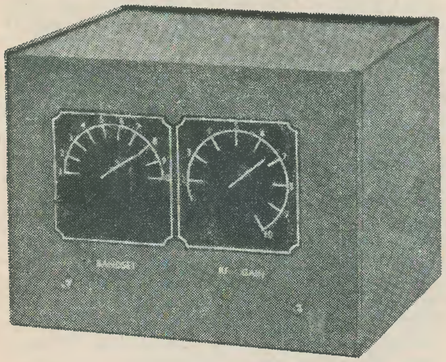
I am told that these Westinghouse rectifiers will be on sale shortly (if not already) for use by the home-constructor. I know I shall be among the first to buy one of those little 20mA jobs!

Band III Photo

The photograph, taken by Mr. John Cura of "Tele-Snaps" fame, shows the Belling-Lee test card now being radiated on the commercial t.v. band, as actually received at Wandsworth Common. Although not far from the transmitter, this is actually a very poor reception location owing to intervening hills. The aerial is a Belling-Lee type 904 6-element yagi, comprising reflector, folded dipole and four directors, and it is mounted on a chimney stack three floors up. The signal strength, measured at the aerial feeders, was 200μV. No attenuation was used, as against 14db employed for reception of the B.B.C. programmes. The contrast control was a quarter advanced from zero. The receiver was an H.M.V. 1805 TRF, with an experimental 2-valve converter.

(*see also page 596*)





A PRE-SELECTOR for the R.C.S. BATTERY RECEIVER

by J. SINCLAIR

IN THE JULY, AUGUST AND SEPTEMBER issues (1954) of this journal, a full description of this receiver was given, together with detailed point-to-point instructions of the wiring. This was followed by the October edition when the mains power unit was discussed. Since that time, many beginner readers—according to information given to the writer—have built the complete three valve receiver and power unit. Many of these readers are now apparently desirous of adding an RF stage to this receiver and, in response to this demand, a simple design has been evolved.

The addition of an RF stage to the 3-valve receiver (0-v-2) will not only greatly increase the range but will also considerably increase the selectivity. The dampening effect of an aerial connected directly to a detector stage has several disadvantages, one of which is to make direct calibration of the dial extremely unreliable; others are that it causes interference to nearby receivers when the detector is oscillating, and reaction may become erratic. These faults are eradicated by the addition of an RF stage.

From the photographs it will be seen that the whole unit, when completed, is housed within a grey sprayed metal cabinet which matches the receiver and power unit. This cabinet, size 5¼in. × 4in. × 4in., is supplied complete with a removable top in order to effect easy removal, and replacement, of the coils selected to cover the range of frequencies for which the receiver was designed. The Bandset and R.F. Gain control transfers shown are those supplied with the Panel-Signs No. 1 set.

In the above-chassis view of the prototype it will be noticed that the same type valve as used throughout the receiver has again been utilised in the pre-selector. This was done in order to keep the valve types used throughout the equipment to a minimum. Thus, one spare 954 Acorn would suffice as a replacement for any stage. In addition, the fact that only one type is used tends to keep the cost at a low level, a most important point to the younger members of the radio fraternity.

All the components specified are currently available on the market. The chassis and cabinet are supplied pre-punched and drilled. All that the beginner has to do is assemble, solder and operate.

The Circuit

This is shown in Fig. 1, from which it will be seen that the aerial is fed to the coil primary winding direct. The secondary winding is tuned by the variable condenser C1; in operation, this must be kept "in step" with the receiver tuning condenser so that both units are tuned to the same frequency. R.F. Gain control is essential in order to avoid overloading the receiver on strong local transmissions. This control has been incorporated in the cathode line to earth. The fixed resistor R1, together with R2—a variable component—will, in operation, take the pre-selector from nil to full gain. C2 is the cathode bypass condenser. The screen grid (grid No. 2), is taken to the h.t.+ line via R3 and bypassed to earth via the condenser C3. The suppressor grid (grid No. 3), is connected directly to the chassis. The anode is connected to the h.t.+ line via R4—the anode load resistor—and the r.f.c. (radio frequency choke). This latter component is necessary in order to prevent the precious r.f. signal from wasting into the h.t.+ line. This r.f. energy is fed via C4 into the receiver aerial input terminal.

The power supply of the pre-selector is taken from the same power unit that supplies the receiver. The earth, or chassis, of the unit should be connected to that of the receiver. This leaves the h.t.+ and l.t.+ to be connected to the pack. Thus, four connections are necessary in adding the pre-selector—h.t.+, l.t.+, chassis and output. Of these, the first two are connected to the power pack and the remaining connections to the receiver itself.

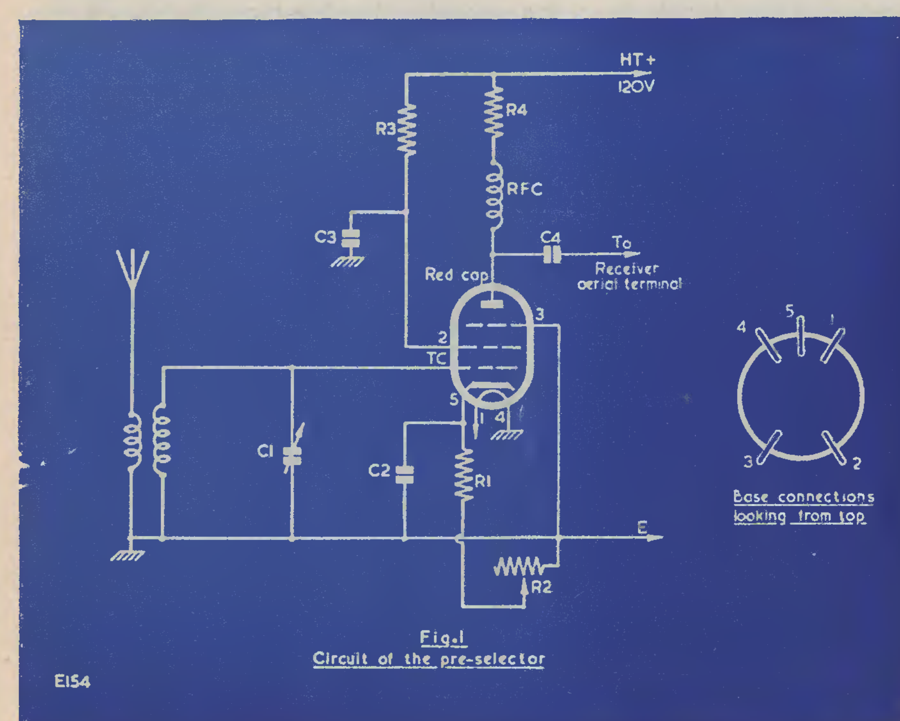


Fig. 1
Circuit of the pre-selector

Assembly

Fix the chassis and panel together by means of the two nuts and bolts provided. At the rear of the chassis bolt into position both the aerial input and output paxolin strips. Through the central holes of these strips respectively, affix two bolts and double nut them, i.e., fix two nuts to each. Next, bolt into position both the valve and the coil holders—a glance at the photographs will show the correct positions of these. Having proceeded thus far, fix both the potentiometer and the variable condenser to the front panel. This completes the assembly, and we are now ready to commence the actual wiring of the pre-selector.

Wiring Instructions—Step by Step. (Colours refer to markings on R.C.S. components).

Dealing with the under chassis wiring first, proceed as follows:—

STEP No. 1. From aerial terminal to YELLOW on coil holder.
,, No. 2. From earth terminal to BLUE on coil holder.
,, No. 3. From WHITE on coil holder to RED on condenser.
,, No. 4. To RED on 3-way tag strip solder one end of R3 and R4.
STEP No. 5. To RED on tag strip solder length of RED connecting wire and allow this to protrude through chassis drop. (This wire is the h.t.+ lead from the power unit).
,, No. 6. Cover free end of R3 with

systoflex, feed through chassis deck and solder to YELLOW on valveholder.

STEP No. 7. Solder free end of R4 to one end of r.f. choke.

" No. 8. Solder other end of r.f. choke to one end of C4, other end of C4 to solder tag on output terminal.

" No. 9. To junction of r.f. choke and C4, solder short length of wire at the other end of which is soldered a valve connecting clip.

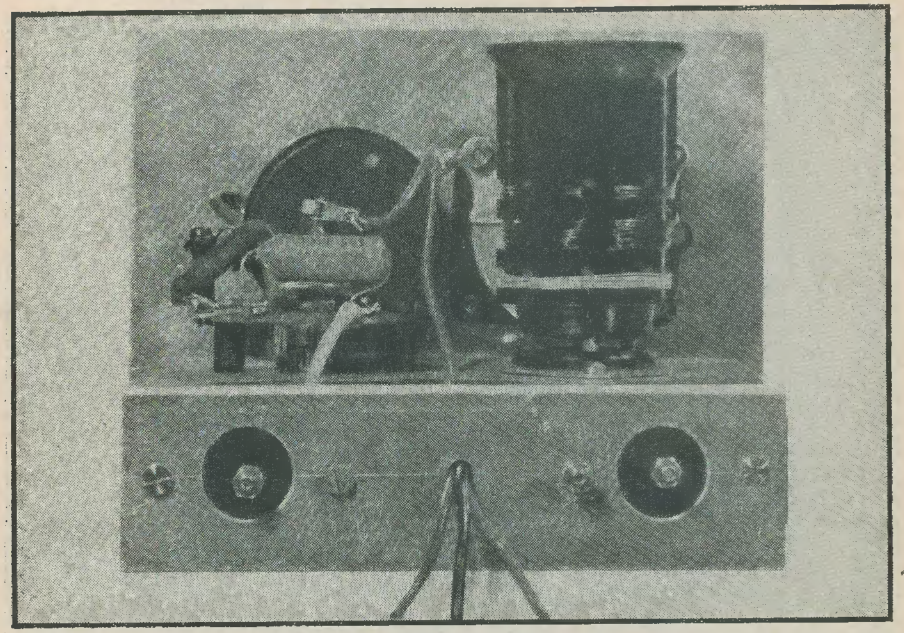
" No. 10. To centre tag on 3-way strip solder length of BLACK wire and push this through chassis backdrop. (This wire is the h.t.–, l.t–, connection, i.e., taken to chassis of receiver).

STEP No. 12 Continue with above chassis wiring as follows: From YELLOW on valveholder solder one end of C3, the other end of which is secured to GOLD on valveholder.

" No. 13. To GOLD on valveholder solder length of bare wire and secure other end to WHITE on valveholder. Next, centre of this bare wire should be soldered to earth tag fitted on valveholder bolt.

" No. 14. To WHITE on valveholder solder short length of wire, other end of which is taken to RED on potentiometer (R2).

" No. 15. To centre tag of potentiometer solder one end of R1. Other end of R1 to RED on valve-



View from rear, showing components above chassis

STEP No. 11. To YELLOW on 3-way tag strip solder length of BLUE wire and push through chassis backdrop. (This wire is the l.t.+ input lead from the power unit). Also to this YELLOW tag solder length of BLACK wire, push through chassis deck and connect to BLUE on valveholder.

holder.

STEP No. 16. To RED on valveholder affix one end of C2, other end of which is soldered to earth tag on valveholder.

" No. 17. To RED on variable condenser secure short length of wire the other end of which is soldered to a valve clip.

" No. 18. Secure this valve clip to the top connection of the valve. (*Note:* The valve is placed into position with the RED end protruding through and under the chassis, the clear end being therefore uppermost, i.e., connected to the variable condenser. Care should be exercised in placing the valve into position. It should be pressed by the pins firmly but gently into the valveholder).

STEP No. 19. To the RED end of the valve, connect the valve clip that is soldered to the junction of r.f. choke and C4.

This completes the wiring of the pre-selector.

Connecting the Pre-Selector

Having completed the assembly and wiring of the unit, we now proceed to connect both to the receiver and power pack. Firstly, place into position the coil selected (same coverage as that in the receiver). With the power pack switched off and disconnected from the mains, fasten into position the RED wire to the h.t.+ line and the BLUE wire to the l.t.+ line. Connect the BLACK wire to the receiver earth terminal. Disconnect the aerial from the receiver and fasten it to the pre-selector input terminal. From the pre-selector output terminal, fasten a short length of wire and connect other end of this to the receiver aerial input terminal. The receiver earth terminal may be left connected to the external earth connection or, if preferred, it may be connected to the pre-selector earth. Later, a length of metal braided co-ax cable should be used for feeding the signal into the receiver, the outer braiding of which should be earthed at both ends to the receiver and pre-selector. Connect to the mains and switch on. The pre-selector valve will be seen to light up. Tune in a station on the receiver and bring the pre-selector into line by rotating the tuning condenser. Turning the r.f. gain control clockwise will greatly increase the signal strength. Having tested the unit, it should now be disconnected and placed within the cabinet supplied. Having done this and re-connected as previously described, fix the two Panel-Signs into position and fit two suitable knobs to the spindles of the r.f. gain control and tuning control respectively. Fixing varnish is not required with this unit, little heat being generated, therefore the gum on the Panel-Signs will suffice for fixing purposes.

The performance of this simple pre-selector is very good indeed and it may be used to gr at advantage with the receiver referred to earlier. It has also been used in conjunction with another receiver, a superhet having no RF stage, with surprisingly good results. As a pre-selector it may therefore be used with any such receiver; taking little current, a small amount of time to construct, and costing little.

A NEW MAGNETIC RECORDING TAPE

High Performance at Low Price

A new magnetic recording tape with an exceptional performance has been introduced by Salford Electrical Instruments Limited, at an unusually low price. Sold under the trade name of "Puretone" for 20s. a spool, it is a paper based material with an output and frequency response which compares favourably with those of plastics tapes costing almost twice as much.

The new tape is sold in lengths of 1,200ft. wound on specially designed plastic spools slotted to facilitate rapid threading, and other lengths of tape will shortly be available. The 1,209ft reels give 32 minutes playing time at 7½ inches/second or 64 minutes at 3¾ inches/second. Twin track recording is also possible and this doubles the playing time; the tape can be used on all types of recorders. The highest grade oxide, with a particle size range from 0.5–1.5 microns, is used in the magnetic coating. The base, which is superior to that of many other paper tapes, consists of a high quality super calendered Kraft paper.

The coating has an unusually high gloss finish, which, coupled with the addition of a lubricant, greatly reduces the friction and wear on the recorder heads. Intimate contact with the heads and improved high frequency response is thus ensured. On a typical recorder the response curve is substantially flat within ±1db over a range of frequencies from 50c/s to 10kc/s.

"Puretone" has the high tensile strength of about 6lb./sq. in. breaking strain with a coercive force and remanence of 220 oersteds and 700 gauss respectively. "Static," the principle disadvantage of plastics based tapes, is eliminated with the use of "Puretone."

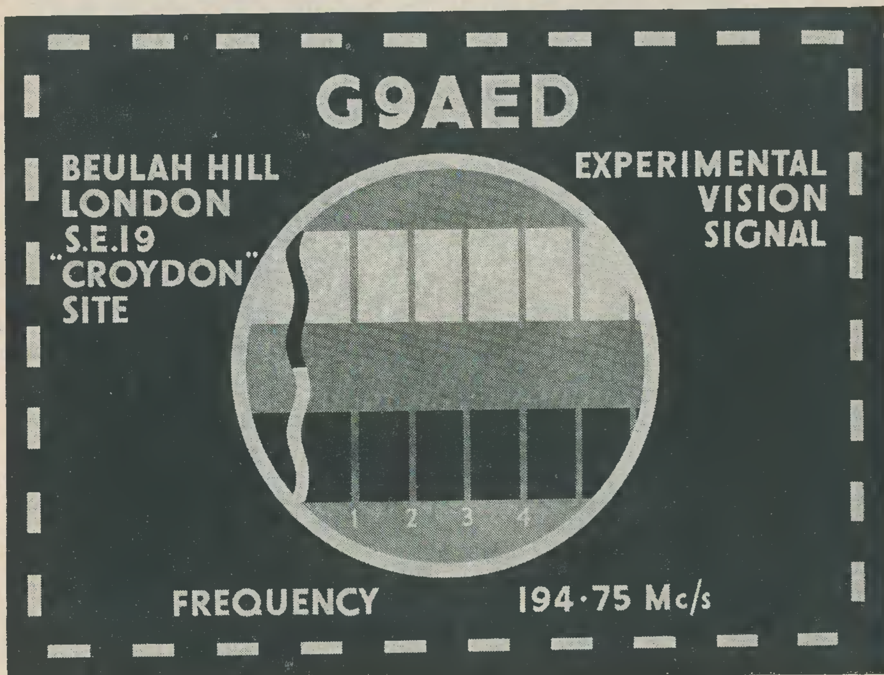
"BELLING-LEE" BAND III TRANSMITTER

G9AED is the call sign allocated to the band III experimental transmitter for which the P.M.G. has issued a licence to "Belling-Lee." Through the helpful co-operation of the Independent Television Authority the transmitter and mast are located on part of the same piece of ground as their temporary mast and transmitter. The site is actually named on the 1" ordnance map sheet No. 170, as "Beulah Hill" with a map reference 333696.

Transmissions commenced on April 1st.

The test card is primarily intended for the investigation of ghost images and provides the following features.

(a) A wavy line in black and white, followed by white, grey and black. This line is wavy to differentiate from the vertical



range marks. With ghost signals the wavy line predominates, and positive or negative ghosts can be identified.

(b) Vertical lines numbered 1, 2, 3 and 4 indicating the additional path in miles that the ghost has travelled, i.e. if the reflecting object is situated directly behind the receiving aerial, in line with the transmitter, the distance of the reflecting object is exactly half the extra distance travelled by the delayed image

(c) A circle to enable approximate linearity adjustments to be made to the receiver.

(d) The black and white border to the card corresponds to the similar design on test card C and indicates the edge of the picture.

The "Belling-Lee" mast is a 75-foot self-supporting "Skytower" to which has been added a 16-foot top mast carrying the aerial system comprising four stacked bays, each of four vertical half-wave folded dipoles spaced equidistantly. Thus there are sixteen dipoles designed to give all round coverage and, it is hoped, a power gain of four.

The transmitter, which has been designed and constructed in its entirety at Enfield, has an output of 250 watts, thus the E.R.P. of the station will approximate 1 kW. The equipment is housed in a temporary wooden hut measuring 24×10 feet.

It is hoped to transmit between the hours of 10 and 12 and certain unspecified periods during the afternoon, excluding Saturdays, Sundays and public holidays. It should be appreciated that the equipment is just as liable to develop a "technical hitch" as is that used by other television services, and that it has not been possible in the time to build st nd-by equipment for every stage, so in the event of breakdown there will be a certain amount of unavoidable inconvenience.

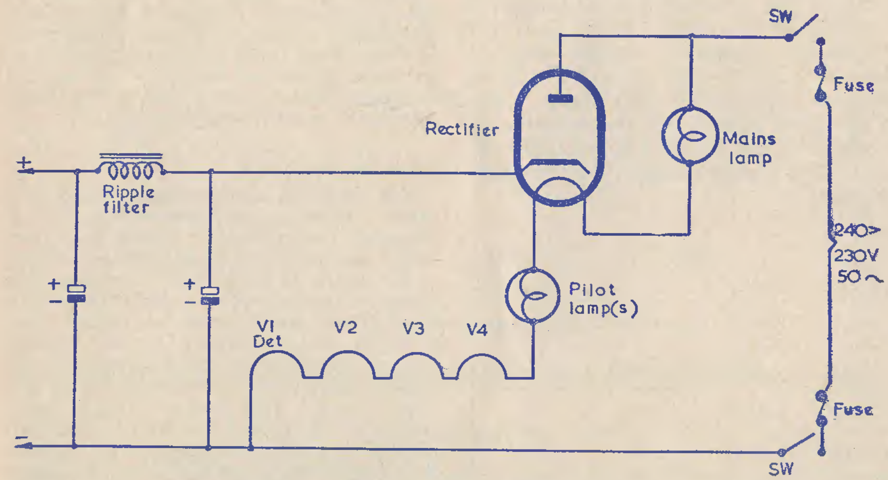
INEXPENSIVE SERIES HEATER RESISTANCE

M. C. PAUL

The design of AC/DC equipment, whether home or commercial, entails the provision of a line cord or wire-wound resistance; some, indeed, aspire to a condenser. Whichever of these is favoured, price and an awkward ohmic value are deciding factors, and in most cases the possibility of future replacements must be kept in view.

wide scope afforded. A stock of less than ten lamps will cover practically all requirements.

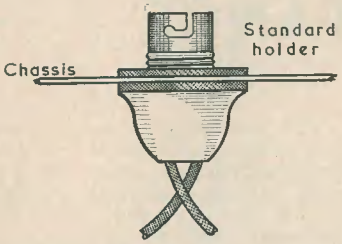
In orthodox circuits series droppers have very awkward values—thanks to awkward people who patent certain valves. Lamps also have awkward values, but these and AC/DC requirements tally very well. In designing one's own equipment it is an easy matter to include such a lamp; any small adjustment in ohmic value being made by the inclusion of a suitable pilot lamp(s) of the dry battery type.



Showing the connection of lamp as series heater resistance in a typical AC/DC line-up

The author has for some time adopted what he feels to be a simple and inexpensive answer to this problem; i.e., an AC mains lamp in series with the heater chain. In this the author does not claim novelty—who can? However, all too few enthusiasts realise the versatility of the method and the

Suitable AC mains lamps and their values are listed in Table 1, together with their respective current ratings which on no account must be exceeded. For the sake of beginners in radio construction an example is given.



Suggested method of mounting lamp

E118

Required line up:—ECH33, EF39, CBL31, CY32. Total consumption of heaters:—86.6 volts at 0.2 amps. Mains supply:—240 volts. Required voltage drop:—(240 – 86.6) 153 volts at 0.2A. Series resistance of lamp = V/I = 765 ohms. It will be seen from Table 1 that the nearest lamp resistance to that required is 768 (240V, 75 watt). This is close enough for all practical purposes.

TABLE 1

Normal Working Conditions			*Resistance* (Ω)
Volts	*Amps*	*Watts*	
230	0.43	100	529
240	0.42	100	576
250	0.40	100	625
230	0.33	75	705
240	0.31	75	768
250	0.30	75	833
230	0.36	60	882
240	0.25	60	960
250	0.24	60	1,042

Should pilot lamps be required, the next lower lamp resistance must be taken, 705Ω (230V, 75 watt). Hence the pilot lamps must together equal (765 – 705) = 60Ω. Two 8 volt 0.3 amp "bulbs" will fulfil this condition. The higher rating, i.e., 0.3 amp, should be chosen for pilot lamps in 0.2 amp heater chassis as they are primarily DC lamps, and on AC at full nominal rating (RMS value), the peak filament current would exceed 0.3 amp and shorten the life of the bulb.

In compiling Table 2 the author has taken 240V as the input mains voltage to each combination. This entails only a 4% error in the event of use on a 230 volt supply or a rise to 250 volts due to bad supply regulation. Such a small error is negligible.

The valves listed are confined to a few manufacturers, but other makes may of course be similarly combined and interchanged providing their heaters are identical. Thus it is obvious that Table 2 does not purport to exhaust the possible combinations, but is rather a ready-made guide for beginners.

Most readers would object to the abundant luminosity so freely provided by this method. The author also objected to it, strongly, but in view of the other advantages decided to try black enamelling the lamp—this worked extremely well, allowing heat to be freely dissipated whilst trapping the light.

Mounting the Lamp

Two methods of mounting a lamp in a radio chassis present themselves, i.e., a standard batten holder, which is rather bulky, and the ordinary lamp holder mounted in the chassis as shown in the accompanying sketch, which is both neat and accommodating. If very small chassis are desired, then a batten holder screwed to the cabinet interior would serve, being wired from the chassis underside via a grommet in the chassis deck. This method would reduce risk of shock, should the lamp be accidentally changed whilst the equipment is energised. Such replacements should never be made under 'live' conditions, as surges would occur, with the risk of resulting damage to components.

(There is, of course, a further way of incorporating such a lamp bulb as a series heater resistance, and one in which the light is not wasted. This is to construct the cabinet so that it fulfills its normal purpose and also acts as a table lamp standard. Apart from the decorative appearance which can be obtained, there is a further advantage in that the heat dissipated by the lamp is removed from close proximity to the receiver components.—EDITOR).

TABLE 2

	VALVE LINE-UP					PILOT LAMPS			MAINS LAMP	
						No.	Volts	Amps	Volts	Watts
0.1 Amps	X101	W101	DH101	KT101	U101	–	—	—	230	100
	W101	W101	DH101	KT101	(MR)	–	—	—	250	60
	10C1	10F9	10LD11	10P14	U404	–	—	—	250	60
0.2 Amps	ECH33	EF39	EBC33	CL33	CY32	1	8	0.3	240	75
	ECH33	EF39	CBL31	CY32	—	2	8	0.3	230	75
	EF39	EF39	CBL31	(MR)	—	2	8	0.3	250	75
	EF39	EF39	EBC33	CL33	(MR)	1	3.5	0.3	230	60
	EF36	EF36	CL33	CY32	—	–	—	—	250	75
	EF36	CBL31	(MR)	—	—	–	—	—	240	60
	EF36	EF36	EL32	EL32	(MR)	1	9	0.3	250	60
0.3 Amps	6K8	6K7	6Q7	25L6	25Z4	2	8	0.4	230	100
	6K8	6K7	6Q7	25L6	(MR)	1	8	0.4	250	100
	6K7	6K7	25L6	25Z4	—	1	8	0.4	240	100
	6K7	6K7	25L6	(MR)	—	2	8	0.4	250	100
	6J7	6J7	(50L6 50L6)	25Z4	—	1	8	0.4	230	100
	6J7	25L6	25Z4	—	—	–	—	—	250	100
	6J7	6J7	25L6	25L6	(MR)	1	8	0.4	240	100

(MR) = Metal Rectifier.

CORRECTIONS

In the MULLARD booklet *The "Universal" Large Screen A.C./D.C. Televisor and Radiogram,* there is an error in the diagram on page 17. Here, on the left, coils L2A and L2B are wrongly described. L2A, the mixer winding, is actually made of fine wire, and L2B, the oscillator coil, is of tinned copper.

In the MULLARD 5-*Valve* 10-*Watt High Quality Amplifier* point-to-point wiring diagram given on page 280 of the December issue, there was an omission. The centre terminal of the 6.3V winding on the mains transformer should have been connected to the bus-bar. Various makes of mains transformer were specified for this amplifier, and some have no heater centre-tap. In these cases an artificial centre tap is made, by connecting two 20Ω resistors one from each side of the dial lamp to the bus-bar. The wiring diagram was taken from a chassis equipped with one of the former types of transformers, whilst the photograph was of a chassis where the artificial centre tap was employed. One of the resistors can be seen in the photograph on page 281, the other being hidden by the shadow cast by the screen. Incidentally, the dial lamp was omitted from the circuit diagram.

USING METAL RECTIFIERS

by C. NOALL

WHENEVER THE BUILDING OF RADIO apparatus for mains use is under review, the question inevitably arises: "What kind of rectifier shall I use?" If a published design is being employed, the average constructor usually works from it uncritically in regard to the power supply, at least, whilst if original work is to be carried out, he just "follows his fancy" so far as the rectifier is concerned. And that, in most cases, means sticking in a U50, or something similar.

The writer believes, however, that a little more care and forethought expended on this rectifier business would result in a great economy in both construction and maintainance costs—particularly the latter. It must be admitted further that bitter experience has left him with a strong "anti-valve" bias (no joke intended!), though he would be the last to suggest that metal rectifiers should be used on all occasions.

Let us try to get the matter in true perspective. Firstly, we will take a look at the valve rectifier—the "plus one" of the conventional superhet circuit. It is expensive—quite expensive, in fact; even the ex-WD types are not greatly below the BVA prices nowadays; moreover, it is notoriously short-lived. My own 1940 vintage domestic receiver has "eaten" six valve rectifiers in its time, though most of the other bottles are still "originals." Faultily made rectifiers, too, have a nasty habit of giving up the ghost just after the expiry of the three month guarantee period.

The most serious drawback to the valve rectifier, however, lies in the damage it can do to the rest of the circuit when it fails. Most of us have seen the havoc that can be wrought by a valve rectifier in its last dying moments—burnt-out mains transformer, ruined mains energised speaker, shorted electrolytics and—in very bad cases—damaged valves as well. In fact, many an elderly set, which might otherwise have enjoyed an active and useful old age, has had to be condemned to the scrapheap following such an accident. The fitting of an HT fuse can, of course, greatly minimise such damage; but how many of us always remember to put it in?

Where economy in current consumption is important—as in car radios, for example —the valve rectifier is at a discount, because of its heavy heater drain. It must, in fact, be regarded as a most inefficient converter of AC to DC, whilst the heat it generates can be a very great nuisance indeed, particularly in the smaller kind of set.

After all this, one may wonder whether anything favourable can be said for the valve rectifier at all. Well, of course, there can. In cases where delayed HT is a "must" it can hardly be dispensed with, whilst the absence of voltage drop is a great virtue in many cases. Moreover, the fact that it can be used in a full-wave circuit means that smaller and cheaper components may be employed in the smoothing section.

So much, then, for the valve. What of the metal rectifier? So far as initial expense is concerned, it is rather difficult to make a comparison with the valve, as the various types available may range from about half a crown to well over two pounds. However, a good 250 or 350 volt metal rectifier can be bought in the surplus market for about six to ten shillings, which compares well with the price of an average valve rectifier.

Even if the original cost proves greater than that of a valve, the investment will soon pay for itself by the elimination of replacement costs. Metal rectifiers are practically indestructible in normal use, and disasters such as often happen with valve rectifiers can hardly ever occur with them. The HT fuse should never be omitted from the power pack, however, no matter what kind of rectifier is employed.

The metal rectifier does offer a certain opposition to the flow of current, even during the conducting phase, and this manifests itself in reduced HT voltage.

The degree of voltage drop which may be expected varies somewhat with individual types of rectifier. It is, however, generally rather less than most constructors appear to believe. Here are listed a few typical MR's showing their respective input AC and output DC voltages, from which it will be seen that the voltage loss can be less than

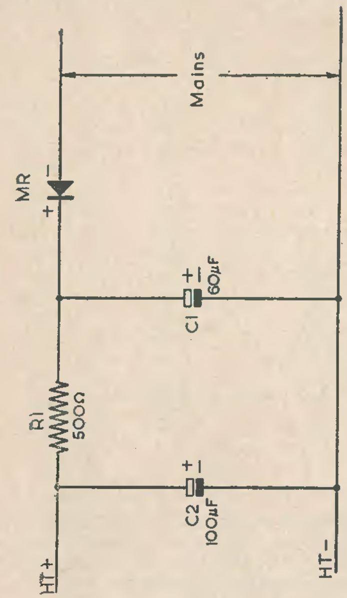


Fig.3 Resistor-capacity smoothing

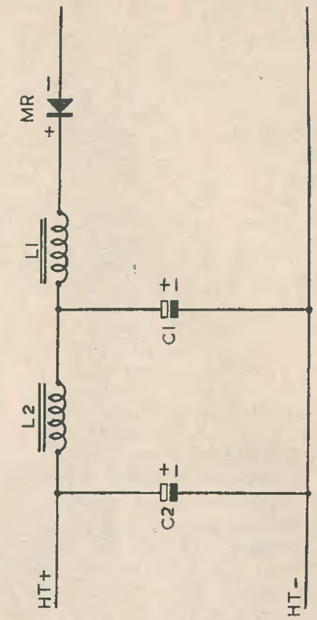


Fig.4 Choke input filter

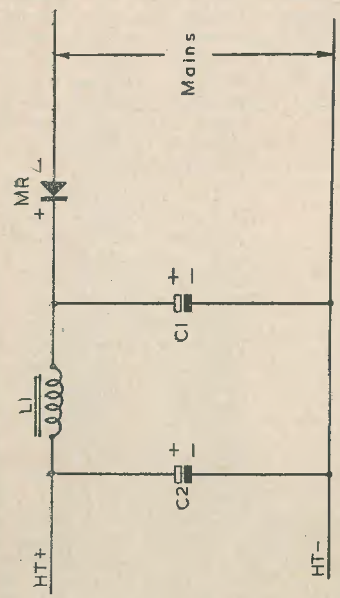


Fig.1 Half-wave rectification

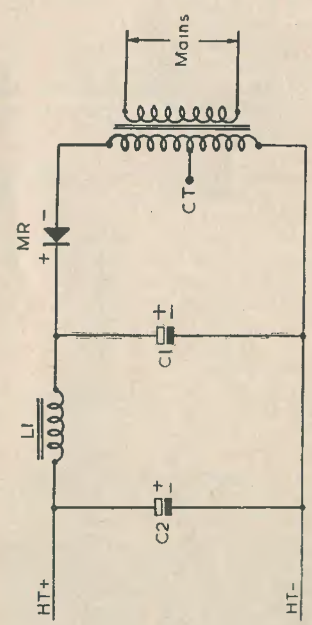


Fig.2 HW Mains isolated power pack

5%, whilst in some instances an actual voltage *gain* is indicated:

Make	*Type*	*Purpose*	*Input Volts RMS*	*Output Volts DC*	*mA max*
Surplus	ZA-15406	HW	250	240	80
Westinghouse	HT42	VD†	270	450	100
Westinghouse	HT46	HW	250	240	120
Westinghouse	HT47	HW	250	260	60
?	—	HW	130	125	25
Brimar	RM1	HW	125	140*	60
Brimar	RM1	VD†	125	240*	60
Brimar	RM2	HW	125	135*	100
Brimar	RM2	VD†	125	270*	100
Brimar	RM3	HW	125	150*	120
Brimar	RM3	VD†	125	300*	120
Brimar	RM4	HW	250	275*	275
Brimar	RM4	FW†	210–0–210	225*	550
Brimar	RM4	VD†	250	550*	275
Brimar	RM5	HW	250	250*	300
Brimar	RM5	VD†	250	560*	300

† 2 Rectifiers.
* approximate voltage with 32μF reservoir.

The actual DC output of any MR depends on the capacitance value of its reservoir condenser (C1 in Fig. 1). For this reason, this capacitor should never have a value of less than 16μF in a half-wave circuit, whilst 32μF should be used when a fairly high load is presented to it. It should be rated at 350 volts working for direct mains use, whilst a correspondingly higher VW rating must be used following a step-up transformer. The effectiveness of the smoothing circuit may be expressed as the product of L1 multiplied by C2. The constructor should aim at keeping the choke resistance to a reasonable minimum, however, so that, broadly speaking, it is better to increase the capacity rather than the inductance value to obtain any required degree of smoothing. (N.B.—C1 and C2 may be combined in a 16×16 or 32×32μF block).

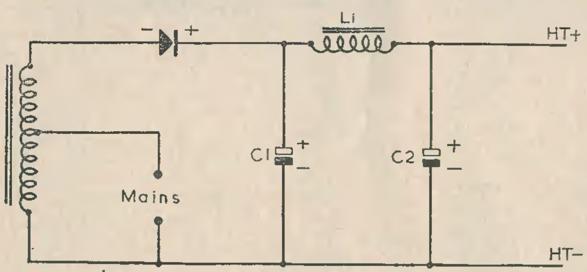


Fig.5
Using an auto-transformer

In the case of commercial rectifiers in current production, no difficulty should be experienced in getting all the necessary data regarding input and output voltages, ratings, etc., from the manufacturers concerned. With the cheap ex-WD rectifiers, however, the position is somewhat different.

The dealer from whom they are purchased can often provide the relevant data, whilst some published information has appeared on this subject. A most useful surplus MR which the writer has employed on numerous occasions with excellent results is the ZA-15406. It is ideal for working a TRF or small superhet directly from the mains, and still appears to be in fairly plentiful supply.

The metal rectifier will be most familiar to constructors from its monotonous appearance in all kinds of AC/DC apparatus. In these circuits it is unfortunately displayed to the worst possible advantage, since its DC output is here severely limited by the low applied mains voltage —220–240V in most districts. Most modern valves require 250V or more to give of their best; and though they will function after a fashion on 200V or even less, one can only expect an inferior performance under such conditions.

To get a suitable output voltage, the mains input should be stepped up to 250V or more by means of a transformer. This could be of the auto type (see Fig. 5) but a mains-isolated secondary winding may also be employed. It is, generally speaking, more convenient to use a half-wave rather than a full-wave winding, as only one rectifier is then required. If ordering a transformer of this type, the secondary should be specified as, say, 0–300V, *not* 300–0–300V as in a conventional CT winding. The current rating of this transformer should be somewhat in excess of the MR's to ensure cool running.

The writer recently built such a power pack, using for the transformer a very good American job whose secondary was rated at 150–0–150V, 150mA. The centre-tap connection was ignored, and an output of 300V at 40mA was obtained quite comfortably. After dropping by the rectifier and smoothing network, this became a nice, steady 260V—ideal for driving a small mains receiver. (Fig. 2).

The HW power pack unhappily suffers from certain inherent disadvantages, which are: (1) a large-value choke is necessary; (2) high-capacity smoothing condensers must be employed; and (3) the mains transformer (if used) must have quite a large core to overcome the "saturation" effect of unidirectional pulse current. Little can be done to overcome the two last drawbacks; but it is now a common practice to eliminate the heavy, iron-cored inductance, substituting for it a high-wattage resistor of about 500–1,000 ohms. With such an arrangement, the values of the electrolytic capacitors should be still further increased if the HT voltage is to be maintained at a satisfactory level (Fig. 3). Resistor-capacity smoothing is only really effective, however, where the load is comparatively light, as in midget receivers, test gear, etc.

The difficulty of obtaining HW transformers, plus the inevitable snags in this kind of smoothing circuit, make the proposition of using MR's in a full-wave HT pack quite an attractive one. *Two* MR's must be used in such an arrangement, and *each* must be rated to stand the full input voltage applied by the transformer secondary.

Many readers will at once be tempted to ask: "Can I substitute MR's for the valve rectifier in any existing apparatus?" To this, the guarded answer must be: "Yes, if delayed HT is unnecessary, and if you can tolerate a slightly reduced performance. If you want the same performance as before, you will have to increase the voltage rating of your transformer secondary to compensate for any introduced voltage drop." This higher voltage *might* be obtained by playing around with the mains input tappings, but any heater windings on the same bobbin would simultaneously be rendered unusable. It would also be highly advisable to use higher capacity reservoir capacitors than is general with valve rectifiers.

When dealing with receivers and amplifiers which present a fairly steady HT load, the question of accurate voltage regulation is not usually of great importance. In transmitters and certain other types of apparatus where the HT load does vary within certain rather wide limits, precautions must be taken to stabilise the HT voltage, however. The simplest way of doing this is to use the choke input filter arrangement (Fig. 4). The value of L1 becomes somewhat critical here, and should be calculated (in Henrys) by dividing the load resistance by 500. (Example; with total load of 10,000 ohms, L1 is

$$\frac{10,000}{500} \text{ which equals 20H).}$$

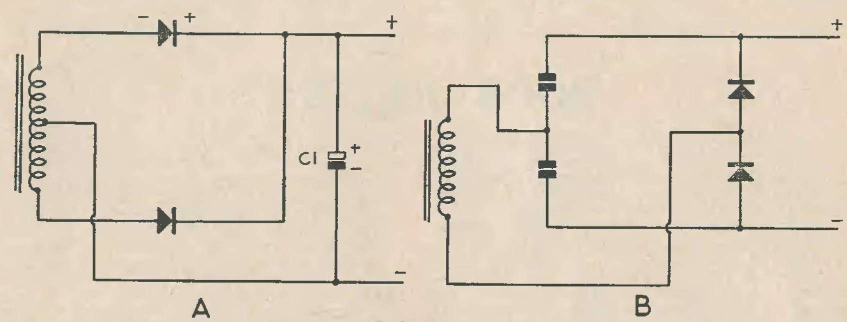


Fig.6
Full-wave (A) & voltage doubler (B) circuits

E135

This choke should, preferably, be of the "swinging" type.

Note.—The threaded rod which projects at each end of the normal MR is for chassis attachment; it is not connected electrically to the rectifier itself. The terminals are nearly always marked red and black. The black end goes to the mains (or secondary of the mains transformer), the red to C1 and the smoothing choke. The disc-like projections from the body of the rectifier are heat-radiators. When fully loaded the rectifier runs quite warm, but the heat should never be sufficient to scorch the paint with which it is normally protected. It sometimes happens that an MR for a particular voltage rating or type of smoothing circuit is unprocurable; in this case, lower-voltage rectifiers may be used in series or in voltage-doubling arrangements to give the required voltage. At a pinch, too, a higher-voltage MR could be used in a lower-voltage circuit (i.e., a 400V MR could be fed with 300V AC), but a bigger voltage drop must be expected under such circumstances.

In this article, the term "metal rectifier" has been used indiscriminately to cover both selenium and copper oxide types. Purists may object to such usage on the grounds that selenium is not, strictly speaking, a metallic element; but we need hardly stop to argue that one here. Generally speaking, selenium is used for low-current rectifiers (up to about 100mA) and copper oxide for higher ratings.

BOOK REVIEWS

SINGLE SIDEBAND FOR THE RADIO AMATEUR. 176 pages, 250 diagrams and illustrations. Published by the American Radio Relay League. Obtainable from The Modern Book Co. (Dept. RC), 19–23 Praed Street, London, W.2. Price 14s. Postage 4d.

During the past few years the American radio journal "QST" has devoted a fair amount of space to articles on single sideband technique. Contributions which have the widest field of interest have been edited and collected in this present book. It is particularly well produced and will doubtless prove valuable to the increasing number of amateurs in this country who are attracted by this method of transmission. It follows, of course, that reception of such signals also requires some difference in receiver design. This, too, is catered for in the book, so it will be of use to those who happen to concern themselves only with reception.

The contents are divided into eight main headings; these cover a general survey of SSB technique, methods of modulation, detection, lattice filters, receivers, phasing systems, linear amplifiers and miscellaneous accessories. In each of these chapters various aspects of the particular equipment are dealt with.

The photographs and diagrams are very clear, and one is impressed by the high standard of construction depicted in the illustrations. An outstanding example is to be seen in the receiver design described in the article by Robert W. Ehrlich, W4CUU.

There is much to commend in the idea of such a digest of the literature on a specific technique, for not only does it make the information conveniently and quickly available; it may well be that certain articles are, or will be, preserved when they would otherwise be out of print. One might suggest that those who require, and will use, the considerable amount of authoritative material in this book would regard its cost as moderate. Indeed, the price is not too high even if the book is purchased solely for study.

WORLD RADIO-TELEVISION HANDBOOK, 1955. 160 pages. Published by O. Lund Johanson, Copenhagen, Denmark. English agents, Messrs. Wm. Dawson & Sons Ltd., Cannon House, Macklin Street, London, W.C.2. Price 9s. 6d.

The 9th edition of this familiar guide has been received from the English agents. Previous editions have been reviewed in these columns. The present issue follows the usual pattern and is no less informative than its predecessors.

Short wave listeners will find considerable interest in the book, for it contains a vast amount of material concerning broadcasting stations throughout the world. They would no doubt find, as the writer of this notice has found during the time the book was in his hands, that it can be of great help in identifying many of the lesser-known stations, and even enable one to look out for stations that otherwise would have been passed over.

GUIDE TO MODERN VALVE BASES, by B. B. Babani, and **ELECTRONIC MULTIMETER CONSTRUCTION FOR THE HOME CONSTRUCTOR.** Price 2s. 6d. each. Published by Bernards (Publishers) Ltd., The Grampions, Western Gate, London, W.6. Obtainable from Kendall & Mousley Ltd., Technical Book Dept., 18 Melville Road, Edgbaston, Birmingham 16.

These two publications have been received from Kendall & Mousley Ltd. for review. They are broadsheets, in stiff covers, which open out to approximately 28in × 19in.

The guide to valve bases is very suitable for affixing to a wall for quick and easy reference. It deals with B7G miniature and B9A noval base valves, 201 base diagrams appearing in the centre of the sheet. On each side of this panel some 700 valve types are listed with a reference to their appropriate base diagram.

The broadsheet dealing with electronic multimeters is printed on both sides and provides full details (i.e. technical data, circuit and wiring diagrams, parts lists, chassis and panel dimensional drawings) for constructing a mains-operated and/or a battery-operated instrument.

Suitable metal cases, and specially calibrated 100μA Pullin meters, can be supplied by Kendall & Mousley Ltd.

The battery version will measure resistance up to 1.0MΩ in three ranges, insulation between the limits 100kΩ–1,000MΩ in three ranges, and voltages 0–1, 0–10, 0–100 with an input impedance of 1.5MΩ. There is a "volts × 10" range to enable measurements up to 1,000V to be made, the input impedance then being 15MΩ.

Similar resistance and insulation ranges are provided in the mains-operated version, but with this model two more basic voltage ranges are available. The ranges are thus 0–1, 0–3, 0–10, 0–30, 0–100 with an input impedance of 1.0MΩ, the "volts × 10" facility then permitting readings up to 1,000V with an input impedance of 10MΩ.

These two valve voltmeters are of simple basic design which will not cause difficulty to the most "amateur" of constructors to make or get going, for provided that the specified components are used, neither instrument would need initial calibration. However, the limitations of the instruments' utility should be realised, for neither of them has provision for A.C. or R.F. measurements. Nevertheless, for their designed purpose, the cost would probably be less than a comparable volt-ohm meter of the normal moving coil type.

W. E. THOMPSON

COMBINED RESISTANCE BRIDGE AND CIRCUIT ANALYSER

by **J. CHANDLER**

WITH A HOME BUILT TEST-METER IT IS often found that the self-contained logarithmic range is insufficiently discriminating when measuring fairly high resistance, so that when doing a job which requires reasonable accuracy, away from home, a resistance bridge is required and another piece of apparatus must be carried.

It was with this fault in mind that I devised a simple circuit which with little extra cost would give a much more accurate indication of resistance.

The instrument may be conveniently divided into two separate circuits:

1. A.C./D.C. Voltage and Current Analyser.
2. Linear Resistance Bridge.

Little extra expense is incurred; as can be seen from the circuit diagram, only 4 extra resistors, 2 potentiometers and a battery are required.

Circuit Analyser

The circuit analyser follows the conventional pattern. It incorporates voltage measuring ranges of 5, 20, 50, 100, 250, 500 and 1,000 volts, both a.c. and d.c., and current ranges of 1mA, 10mA, 100mA, and 1 amp. on d.c. The ranges chosen are calculated to give a needle deflection on any voltage range of at least one quarter full scale deflection.

The use of one set of resistors for both a.c. and d.c. ranges (i.e., R5–R11) naturally results in a discrepancy in the a.c. reading, if the d.c. range is regarded as the basic, but this can be overcome in one of two ways:

(1) By putting an additional scale on the meter,

(2) By placing a chart inside the lid of the meter box showing reading corrections.

Resistance Bridge Circuit

This is a conventional Wheatstone Bridge circuit which is switched in and out by means of S2b and S2c.

R4 is a fixed 1%-tolerance resistor which with R1, R2, and R3 (also 1%-tolerance) gives a multiplicative factor of 1, 10, 100 respectively. VR2 is a wire-wound linear potentiometer which must be calibrated against some standard to the following formula:—

$$\frac{R3}{R4} = \frac{VR2}{\text{Standard}}$$

$$VR2 = \frac{R3 \times \text{Standard}}{R4}$$

By using one or two standard resistors (which if not owned can usually be borrowed from a fellow constructor), VR2 can be calibrated sufficiently accurately for most purposes.

Better tolerance resistors are, of course, available for use in the ratio arms, but this was considered unnecessary as the meter accuracy is, more often than not, no better than 1%, and thus no useful purpose would be served by using really high grade resistors unless a sub-standard meter were used.

VR1 is merely a battery limiting resistor, and its value must be determined by the voltage of the bridge energising battery. For a 1.5V battery and a 1mA meter, a 2.5k potentiometer should be adequate.

Switching

The rectifier switching is self-explanatory, being achieved by a 4-way 2-position switch.

The range selection switch is of the eleven-way single-pole type with four wafers. The wafers are as follows:

S2a	Voltage range selector
S2b	Bridge cut out
S2c	Bridge cut out
S2d	Current range selector.

The wafers are connected so that when the bridge is in use (i.e., S2b and S2c are closed) S2a and S2b have no connection. This is so that the voltage resistors and current shunts do not affect the bridge.

It will be seen that connected directly to the positive Voltage/Current terminal is a single-pole cross-over switch. This is used to connect the terminals to either the voltage

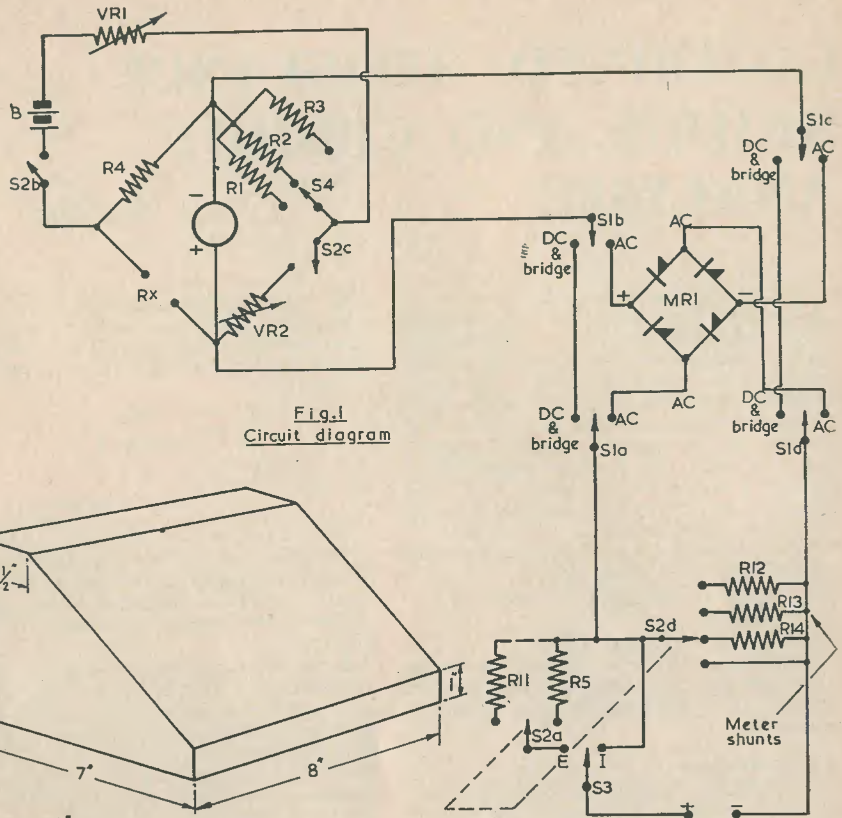


Fig.1
Circuit diagram

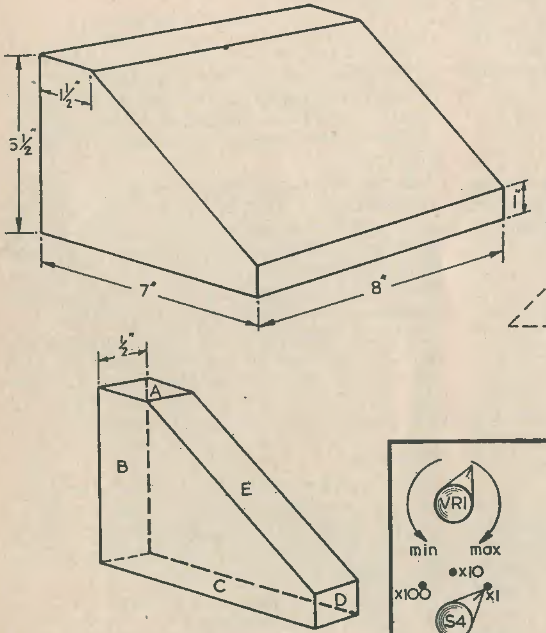


Fig.2
Case design

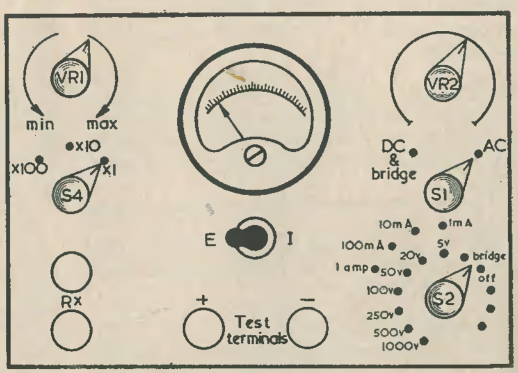


Fig.3
Panel layout

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or current switch wafer, as can more easily be seen from the circuit diagram.

Components

A 1mA meter movement of internal resistance 100Ω was used in the original circuit, for which components are given below together with those for a 5mA movement. It is not advisable to use a 5mA movement except in cases of extreme necessity, since the load placed on the source being measured is rather large and may lead to erroneous readings. The more sensitive the meter, the more accurate are the readings obtained, as the resistance of the meter circuit is much higher and the current drain is much less.

Construction of Meter Case

The meter case was made of aluminium to the dimensions given in the diagram. The object of making it to such dimensions was in order to carry it in an ex-W.D. transit case 10D/11780; these are, however, in short supply and some constructors who have other cases may wish to alter the sizes given.

The use of the sloping panel is a great advantage since it eliminates reading the meter from awkward angles.

The construction of the end pieces, is, with the aid of the diagram, self explanatory. Flat plates of metal are bolted to flanges

COMPONENT LIST

Component		*Function*	*1mA* (100 *ohms*)	*5mA*
R1	..	Bridge Ratio Multiplier	100Ω 1%	100Ω 1%
R2	..	Bridge Ratio Multiplier	1,000Ω 1%	1,000Ω 1%
R3	..	Bridge Ratio Multiplier	10kΩ 1%	10kΩ 1%
R4	..	Bridge Ratio Standard	100Ω 1%	100Ω 1%
R5	..	Voltage Dropper 5V	5kΩ 1%	1kΩ 1%
R6	..	Voltage Dropper 20V	20kΩ 1%	4kΩ 1%
R7	..	Voltage Dropper 50V	50kΩ 1%	10kΩ 1%
R8	..	Voltage Dropper 100V	100kΩ 1%	20kΩ 1%
R9	..	Voltage Dropper 250V	250kΩ 1%	50kΩ 1%
R10	..	Voltage Dropper 500V	500kΩ 1%	100kΩ 1%
R11	..	Voltage Dropper 1,000V	1MΩ 1%	200kΩ 1%
R12	..	Current shunt 10mA	11Ω	See
R13	..	Current shunt 100mA	1.01Ω	Calculation
R14	..	Current shunt 1 Amp	0.1Ω	Below
VR1	..	Bridge Battery Limiter	To suit battery 1.5kΩ for 1.5V	To suit battery 250Ω for 1.5V
VR2	..	Bridge Ratio pot'meter	1kΩ w/w 1%	1kΩ w/w 1%
MR1	..	Meter Rectifier	This should allow for any excess of current and should be capable of handling 2-3 times the basic max. meter current for f.s.d.	
Sw1	..	Rectifier Switch	4-way 2-position 1-pole	
Sw2	..	Range Selector Switch	8-position, single-pole (4 wafers)	
Sw3	..	Voltage/Current Selector	Cross-over switch	
Sw4	..	Bridge Multiplier Switch	4-position, single-pole	

Miscellaneous—2 Terminals, 6 knobs, 2 crocodile clips, wire, etc.

Calculation of Current Shunt

Let Rs be shunt resistance
Rm be internal meter resistance
N be current multiplying factor.

$$\text{Then } Rs = \frac{Rm}{N-1}$$

e.g.:

A meter of f.s.d. 1mA having an internal resistance of 100Ω is required to read up to 10mA. What is the shunt resistance?

$Rm = 100\Omega \quad N = 10$

$$Rs = \frac{100}{10-1} = \frac{100}{9} = 11.1\Omega.$$

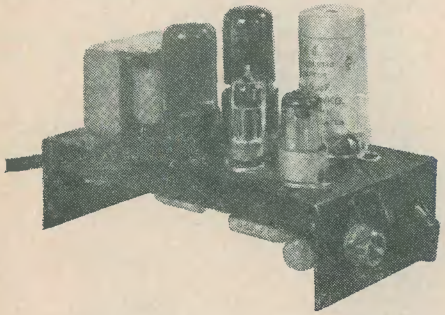
A, B, C and D, whilst on flange E the meter panel is fitted.

If G.K.N. anchor nuts are rivetted to the underside of flange E in line with the bolt holes, the meter panel can be fitted and removed at will quite simply.

Panel Layout

Most of the controls in constant use are placed on the righthand side of the panel to prevent obscuring the meter with the hand when changing range, although the disposition of the components is in no way critical.

THE "FULL-TONE" 8 Watt AMPLIFIER



PART 1.

by **M. HARVEY**

Another "Radio Constructor" Design For The Beginner

FOLLOWING THE SUCCESS OF THE "EASI-BUILD" Receiver, (published in the September, October and November, 1954, issues of *The Radio Constructor*), it appears evident that there is a considerable demand from readers for articles describing simple but serviceable items of radio equipment which can be constructed at home with the very minimum of tools and test gear. As readers may remember, the "EASI-BUILD" was a t.r.f. receiver which required no trimming adjustments at all after it had been completed. As soon as the last connection had been made, the set was ready to work.

The "Full-Tone" Amplifier

The "Full-Tone" Amplifier, described in this and the succeeding issue, is in the same category. This is a simple general-purpose amplifier capable of offering a high level of fidelity, and designed especially for ease of construction. No "trick" circuits are employed and, so long as the layout given in the instructions is followed, it should work correctly immediately it has been completed. Although a conventional test-meter is of use during the con truction of the amplifier (it being employed mainly to test for h.t. shorts, etc., before the power supply is connected up and switched on), such a meter is by no means essential. No other test gear at all is required.

A small amount of negative feedback is employed, this feeding back directly from the output transformer secondary to the cathode circuit of the input stage. This small amount of feedback is very useful, insofar as it flattens the response curve quite appreciably without being so large as to cause any instability when used in combination with the condenser-coupled stages which are, for simplicity, employed in the amplifier. The negative feedback has the secondary advantage of reducing any hum which may be caused by an insufficiently smoothed h.t. line from the power pack. Because of the feedback loop it is necessary to make temporary connections only between the output anodes and the speaker transformer tags during the period of construction. When the amplifier is completed these connections may have to be reversed to ensure that the feedback given is, indeed, negative and not positive. The procedure needed to check this point is extremely simple and takes only a few moments to carry out. This is the only process which is required that could be conceivably described as "setting-up".

Performance

The "Full-Tone" amplifier consists of a high-gain pentode feeding into a triode phase-splitter (actually a double-diode-triode with the diode anodes strapped to the cathode) and thence into the output stage. The latter comprises two 6V6GT's in Class A push-pull. (The phase-splitter does not, of course, provide any amplification). The two 6V6GT's are connected to a speaker transformer which is wound to provide two output impedances. One of these is at 3Ω, the other at 15Ω. The negative feedback connection is taken from the 15Ω tapping.

The power output of the amplifier depends, to a large extent, upon the h.t. voltage applied to it. This voltage may lie anywhere between 180 and 275 volts. At the lower voltage, the power output is approximately 4 watts. At 275 volts it is in excess of 8 watts.

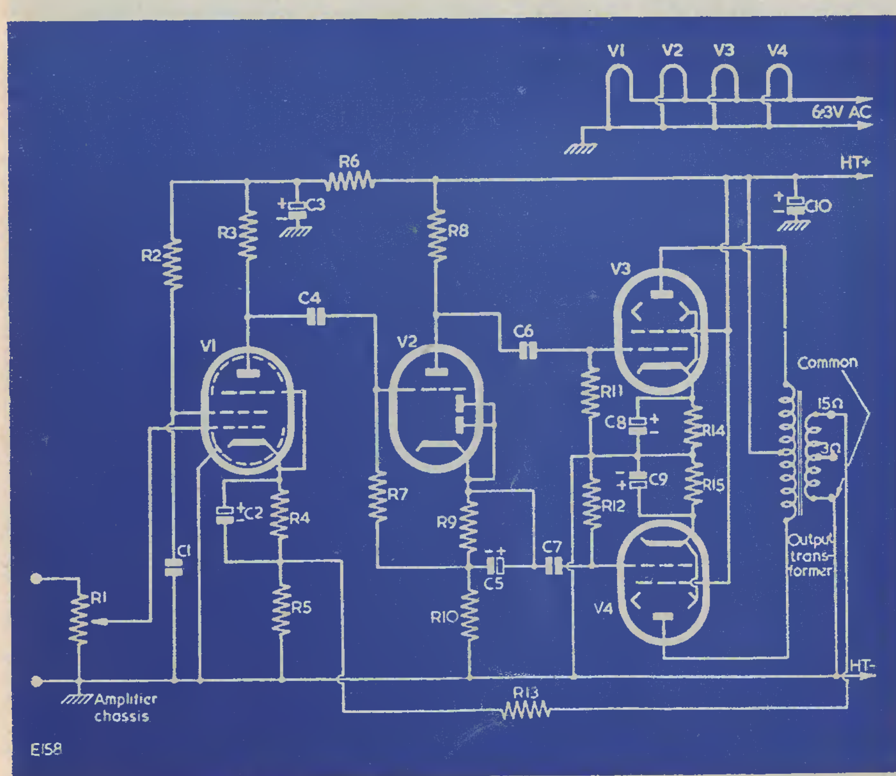


Fig. 1. Full circuit of the "Full-Tone" Amplifier

The "Full-Tone" is not intended to be considered as a "high-fidelity" amplifier (using the term in its un-debased sense as applied, to say, the Williamson amplifier) because, quite simply, it is not in the price class of such an amplifier. Nevertheless it provides excellent fidelity, giving an output whose quality of reproduction is well above the sort of thing one has grown used to these days, even from the better class of radiogram. The gain level is such that it will provide more than adequate volume if connected directly after the detector of an a.m. tuner, or the discriminator of an f.m. tuner. Tone control circuits are not included in the amplifier itself as it is intended that, if needed, such circuits be employed in a separate unit designed to suit the type of equipment feeding into the amplifier.

Components

Most readers who wrote to the author concerning the "Easi-Build" receiver stated that they appreciated the fact that manufacturers' reference numbers were given for the components. One correspondent, however, was critical of this procedure. His argument was that one could not walk into a "popular" radio component shop and buy all the components specified for the design straight off the shelf. He complained especially that, in his own particular shop, the essential coils and transformers were not available, and that he had to use alternatives. This was rather a pity, because both coils and transformers for the "Easi-Build" were, and still are, available direct from the manufacturers concerned by mail-order, as well as through retail sources. Indeed, the two firms supplying these components quoted mail-order prices, in their advertisements, in the same issues of *The Radio Constructor* as were devoted to the "Easi-Build!"

available both through retail sources or direct from the manufacturer by mail-order.

Whilst on the subject of components, a further item of interest is given by the fact that a Pye-type co-axial socket is recommended for the input connections. A socket of this type is excellent in this position since it allows the input lead to be fully screened all the way to the amplifier chassis. Pye plugs and sockets will be readily available from most stockists.

It may have been noted, also, that a plain valveholder is specified for V1 whereas a

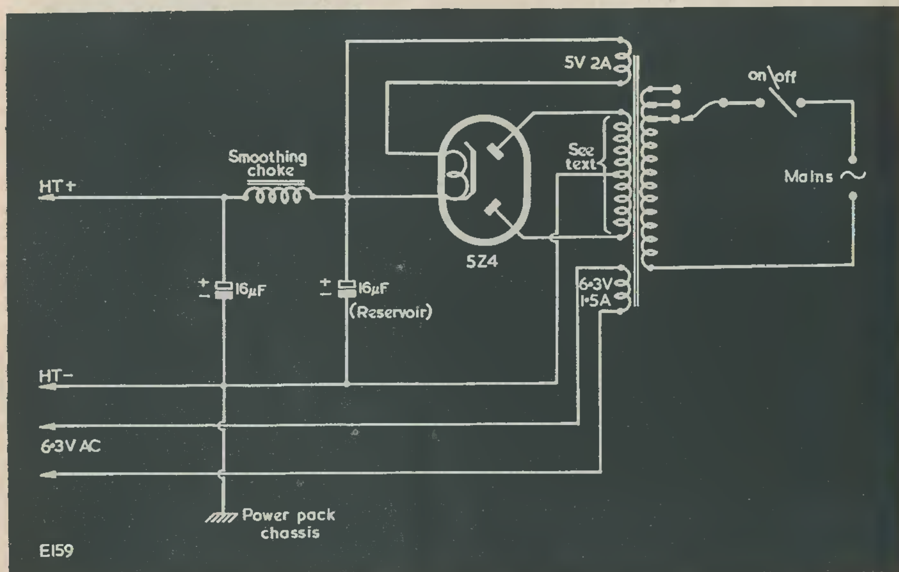


Fig. 2. A suitable power-pack for the amplifier. The smoothing choke may have an inductance of 8H or more, and should be capable of passing a steady current of 110mA. The mains transformer is discussed in the text

Where applicable, component specifications by manufacturer's name and reference number have, again, been given for the "Full-Tone." As with the "Easi-Build," constructors may use alternatives if they wish, but this course will not help to guarantee that the alternative components may not cause trouble due to altered layout and consequent short-comings in performance. The possible use of alternatives does not apply to the output transformer, however. The employment of a component differing from that specified is, indeed, somewhat inadvisable, since the circuit has been designed around it. The writer has been assured that the output transformer will be

valveholder fitted with a skirt (to take a screening can) is shown in the photographs. The choice of a plain valveholder is quite in order, since the valve types employed are fitted with their own internal screens.

A further point is given by the fact that an output socket for the speaker terminals is not specified, since it is intended that the speaker connection be taken direct from the output transformer tags themselves. However, should the constructor feel that he would prefer to fit such a socket, plenty of room has been left available for it on the rear apron of the chassis.

Finally, readers may be interested to learn that, by the time this article appears

in print, suitable chassis will be available, already drilled and cut to size, from an advertiser in this issue.

The Circuit

The circuit of the amplifier is illustrated in Fig. 1. As may be seen, it is quite simple and straightforward.

The input a.f. voltage is applied to the volume control R1, the slider of which connects directly to the grid of V1. V1 is a high-gain pentode whose output is fed, via C4, to the phase-splitting valve, V2. V2 works in a conventional circuit, a.f. voltages of opposing phase being built up across the two equal resistors R8 and R10. These voltages are next applied, via C6 and C7, to the output valves, V3 and V4. Two separate bypassed cathode resistors are used for these valves, this method of connection being found empirically to offer slightly better results than is given by a single cathode resistor for cases when the two valves are not too accurately matched. V3 and V4 feed into the output transformer which, as was mentioned above, has secondary tappings at impedances of 3Ω and 15Ω. A negative feedback loop connection is taken from the 15Ω tapping and applied, via the potentiometer given by R13 and R5, to the bottom of the bypassed cathode resistor of V1, thereby applying negative feedback over the whole amplifier.

It will be noted that especial care has been taken to ensure that the h.t. rail is adequately decoupled. For instance C3, which is half of a dual 16+16µF electrolytic condenser, ensures adequate decoupling for the anode and screen-grid of V1. Similarly, C10, the second half of this dual condenser, decouples the h.t. rail employed for the output valves and phase-splitter.

Incidentally, C10 is not fitted merely to improve the smoothing of any power unit which may be connected to the amplifier; it also performs the more important function of providing a low-impedance decoupling path, over short leads, between h.t.+ and chassis within the amplifier chassis itself.

The amplifier circuit does not include a power-pack. The reason for this is that it is presumed that most readers will either

Component List

Resistors (All ±20% unless otherwise stated).

R1	250kΩ, potentiometer, log law, screened, without switch
R2	1MΩ, $\frac{1}{4}$ watt
R3	220kΩ, $\frac{1}{4}$ watt
R4	2.2kΩ, $\frac{1}{4}$ watt
R5	33Ω, $\frac{1}{4}$ watt
R6	22kΩ, $\frac{1}{4}$ watt
R7	680kΩ, $\frac{1}{8}$ or $\frac{1}{4}$ watt
R8	100kΩ, $\frac{1}{4}$ watt ±5%
R9	3.3kΩ, $\frac{1}{4}$ watt
R10	100kΩ, $\frac{1}{4}$ watt ±5%
R11	470kΩ, $\frac{1}{8}$ or $\frac{1}{4}$ watt, ±10%
R12	470kΩ, $\frac{1}{8}$ or $\frac{1}{4}$ watt, ±10%
R13	6.8kΩ, $\frac{1}{4}$ watt
R14	250Ω, 1 watt, ±5%
R15	250Ω, 1 watt, ±5%

(*N.B.*—R8 and R10 may be ±20%, matched within 5% *of each other*. Similarly, R11 and R12 may be ±20%, matched within 10% *of each other*).

Condensers

C1	0.25µF, 350V wkg; T.C.C. Type 343
C2	50µF, 12V wkg; T.C.C. Type CE87B (Micromite)
C3	See C10
C4	0.05µF, 350V wkg; T.C.C. Type 343
C5	50µF, 12V wkg; T.C.C. Type CE87B (Micromite)
C6, 7	0.05µF, 350V wkg; T.C.C. Type 343
C8, 9	50µF, 25V wkg; T.C.C. Type CE88CE (Micromite)
C10+C3	16+16µF, 350V wkg; T.C.C. Type CE28L (with Clip No. S.3372).

Valves

V1	EF86, Mullard Z729, Osram (Also 6BR7, Brimar, see text).
V2	EBC90, Mullard DH77, Osram Or 6AT6, Brimar
V3, V4	6V6GT, Brimar.

Valveholders

1 B9A, plain, McMurdo type BM9/U
1 B7G, plain, McMurdo type BM7/U
2 Int. Octal, McMurdo type B8/U.

Transformer

1 Push-pull output transformer. Allen Components, type OP1348*

* *Anode to anode impedance* 10kΩ.

Plugs, Sockets

1 "Pye" co-axial socket
1 Plug for same

Tag-Strips

3 5-way, centre earthed, length $1\frac{3}{8}$in. (R. Davies, Swansea)

Chassis

Either home-constructed or obtainable from R. Davies, Swansea

Sundries

2 Grommets. d$_1$ $\frac{3}{8}$in.
Connecting wire, sleeving, etc.
4-way power cable.

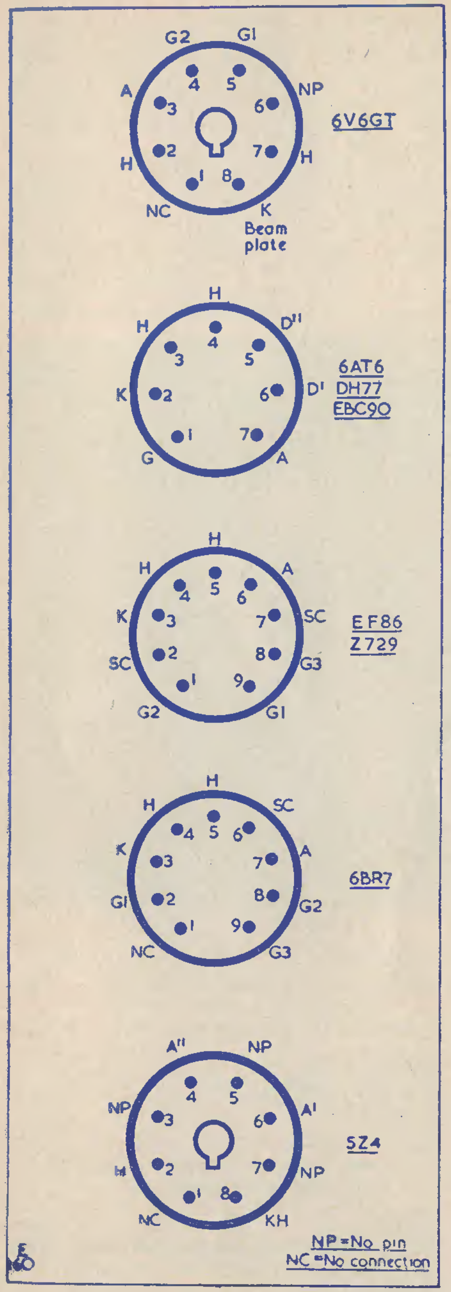


Fig. 3. Base connections of valves suitable for the "Full-Tone" Amplifier. (See text concerning the 6BR7)

have a power-pack, or power-pack components, already on hand. When it is separate from the amplifier proper, the power-pack is not at all critical so far as layout and components are concerned. It may, therefore, be built entirely to suit the constructor's own particular needs; and can employ any components which he already has or wishes particularly to obtain. The minimum output requirements from the power-pack are 6.3 volts a.c. at a current of 1.5 amps, and an h.t. supply between 180 and 275 volts. (See remarks above concerning amplifier output power). The h.t. current required at 180 volts will be a minimum of 80mA; at 200 volts, 90mA; and at voltages in excess of 225, 110mA.

A suitable power-pack circuit is shown in Fig. 2. (If desired, equivalent rectifier types may be employed in place of the 5Z4 specified in the diagram). Using the 5Z4 in the circuit of Fig. 2, a good-quality 250-0-250V transformer will supply an h.t. voltage to the amplifier in the neighbourhood of 270 volts, the increase in voltage over the transformer secondary r.m.s. value being occasioned by the 16μF reservoir condenser. A 200-0-200V transformer, on the other hand, will provide an h.t. voltage in the same circuit of approximately 205 only. An indirectly-heated rectifier, such as the 5Z4, is preferable to a directly-heated type since it helps to prevent excessive voltages being applied to the h.t. electrolytic condensers during the time that the amplifier valves are warming up after switching on.

Another point of importance is given by the 6.3V heater supply. One side of this supply is earthed in the amplifier chassis itself. In consequence, the heater supply must not be earthed at the power-pack chassis at all, or short-circuits, with consequent damage to the mains transformer, may result.

It is intended that the amplifier be connected to the power unit chassis by means of a flexible 4-way cable, preferably terminated in a suitable plug at the power-pack end, and whose length suits the constructor's requirements.

Valves

A few words concerning valves may not be out of place in this introductory article. As specified, the output valves, V3 and V4, are 6V6GT. There are, however, other equivalents of this valve in manufacturers' catalogues, and these may be used in place of the 6V6GT's if desired, so long as the h.t. voltage applied does not exceed the equivalent valves' maximum ratings. (If "metal" 6V6's are used, their pins No. 1 should be connected to amplifier chassis). The point-to-point wiring diagrams which are given in the succeeding article apply only to 6V6GT valves or to their *direct* equivalents.

V2 is, as specified, a Brimar 6AT6, an Osram DH77, or a Mullard EBC90.

V1 is specified as Mullard EF86 or Osram Z729. An alternative for this valve is the Brimar 6BR7. However, the pin connections of the 6BR7 differ from those of the EF86 and Z729, with the result that this valve could not be plugged *directly* into a valve-holder wired up for one of the other two valves. The point-to-point wiring diagrams which follow apply to the EF86 or Z729 only.

Fig. 3 gives details of pin connections for the valves mentioned.

Next Month

In next month's article, constructional details of the "Full-Tone" amplifier will be given.

Can Anyone Help?

Dear Sir —May I request as a regular reader if anyone has a copy of the B.21.A Tuner Amplifier manual, or circuit diagram, which I could borrow or purchase.—H. Shannon, 1 Orcades Green, Walney Island, Barrow-in-Furness.

* * *

Dear Sir,—May I take this opportunity of using your service to find out whether any reader can help me. I have just acquired a BC348/J receiver, and would like help from anyone who has a circuit or information on this type of set. I will reimburse anyone for the expense involved in sending circuit on loan or for sale. I wish to convert for mains use.—J. E. Howard, 48 Hazledene Road, Chiswick, London, W.4.

* * *

Dear Sir,—May I appeal through your columns for the circuit or, preferably, service sheet of the Gamages 49 model radiogram for a.c. mains. I would gladly refund costs and expenses.—S. W. J. Green, 6 Elmwood Avenue, Baldock, Herts.

* * *

Dear Sirs,—Over the past three years I have tried to obtain data for my Romac TV189 TV set, without success. Can any reader please help me?—G. Caunt, 11 Crescent Green, Kendal, Westmorland.

* * *

Dear Sir,—May I appeal through your "Can Anyone Help?" columns for information as to where I can obtain a circuit diagram of the R.C.A. Monitor Amplifier type 8L/C4, or any details on connections to the output transformer. This amplifier uses four 6J7's, two 1622 in push-pull, and a 5U4G rectifier. —M. Halvey, 16 Fleetwood Road, Norbiton, Kingston-on-Thames, Surrey.

Dear Sirs,—Can any reader help our school radio society with information on converting the 1191A Wavemeter to work on a.c. mains, using 6.3V valves?—C. W. Sutcliffe, Handicrafts Master, Greenford County Grammar School, Ruislip Road, Greenford, Middx.

* * *

Dear Sir,—Would you allow me space to ask if any other reader can lend, or preferably sell, the circuit of the Indicator Unit type 184A.—J. H. Dewhurst, 100 Railway Road, Adlington, near Chorley, Lancs.

* * *

Dear Sir,—I have a German A.E.G. set which to me is sacred, but I am in trouble with the valves, which I am told cannot be obtained in this country. Has anyone a set, new or used, please? They are Telefunken AL4, AH1 and AF7. Full cash sent.—R. Clapp, 16 Market Hall, Kington, Hereford.

* * *

Dear Sir,—Could any of your readers help me by supplying the circuit of the "Eddystone All-World Eight" battery communications receiver, please? J. Heinrichson, 21 High Street, Annan, Dumfrieshire.

* * *

Dear Sir,—Can any reader supply me with the manual for the receiver type DST100 Mark II. I am willing to purchase.—W. Shaw, 31 Boris Crescent, Great Moor, Stockport, Cheshire.

* * *

Dear Sir,—May I ask if anyone has details of the plug connections on the Canadian Wireless Set 58, Mk. 1, i.e. the battery Rx and Tx h.t. leads, which are separate. I have traced the wiring and have the set working, but would like to check. Any expense will gladly be refunded.—J. Wilkinson, "Fern-Royd," 113 Meadow Lane, Coalville, Leics.

(continued on page 625)

A PROGRESSIVE RECEIVER

PART 2

by A. S. CARPENTER

Stage 2

To complete the receiver the following additional components are required:—

C19 50pF (mica)
C20, 21 0.1μF (350V)
C16, 17 50pF compression type trimmers
C18 200pF
C22 25μF, 12V (Bias)
R11, 12 1MΩ, $\frac{1}{4}$ watt
R13, 14 500kΩ $\frac{1}{2}$ watt
R15 1kΩ, $\frac{1}{2}$ watt
One Osmor Coil type QA9
One Osmor Coil type QO6
One WX6 Metal Rectifier (V6)
One IO Valveholder
One 6SH7 (V7)
One 2-pole, 2-way Yaxley type switch

Fit the wavechange switch in position, and also the IO valveholder, in the holes already drilled out during Stage 1. Next, fit the QA9 coil close to the medium wave aerial coil and the QO6 coil close to the medium wave oscillator coil.

Now rewire the frequency changer circuit of V1 until it conforms to that shown in Fig. 3. This is not as complicated as it may appear. Break the wiring at point 'B' (Fig. 2), and connect one pole of the wave change switch to the top cap of V1 and also to the aerial section of the twin gang condenser. Note that the primary windings of the two aerial coils are in series. This saves complicating the switching somewhat. The 'top' ends of the aerial coils are connected to their respective positions on the switch and the two 'bottom' ends of the secondaries are connected together to C1, R1, which are already in position. A 50pF trimmer should be fixed across the long wave aerial coil secondary.

The oscillator section can now be tackled. Break the wiring at point 'C' (Fig. 1) and connect C7 and the oscillator section of the twin gang condenser to the other pole on the wavechange switch. A 50pF trimmer (C17) can be wired across the long wave oscillator coil. Note that the 'bottom' ends of the two oscillator coils are connected to C9 (already in circuit). The 'top' ends are connected one to each terminal of the wavechange switch, but a 200pF (C18) should be put in series with the QO6 coil. The recommended padding condenser for this coil is 150pF. C9 is therefore too large, and C18 must be put in series with it to reduce the overall capacity.

When all this has been completed, the receiver may be tested out and the long wave coils lined up. *Do not alter the settings of the IFT cores.* Trim with the new trimmers and pad with the cores.

Fitting the AVC

Firstly, disconnect R1 from chassis at point 'E' (Fig. 1) and fit the additional components as shown in Fig. 4. The 'bottom' ends of the aerial coil secondaries should now be connected to chassis via R1, R12, R11, in that order. Make sure that this is so, otherwise V1 will not receive its correct bias. This part of the circuit operates as follows: Part of the IF present at the anode of V2 is fed, via C19, to the small rectifier (V6), the cathode (red end) of which is held positive with respect to chassis by virtue of the voltage drop across R10. V6, therefore, is held in a non-conducting condition until the peak IF applied to its anode exceeds that of its cathode, when it conducts and a negative voltage is developed across R11. This is smoothed by R12 and C20 and fed back, through the aerial coils, to the grid of V1, so reducing its gain. If the peak IF applied to V6 is less than the delay voltage, then the AVC is inoperative, so enabling full sensitivity to be regained.

Before proceeding with the alterations it may be as well to once again try out the receiver to make sure all is well.

Incorporating an LF Stage

The circuit diagram is shown in Fig. 5. It consists of a 6SH7 triode-connected, and used as such will give a large amount of low frequency amplification. Lead 'D' (Fig. 1) is now taken to pin 4 on this valve and the output developed across R13 is conveyed, via C21, to the grid of V4, R14 being used in order that the output valve may receive its proper bias.

This is quite a straightforward stage to fit, but note that pin 8 is the anode and that it is situated between pins 1 and 7. Pin 1 is the valve metallising and pin 7 the heater, so take care. These remarks also apply to V2, of course.

Conclusion

Either or all of these modifications may be carried out irrespective of the other. The AVC circuit can be used and the LF stage omitted, or *vice versa*. Also, the long waveband may not be required in the user's locality. If, however, all the additions to Fig.1 are made, a powerful receiver will result.

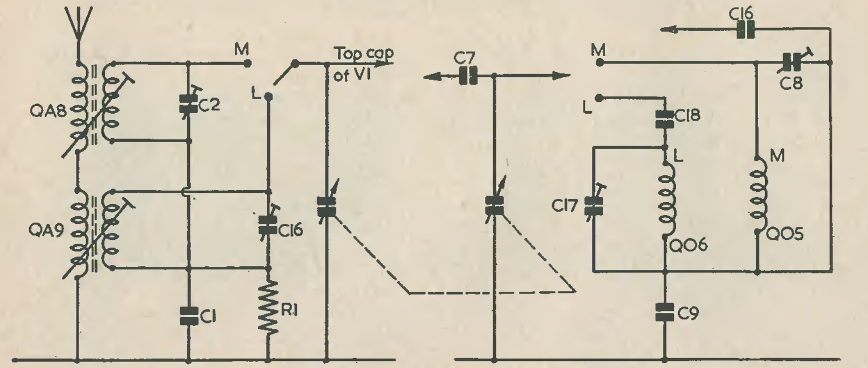


Fig.3

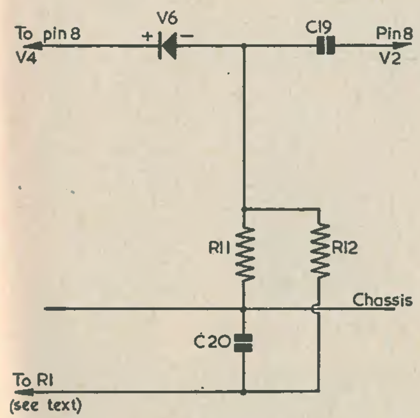


Fig.4

E161

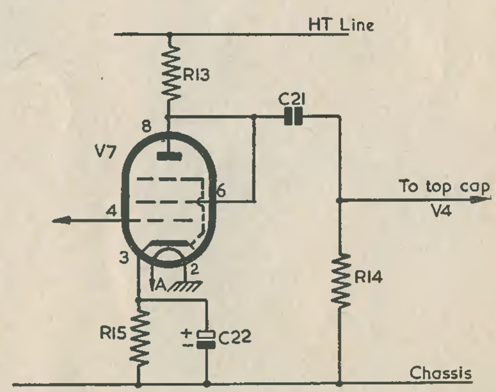


Fig.5

NOTES ON RADIO CONTROL

7: *A Crystal Controlled Transmitter*

by QUENCH COIL

HAVING WORKED OUR WAY, SO TO SPEAK, through the simpler types of transmitter, we will now consider what one might term the "ultimate" in radio control transmitter design. There is no doubt that whilst crystal control of the transmitter frequency does add complications to the circuit, the consequent freedom from worry that the transmitter is not operating within the radio control frequency band is well worth the extra effort needed in construction.

The circuit consists of two valves, the first a type 3A5, being a double triode—really two valves in one—and the second being a type 3A4.

The first half of the 3A5 is the crystal oscillator section, oscillating at 9Mc/s, a crystal for this frequency being connected up as at X1 in the circuit diagram. The second half of this valve is wired up as a tripler circuit, the inductance L_2 and capacitor C_4 in its anode circuit being designed to tune to 27Mc/s. This 27Mc/s output is fed to the second valve via capacitor C_6, being amplified up to a worth-while signal.

The first section of V_1 generates a number of frequencies from the 9Mc/s crystal, i.e. the fundamental as well as numerous harmonics. The second section, by reason of the tuned circuit L_2C_4, selects the third of these harmonics, that is the one on 27Mc/s, thus providing a stable frequency for the transmitter to work on.

As both L_2C_4 and L_4C_8 are operating at the same frequency, these two tuned circuits must be carefully isolated from each other. This is done by dividing the chassis on which the unit is built into two compartments by a metal screen, the components constituting L_2C_4 being in one of these compartments, and the components forming L_4C_8, together with those associated with V_2, being located in the other compartment.

The chassis itself should be of good quality tinplate, 7in × 4in × 2in deep and, as already stated, is divided by a screen across the centre, the screen being soldered in position, not bolted. The position of valves and other components is shown in Fig. 2. The two variable capacitors C_4 and C_8 have to be insulated from the chassis. The easiest way to arrange this is to fix a polythene or paxolin panel to one side of the chassis, either cutting out this side of the chassis entirely, or cutting holes in it sufficiently large to clear the capacitors. The keying chokes, valves and crystal are the only components which are

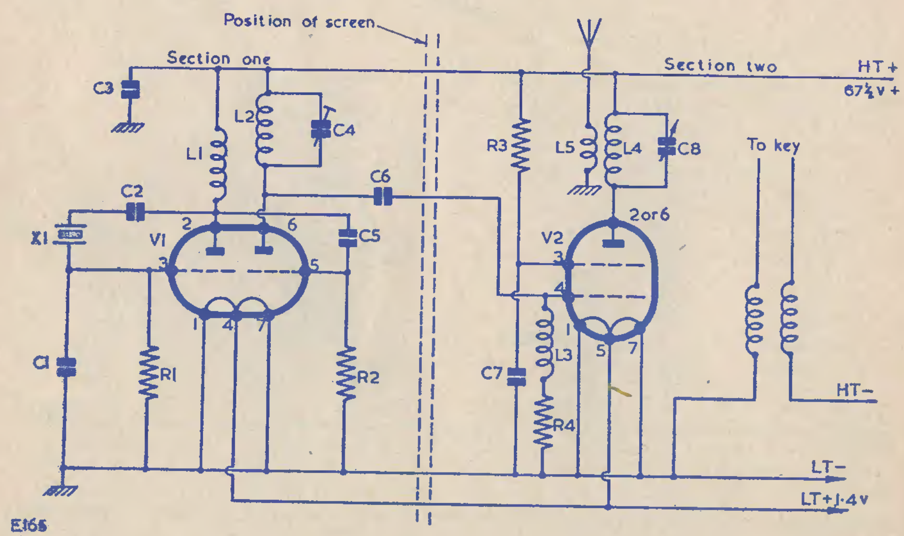


Fig. 1. Circuit of the Crystal Controlled Transmitter

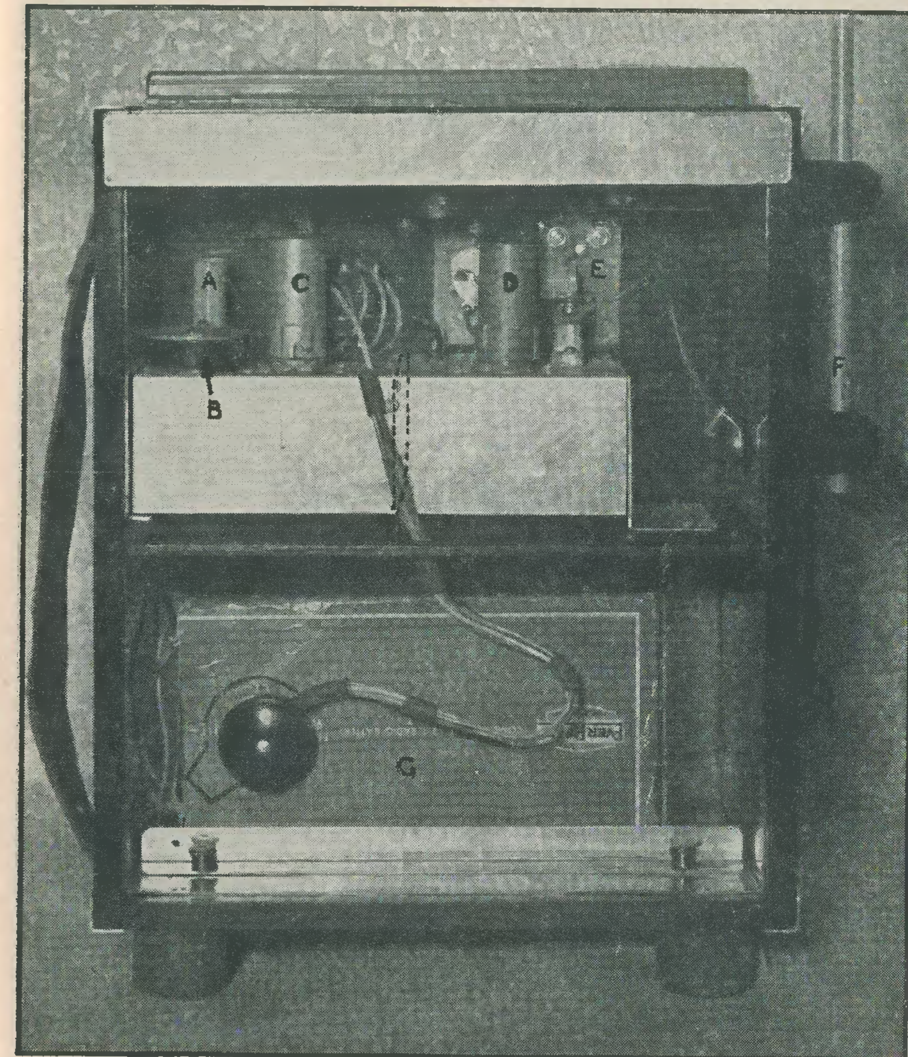


Fig. 2. Rear view of complete Transmitter. Note the clean layout. Key to Notation: A, keying chokes; B, crystal; C, 3A5 valve; D, 3A4 valve; E, built-in wavemeter; F, aerial; G, h.t.-l.t. battery. Size of chassis 7in × 4in × 2in.

mounted on top of the chassis, everything else going beneath in one or other of the compartments. The insulated panel already referred to can be made sufficiently large to fill the front opening of the case, when the meter, etc., can also be mounted on it. Alternatively, this panel can be fixed directly to the cabinet, extension spindles being fitted to the variable capacitors.

As symmetrical a layout of components should be arranged as possible. Wire up with 22 s.w.g. tinned wire and sleeve where possible. Twist all battery leads together and keep short.

Coil Data

Coils should be constructed as already indicated in previous articles. L_2 consists of 10 turns of 16 s.w.g. tinned copper wire wound on a $\frac{5}{8}$in diameter former, the winding extending about $1\frac{1}{8}$in long; L_4, 11 turns 16 s.w.g. tinned copper wire on $\frac{3}{4}$in former, length of winding again being $1\frac{1}{8}$in. The aerial link coil L_5 should consist of two turns of insulated wire around L_4, one end being taken to an earth tag on the chassis, the other going to the aerial socket. Make sure that the link is wound in the same direction as the coil windings. Some experimenting may be advisable with regard to the number of turns of the link coil and its actual position on coil L_4.

Keying Chokes

Two keying chokes should be fitted in the leads from the keying switch, as shown in the circuit diagram. They should be wound on polythene formers $\frac{1}{2}$in diameter, $1\frac{1}{2}$in long, with 30 s.w.g., s.c.c. wire, close wound. The two chokes should be mounted side by side on the top of the chassis.

Tuning Up

With this type of transmitter the frequency is set, as we have said, by the crystal. On first switching on, oscillation will take place in V_1 if all is well. To check that this is happening, place the loop of a lamp-loop over the end of L_1. A lamp-loop consists of a flash lamp bulb, to the terminal points of which has been soldered a single turn of insulated wire. This will pick up enough radio frequency energy to cause the lamp filament to glow and thus indicate that a circuit is oscillating.

Having checked that the crystal is functioning properly, L_2C_4 must be tuned to 27Mc/s by means of a wavemeter as described before. Once this circuit is functioning properly the final circuit L_4C_8 can be similarly tuned, the aerial not being connected to start with. Tuning L_4C_8 will produce a drop in the h.t. current as read on the meter, and coupling up the aerial should produce an increase in this current. With full length aerial fitted, the current reading should be about 30mA, with 90 volts h.t. supply.

The Case

Details of the case can be seen from the photos illustrating this article. In the writer's case, aluminium lined wood was used, as the writer is a much better carpenter than metal worker! At the same time it is a cheaper method of construction. The actual size and type of case can, of course, be left to the individual requirements of the constructor. That shown will act as a guide to the general plan to be followed, and the sizes given will prove adequate to house the transmitter and batteries.

Component List

C1	10pF ceramic, Erie
C2	100pF ceramic, Erie
C3	0.1μF 350V, T.C.C.
C4	5–50pF air-spaced trimmer
C5	50pF 350V mica
C6	100pF 350V mica
C7	0.01μF 350V T.C.C.
C8	5–50pF air-spaced trimmer
R1	33kΩ type 9, Erie
R2	47kΩ type 9, Erie
R3	2.2kΩ type 9, Erie
R4	33kΩ type 9, Erie
X1	9Mc/s crystal
V1	3A5 (Mullard DCC90 direct equivalent)
V2	3A4 (Mullard DL93 direct equivalent)
L1	2.5mH R.F. choke
L2	10 turns, see text
L3	2.5mH R.F. choke
L4	11 turns, see text
L5	Aerial loop, 2 turns around L4

TELEVISION SOCIETY PREMIUMS

The Television Society has awarded the following Premiums, value £5 each, for outstanding papers read before the London meetings in 1954:

The "Electronic Engineering" Premium: To Dr. G. N. Patchett of Bradford Technical College, for his paper on "Problems of Interlacing."

The Mullard Premium: To Messrs. G. B. Townsend, E. Ribchester, and D. Bauer (G.E.C.) for their paper on "An Investigation of the 625-line C.C.I.R. System."

The E.M.I. Premium: To Messrs. R. J. Boddy and C. D. Gardner (E.M.I. Research Dept.) for their paper on "An Industrial Television Channel."

A special premium for the Society to Mr. G. G. Gouriet (B.B.C. Research Dept.) for his papers on "Colour Television."

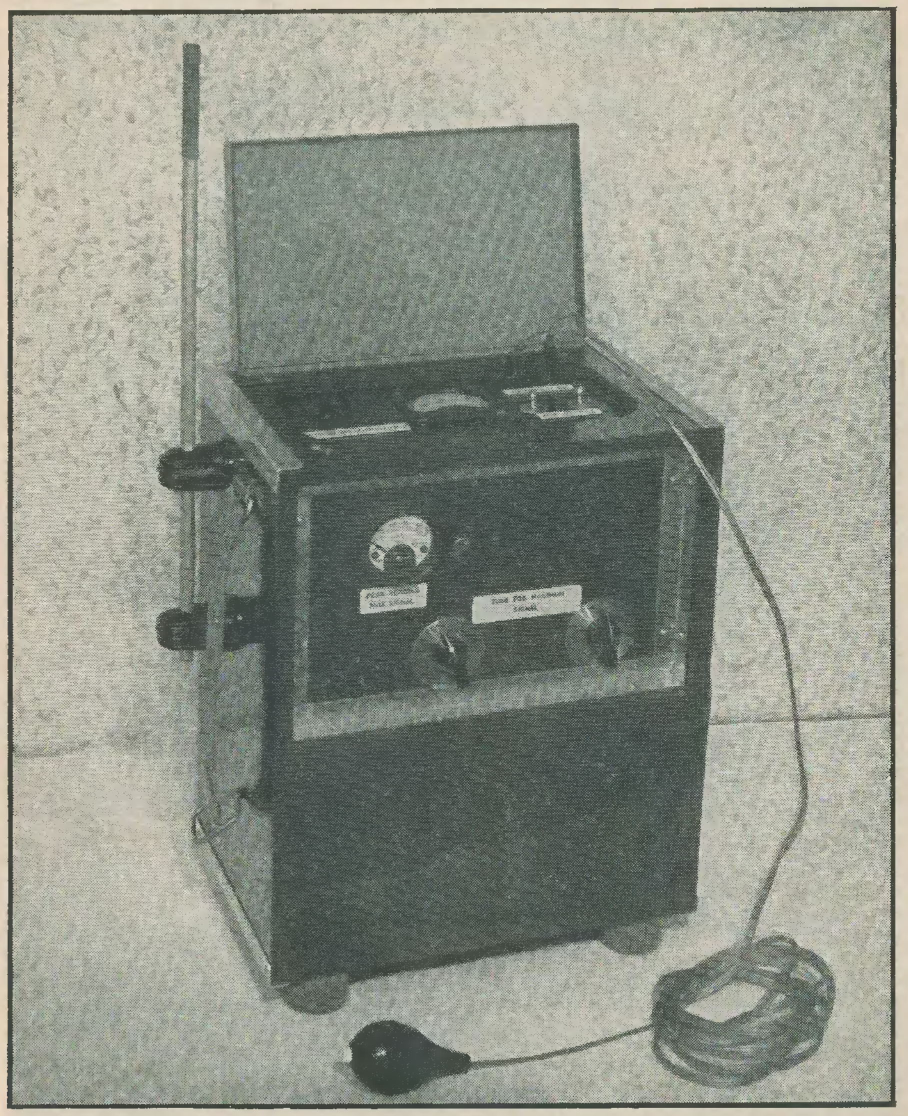


Fig. 3. Front view of Transmitter, taken before the front panel lid was fitted. The dimensions of the case are $11\frac{1}{2}$in high, $9\frac{3}{4}$in wide, and $6\frac{1}{2}$in deep, and it stands on four rubber feet. The carrying handle is in two lengths fixed to the sides, and secured in the middle by a buckle. The opening in the top measures $7\frac{1}{2}$in × $4\frac{1}{4}$in, the panel fitting in from underneath, and it is covered by a metal lid. The front opening measures 9in × $5\frac{3}{4}$in deep, also covered by a metal lid, and the panel of insulating material fits from inside. The aluminium angle is $\frac{1}{2}$in × $\frac{1}{2}$in. The meter is part of the built-in wavemeter. Underneath it is the dial and knob of C_8, and to the right those of C_4.

Radio Miscellany

CENTRE TAP *talks about* CUTTERS SPRAY GUNS NO-AERIAL TV

That no one has yet consciously written a best-seller is a truism. Authors simply write books, and one, for no predictable reason, suddenly happens to catch on and begins to sell like wildfire. Something of the same thing occurs in column writing. When I was less experienced I used to think to myself after writing on some controversial point, "I'll bet somebody has something to say about *that*." Invariably nobody raised an eyebrow. Then, perhaps in the very same column, an item which I felt was a minor point would create quite a stir.

This sort of thing once again happened to me a couple of months ago, when I wrote of the remarkable cutting power of a combined wire stripper and cutter. Actually I was relating what I thought to be a humorous little incident. Almost before the printer's ink was dry, the Editor began to receive enquiries from readers (a couple of them even telephoned) to ask who made them. The next we heard was from the makers. A reader sent to them to know if theirs were the cutters I was referring to—if so, he'd take a pair! Would I please confirm?

As a consequence I have had a caution telling me next time I write anything which is going to cause such a fuss, to be careful to mention the make so as to reduce unnecessary work.

Readers are warned that any cracks about this column containing as many "plugs" as a commercial TV programme are entirely undeserved.

P.S.—I nearly forgot to include the name of the cutters once more! They were the "Bib," manufactured by Multicore Solders Ltd.

All over the Place

In previous years I have confessed to a seasonable weakness for spring-cleaning the workshop and shack. Fortunately it doesn't recur every year. It just comes at irregular intervals—possibly after a bad winter. Thus it came this spring, extra early. The attack came on after reading a convincing advertisement for a super spray gun. I seem to have sampled every sort of crinkle finish there is, and the fancy came over me for some of the lustrous unfingermarkable coachwork finishes one sees nowadays.

Already I am going to break the new rule. I am not divulging the name, simply because it is the only home spray gun I have ever handled, so I don't know whether it is better or worse than the average. Perhaps it is only my ignorance, but I have a notion that it is not the gun that is so important, as much as the paint.

I have for some time been the owner of a double-action footpump—one which pumps on both the upward as well as the downward stroke. Although it cuts out half the labour it costs three times as much as the ordinary sort, so it cannot be claimed as a real bargain. Except, of course, for its snob value. This can be quite a bit if you can only find the right moment to put it across your pals.

Spraying enamels cost quite a bit. The chap who wrote that advert. about the gun forgot to mention that, or about the primer surfacer. However, my first project was to spray a few lightly rubbed-down enamelled surfaces, so I was able to charge up with the real stuff and connected up the pump. A couple of beefy jabs and the gun sent out a jet like a flame thrower. Obviously the first thing one must learn is just how far to stand back. This, in turn, requires the user to gain some proficiency in the matter of markmanship.

At the moment of writing I am on my third lot of enamel; and although the family still dive for cover when the gun comes out, that is only their idea of being funny. Indeed, I shall soon be reasonably sure of getting some 25 per cent of the spray on the target area.

After reckoning the cost of the gun (without the pump) it works out to very little more than four times the expense to do a job than

to have it done professionally. Still, it is good fun and, naturally, the more you use it the cheaper the rate. Like the old lady selling the oranges who said, "It's not what you lose on each one that matters. It's the number you sell."

Thinking, too, of publishers, also recalls the old farmer who bought a disappointing book and then bitterly complained: "The chap as writ the advert. ought to writ the book." To this I would add the chap who thought up that spray gun advertisement ought to explain how much paint you want to learn to use the wretched thing. Most of us buy our experience the dear way, which is why radio sometimes unfairly gets the reputation of being an expensive hobby.

Yeoman Service

The skyline of TV aerials to be seen in and near the fringe areas makes an unsightly array at the best of times, but after the winter's rough weather they are apt to become a positive eyesore, as well as a possible source of danger should they collapse. The erection of a normal "H" aerial costs several pounds, and for every foot they are pushed nearer the clouds the cost goes up by leaps and bounds—as well as increasing the risk of having the elements askew after high winds.

Many purists would like to see TV aerials done away with altogether, and the recent press reports of the disappearance of the aerials on the living quarters at the Tower of London has been eagerly seized upon as a sign that all aerials might be out of sight if only somebody "did something" about it.

True, an unsightly collection of aerials projecting at all angles from the Tower is very much out of character with the building's historical associations and with national dignity. Fortunately, the Ministry of Works were well able (at the taxpayers' expense) to arrange for an invisible master aerial and distribution amplifier. The cost, of course, was beyond what anyone could be expected to pay for, say, a private block of flats.

The work was carried out by E.M.I. and entailed the use of nearly half a mile of lead-covered cable, and a couple of roads had to be dug up. Nor was that all. The Tower is still supplied by d.c., so a rotary converter to power the distributor amplifier had to be installed. In all, this was quite an undertaking and is, I hear, working very successfully. Naturally, *all* these difficulties would not be encountered on other sites, but "doing away" with TV aerials is not so simple (or cheap) that it is likely to become general—just yet!

Crystal Gazing

Chatting with a few friends over a pint, we discussed the elimination of outside TV aerials altogether, which subject soon led us round to arguing about the finality of design of television receivers. Any form of mechanical system, of course, we dismissed out of hand. CRT projection methods received some support, but were voted out because they will be expensive and "tricky" to bring to a standard high enough for colour viewing in bright daylight. They would also be bulkier than the ideal demanded.

Any attempt to look into the future must take into consideration not only colour, but 3-D. The complication of circuits of present-day colour TV receivers (for those who have examined them) almost makes one feel giddy. To superimpose on top of that a second picture to obtain a stereoscopic effect would require an enormous number of valves or transistors.

We eventually decided the approach must be something simpler than that. After several pints we visualised the future TV receiver as taking the form of a specially prepared surface consisting of a mosaic of a million or so spots which, when electrically excited, will glow in three colours in their proper lineal (and colour) sequence. But, seriously, development on lines of this sort is well within the bounds of early possibility. Indeed, to anyone who has studied the crude beginnings of television (from the disc scanning of thirty years ago) it will seem less of an advance than we have made to the existing type of set.

Then, of course, we shan't need outdoor aerials at all—except in the wide-flung fringe areas—and historical buildings will be safe from disfigurement.

INDOOR TRANSMITTING AERIALS

by O. J. RUSSELL, B.SC.(HON.) G3BHJ

HAVING CONCLUDED A PERIOD OF SOME five months of "/A" operation using an indoor transmitting aerial, it is clear that a few words on this neglected subject are in order. In these days of restriction and housing shortages, there must be many potential and actual holders of a ticket who are faced with special difficulties in the realm of aerial erection. In many cases, due to living in rooms, or flats, it is impossible to consider hanging even the most modest skyhook out of the window, and the outlook may appear black. However, as in the case of unavoidable QRP operation, those who are determined to put out some signal whatever the difficulties may be agreeably surprised at the results.

We must first consider one or two points connected with the simpler aspects of indoor aerials. So much could be written on the subject, that to cover the aspects even partially would require several articles. However, the following points may be taken as "first steps" in the subject. The ideal, of course, is to get up at least a resonant length of wire, for earthing difficulties if one is in a flat or room render Marconi and similar "against-ground" aerial systems an uncertain and difficult proposition in most cases. The possibility of centre-feeding a resonant length of wire is also of some help as a discrimination against harmonics, and centre-fed systems have other advantages, not to mention the important fact that BCI troubles appear to be less frequent than with end-fed systems. This may appear to be a counsel of perfection, except upon 10 and 2 metres, where a resonant length is not impossible to obtain even in a very small room. In some rooms, however, even on 10 metres, it is not possible to put up a straight stretch of wire, and it is necessary to let the excess length hang down vertically. For 10 metres, however, a vertical length of wire allowed to hang from the window, is nearly always possible . . . except perhaps for the basement dweller who has our heartfelt sympathy!

Even such limited arrangements have their disadvantages, however. A 10 metre length of wire slung across the room is definitely not likely to meet with the approval of the average landlady, and the picture rail must be employed as a more discreet support. With the restriction of wire necessarily concealed behind the picture rails, the outlook for bands lower than 10 metres would appear hopeless; but by employing known facts about aerials, it is possible to operate on 40 metres with a resonant aerial, and on 80 and even 170 metres with loaded aerials. We must consider carefully the following points about aerials, as the writer was forced to do, before neglecting the lower frequency bands.

It is not generally realised that a 40 metre dipole of, say, 67 feet in length, centre-fed with quarter wave feeders, is actually an 80 metre half-wavelength if we include the feeder length. We have two feeder wires each of 33½ feet, so that the overall length of the system is 134 feet, which is just a half-wave at 80 metres. The system can be imagined as derived from an 80 metre half-wave dipole, in which the centre portion has been folded in to make the feedline. Such a system will resonate overall as a half-wave at 80 metres, and will require current feed, that is a series tuned circuit at the end of the feeders, to transfer power efficiently. This point is very often overlooked and should be stressed more in antenna handbooks, for such a use of an aerial apparently at half the resonant frequency of the top is actually quite efficient. It is generally to be preferred to operating the system against ground as a Marconi for 80 metres, with the feeders tied together, again because the symmetrical centre-feeding is highly advantageous. Those who have normal 40 metre doublets with suitable feeder length, should try a series tuned aerial feeding circuit for 80 metre operation. Having used powers from 1½ watts upwards on such a system, it is confidently recommended for normal outside aerial working.

Such a use is strangely enough often overlooked, particularly as the need for a series tuned aerial circuit is not considered, and attempts to use a parallel circuit will not succeed. On the top fundamental and harmonics, of course, such a system is exclusively voltage fed from a parallel tuned circuit. The change to a series tuned circuit for 80 operation is so simple that it is hoped those with normal aerials who are in difficulty will try it. This little considered point about aerial systems with tuned feeders has to be realised. In a tuned feeder system it is not possible to separate the feeder portion and the radiating top, as they are in fact together one resonant system. The obsession of getting a resonant top, and then adding a resonant feeder, completely overlooks the fact that the top can be any length, provided that the total length of wire in the system adds up to a resonant length. Thus the normal half-wave 40 metre aerial with its quarter-wave two-wire feed line is actually an 80 metre fundamental resonant system. Once this fact is grasped, we can free ourselves from the tyranny of using exactly resonant lengths of radiating top, provided that the total system is of the right resonant length. This is of considerable importance to any amateur who has restricted space, for quite obviously the simplest resonant system for 40 metre operation is actually a 20 metre half-wave fed with quarter wave feeders. This would have a 33 foot top, say, with a 17 foot length of tuned two-wire feeder. There would be nothing to stop the top length being, say, 47 feet, and the feeder length 10 feet, or the top being reduced to, say, 25 feet, and centre-fed with 21 feet of two-wire line, as the total resonant length remains unaltered at 67 feet. To a writer of text-books on aerials, such points are of little importance, but to the amateur who has to make the best of circumstances they are of primary importance. In any case the radiation patterns are very little different from conventional dipoles, and the efficiency may actually be higher in cases where the top length is greater than a half-wavelength. The practical difference is not worth worrying about, especially in cases where such systems represent the solution to putting up a reasonable system as against an odd length of wire. In any case the fundamental resonant length is unaltered, only the amount used as the radiator is, and this flexibility is of importance in all cases where aerial difficulties are encountered.

We can now see that any amateur faced with restricted space can effect a certain degree of control over the actual radiating length of wire employed, more especially when the special case of indoor operation is considered. Assuming that we are restricted to the picture rail as the support for an aerial which must be unobtrusive, there is one

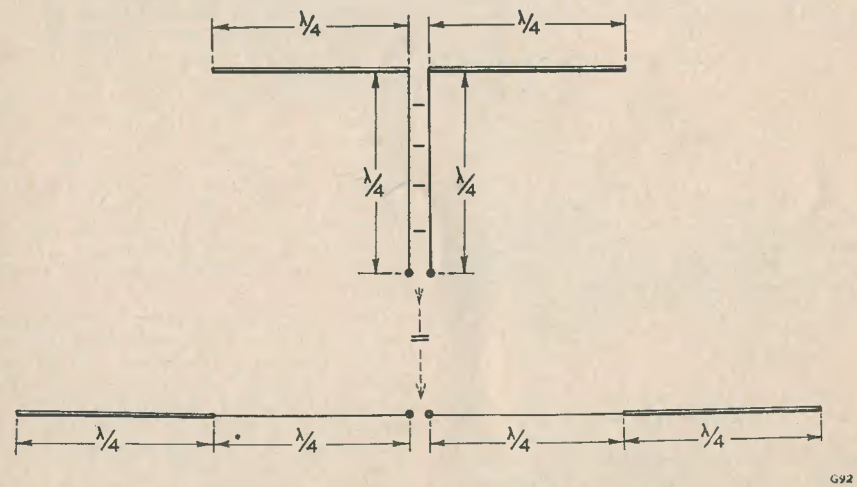


Fig. 1. The half-wave top centre-fed with quarter-wave feeders totals one full wavelength of wire, so that the whole system may be resonated with current feed at half the frequency of the top. A 40-*metre doublet with quarter-wave feeders can be used in this way as an effective* 80-*metre radiator. Why not try it?*

type of aerial that can form a basic type for discussion. This is the square aerial, in which a half-wave of wire is bent into a horizontal square, and can be centre-fed. Such a system can be made to fit more or less into a room. A 20 metre system of this type will just about fit an average small room, and it should be noted that the radiation efficiency is equivalent to a normal dipole. Naturally, for indoor operation, the efficiency of any aerial will be affected by proximity effects, partial shielding, etc., so that full outdoor efficiency is not to be

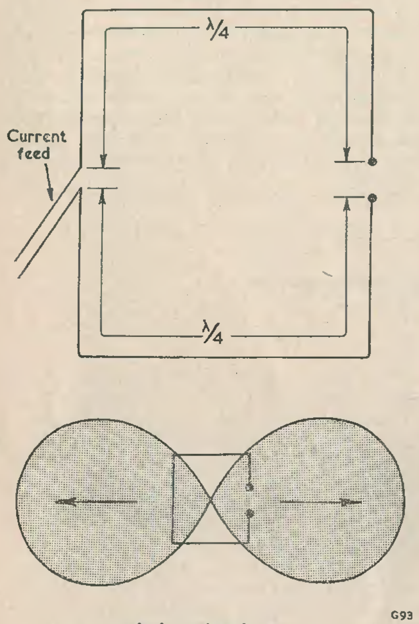


Fig. 2. The square dipole. A half wave-length of wire arranged as a horizontal square loop. It can be centre-fed as shown. Ideal for a "picture rail" indoor aerial

expected; but with reasonable care, results from a system of this sort can be very little different from a conventional outdoor antenna. Due to the closeness to the walls, some adjustment of the resonant length may be necessary, but this is relatively easy when the transmitter tuning controls and aerial circuit are, together with the aerial, all within easy reach . . . perhaps the only real advantage of an indoor system! The directivity is bi-directional along the line joining the centre to the open ends, and closely resembles that of a normal dipole, so that the aerial can be lined up for radiation in a desired direction. However, in this connection, remember that the open end is the "hot" end, and should be kept away from waterpipes or other metallic bodies if possible.

The above system, if arranged for 20 metres, would be centre fed by a quarter-wave tuned line, and this would require voltage feed from a parallel-tuned aerial circuit, which could be link coupled to the transmitter tank. Such a system, as we have previously seen, would actually be basically resonant at 40 metres, providing we series-tuned the aerial circuit. So far so good, but due to space limitations, even this may not be fully practical. The following solution has been adopted at G3BHJ/A. Starting with a resonant 66 feet of wire, 20 feet were combined into 10 feet of spaced tuned feeder. This left 46 feet of wire, which was carried round the picture rail. Instead of forming the full loop, which was impracticable, the remaining lengths were allowed to hang down from opposite walls. Actually a few odd feet were left lying on the floor at each end, although this is concealed from view. The object of leaving the vertical hanging sections is that they will form an out-of-phase pair of vertical elements which are expected to add useful radiation when operating on 10 and 20. So far operation has been restricted to forty metres, but the system should be of use from at least 80 and even 160 metres down to 10. Further details may be given in a later article on this aspect.

The above considerations were turned over mentally for a long time before placing such a system in operation. A perfectly good transmitter was lying on the floor gathering dust, and the use of the receiver was more than enough to excite a desire to return to the air, especially as hopes of a QTH where an outdoor aerial could be erected, receded further away. Something had to be done, and it was hoped to make it as effective as possible, even though the room was not at the top of the house, but only on the first floor in an average type of locality. The memories of excellent reception results on indoor aerials during the early thirties even at ground level, meant that some sort of signal should be radiated. Even a local contact or two would be preferable to an indefinite period of inactivity. The system was accordingly erected, and the feeder terminated in a series-tuned circuit link coupled to the PA, running a modest fifteen watts. The first evening produced exactly zero contacts, but after a second evening contacts resulted. Results were not too good, however, and the system did not appear to load the PA too well. Struck by a sudden thought, the six-turn link coil around the aerial tuning coil was cut down to three turns. This made a startling difference, as the PA could be loaded up to 25 or 30 watts easily, and the aerial bulb

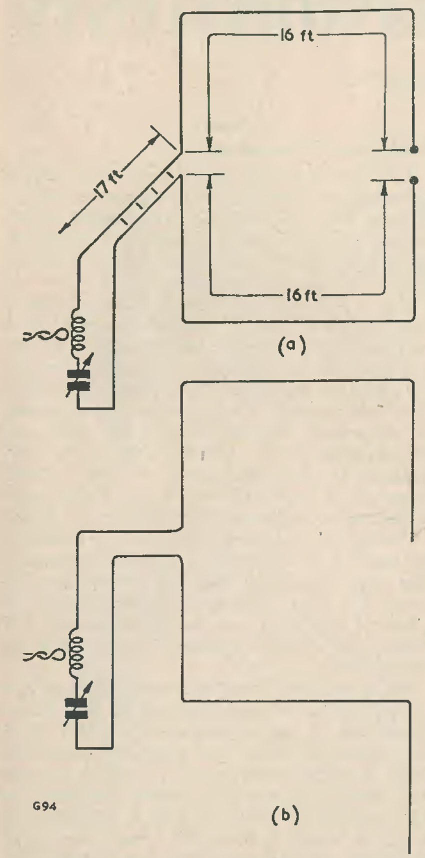


Fig. 3 (a). The smallest square aerial that will tune to 40 metres, makes up the total length to 66 feet with the feeders. The loop need not even be square.
Fig. 3 (b). The picture rail aerial made up to 66 feet with short feeders, and vertical hanging ends to give as much radiating length as possible

coupled loosely into one side of the feeders lit brilliantly as a pleasant change from its former modest orange glow. Results from then on appeared little different from those obtained a year earlier at a nearby QTH when a full outdoor half-wave 40 metre dipole was used. Due to concentrating exclusively on 40 metre CW, instead of wandering off into the lotus land of phone ragchews, about 20 countries were worked in very few hours of operation over a period of 3 months. No BCI reports have been obtained, despite the fact that at least three other receivers are in use in the house. No phone operation has as yet been seriously contemplated.

The above results may perhaps hearten those faced with a similar situation, as the experience is that not only are contacts possible under restricted conditions, but contacts are in fact easily possible. The experiences of G4HT, who is also forced to work out on indoor aerials, have been a stimulating factor towards trying out an indoor aerial. Although the outdoor aerial is the ultimate goal, the results obtained on an indoor aerial can be very little inferior to a normal aerial system, and one has the added satisfaction of overcoming the special difficulties one has had to face.

Can Anyone Help?

(continued from page 613)

DEAR SIR,—I have recently acquired a Power Unit type 266; input 80V 1.5kc/s a.c., outputs h.t. 120V d.c., bias 3V and 9V, l.t. 2V, smoothed and stabilised, with 5U4G valve and VS110 stabiliser, 12V 1A metal rectifier, etc. I wish to run the R1224 receiver with same, and wonder if any reader could help me re the parts to re-wire, etc., I should be most grateful for any help received.—J. L. Murray, 21 Highfield Road, Winchmore Hill, London, N.21.

* * *

DEAR SIR,—Can any reader fully conversant with the B2 equipment inform me of the correct connections in the bakelite plug which connects from the B2 receiver to the power pack? This bakelite plug is in two halves, clamped together. In each half there are six slots or grooves on the inner side. When clamped together, six pins are held in position, but only five of these carry wire connections. The sixth pin, somewhere in the middle, appears to be only a dummy. Any information as to correct assembly will be gratefully received.—C. N. Blatherwick, G3VU, "Villette," 20 The Drive, Roundhay, Leeds 8.

* * *

DEAR SIR,—Can anyone lend me the handbooks on the Army Set 38 and 68/P/R/T types, also the 46 Set for portable operation? I also wish to buy a copy of "QST" for November 1951.—G. V. Haylock, G2DHV, 63 Lewisham Hill, London, S.E.13.

Let's Get Started 23:

FREQUENCY MEASUREMENTS

by **A. P. BLACKBURN**

Roughly speaking, measurement falls into two classes. One is the measurement of signals and supplies, and the other deals with the determination of values of components. This is a broad generalisation, but it serves as a satisfactory classification to the radio man. We have already seen how the first category applies to the measurement of supplies (h.t., l.t., etc.). The voltage of a signal may also be measured by similar means, but special techniques have to be used to determine its frequency..

As in most cases of measurement, it is necessary to take someone else's word for the accuracy of the result. If the frequency were low enough, it would be possible to count the number of cycles occurring per second, and a stopwatch would be needed to fix the second accurately. So it is obvious that the primary requirement is to have an

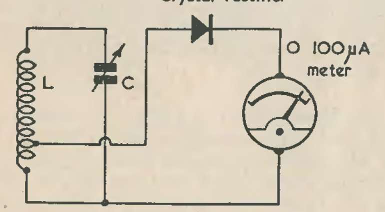


FIG.1. ABSORPTION WAVEMETER

accurately measured second. This, of course, does not concern us, but it does concern the people who set the standard—a standard upon which we have to rely. It is unfortunate, perhaps, that we have to be dependent upon an outside factor in this respect, but the easiest and most effective method of frequency measurement is by comparison. We shall hear more later of the number of sources to which we may refer ourselves.

Absorption Wavemeters

Let's say we have an r.f. oscillator, all set up ready and working. But we would like to know at what frequency it is oscillating. There is a very simple device called the absorption wavemeter which can give an answer to this with a fair degree of accuracy.

Fig. 1 shows the circuit of the wavemeter. You can see that it consists merely of a tuned circuit, a crystal detector and a meter. The coil, L, is brought reasonably close to the circuitry of the oscillator, and the tuning capacitor rotated until a reading is obtained on the meter. At this point the L and C of the wavemeter are tuned to the same frequency as the oscillator. If the tuning capacitor is provided with a knob and scale calibrated in frequency, our problem is solved.

There are many versions of this simple wavemeter, which only vary in complexity. The one illustrated has the crystal tapped down L. This relieves the tuned circuit of some of the load due to the detector and meter, and enables a reasonable Q value to be obtained.

If the oscillator produces insufficient power to deflect the meter, the coil of the wavemeter can be moved very close to the coil of the oscillator. This will stop the oscillator from working when the LC circuit of the wavemeter is tuned to the same frequency as the oscillator. This is not a particularly accurate method, however, since the close proximity of the wavemeter coil affects the frequency at which the oscillator is working. In view of this, if the oscillator does produce a reasonable power, the wavemeter should be held as far as possible from the oscillator, consistent with a deflection on the meter.

When using the meter, the circuit absorbs a little power from the oscillator. As the wavemeter is moved closer, it absorbs more and more power until it is so close that it absorbs all that the oscillator can give, and the oscillator stops. Of course, this is all very well, but how is the wavemeter to be calibrated in the first place? And here it is that we find ourselves in the deep water of all measurement.

Beating

A way out of this difficulty is by a further comparison. Ordinary radio stations work on pretty accurately defined frequencies, all of which we can easily look up if we wish to know them. But one could scarcely expect broadcast radio signals to provide sufficient power to deflect the meter on our wavemeter. So we must build an oscillator and compare it with, say, the signals from a few radio stations. The way we compare two signals is by beating them together. All that is necessary is to tune a radio receiver to any station and place the oscillator close to the aerial of the receiver. The oscillator is tuned until a whistle is heard superimposed upon the programme. If you continue to tune the oscillator, the whistle will decrease in frequency, until eventually it disappears. Further tuning will cause the whistle to start again at a low frequency, which will increase as tuning is continued in the same direction. The centre point of the period having no whistle is the point where both signals are of the same frequency. Once again, the oscillator should be placed as far as possible from the receiver aerial, consistent with introducing enough signal to produce the whistle.

We may, therefore, calibrate this oscillator against any number of broadcast stations, which also enables us to calibrate our wavemeter from the oscillator. We could have found the frequency of the original oscillator by beating it against a broadcast signal, if there had been a convenient signal at the frequency of the oscillator. By using the wavemeter, we may calibrate at any frequency.

Standards

It is often useful to have permanent gear set up in the workshop with which frequency may be checked. Then, of course, the question of accuracy arises. We have to decide to what limits of accuracy we want to work.

The wavemeter is an excellent device if a rough check only is required. It requires no power supplies and is usually made up in a small box with a handle, so that it may be used in awkward places without a mass of leads. Its drawback is that the stability of calibration is not very good unless considerable precautions are taken. The discrimination depends upon the Q of the circuit. Discrimination in this context means how accurately the maximum reading on the meter can be judged. If, for example, the tuning control could be moved 50kc/s at 5Mc/s without a noticeable change in meter reading, we could not hope to read to better than 50kc/s accuracy at this frequency.

A permanently built calibrated oscillator (a signal generator, for example) can be made to be more reliable and accurate. In this case, the discrimination can be a few cycles

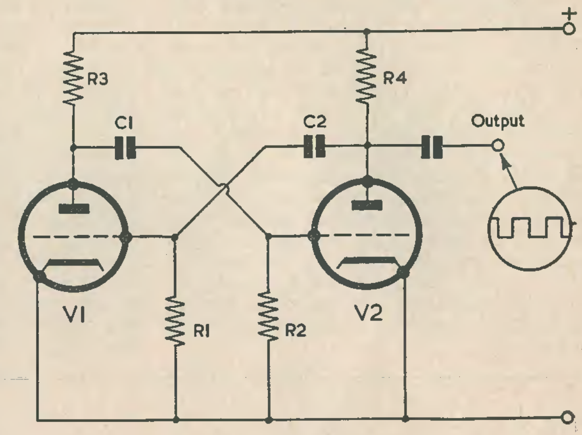


FIG.2.THE MULTIVIBRATOR

per second at any frequency, but once again it is necessary to take considerable care in the design and construction of such an oscillator, if it is to hold its calibration.

The answer to stability problems in oscillators lies, of course, in the quartz crystal. We substitute a crystal in place of the L and C, but the oscillator will be fixed at one frequency. Unless, however, we are willing to invest in a few dozen crystals, which would be very expensive indeed, we are stuck at one frequency. Fortunately for us, someone has been faced with this problem before us, and has found a very ingenious answer. It is called the frequency divider.

Frequency Dividers

These devices serve to generate a frequency less than the primary oscillator frequency. Suppose a crystal oscillator running at 1Mc/s has been produced, and it is desired to obtain a signal at 100kc/s, at the same accuracy and stability as the crystal.

The circuit for achieving this result is probably new to some readers. It is a particular form of oscillator, known as the "multivibrator," and the circuit is shown in

Fig. 2. It consists of two valves, V_1 and V_2 with the anode of each valve coupled to the grid of the other.

We will imagine that, upon switching on, some small disturbance at the grid of V_1 causes the voltage at the anode of V_1 to drop. This drop in voltage will be passed to the grid of V_2 via C_1. As the grid voltage goes negative, the current in the valve will decrease, and the standing voltage drop across the anode load R_4 will also decrease. The anode of V_2 will become more positive. This increase in volts will be passed to the grid of V_1 via C_2, which will cause V_1 to pass more current, and the voltage at the anode will drop even more. This regenerative process will continue until V_2 is cut off, that is, passes no current. In such a condition, V_1 is passing current heavily and V_2 is cut off. The circuit remains in this condition until C_1 has discharged through R_2, which will cause the grid of V_2 to move positive again. When the grid is sufficiently positive to allow current to start flowing in V_2, the anode of V_2 will drop. The drop will be passed via C_2 to the grid of V_1 and the whole process will continue until V_1 is cut off and V_2 is conducting.

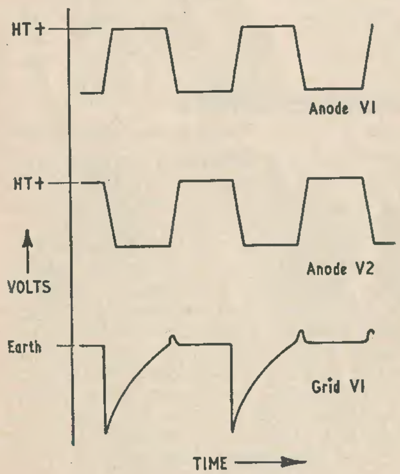


FIG.3(a) MULTIVIBRATOR WAVEFORMS

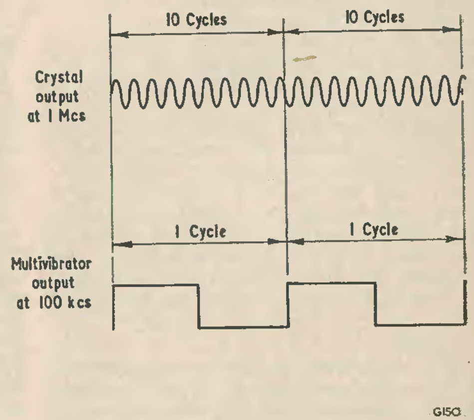


FIG.3(b) FREQUENCY DIVISION

From the description, we can see that this is an oscillator which works in jerks, with a pause in between. In these circumstances we can hardly expect to find a nice even sine wave appearing at either anode. The waveforms are shown in Fig. 3a. The fact that these waveforms are "square waves," that is, highly distorted from the sinusoidal, means that they contain many harmonics. If they occur at a rate of 100,000 per second, then harmonics will be found at 200kc/s, 300kc/s, and so on, up to many megacycles. If this multivibrator were coupled to a receiver, therefore, signals would appear at intervals of 100kc/s throughout the band.

The circuit has another interesting characteristic. The frequency of oscillation is inherently unstable. We can use this characteristic in the following way. If we feed a voltage of stable frequency to the appropriate point in the multivibrator, the multivibrator will fall into step with the applied voltage. If the frequency of the multivibrator, when "free running," were one-tenth of the applied locking frequency, the multivibrator, when locked, would fall into step at one-tenth of the applied frequency. For example, if we feed the output of a crystal oscillator operating at 1Mc/s to the multivibrator oscillating at 100kc/s, the multivibrator will run at exactly one-tenth of 1Mc/s, i.e. 100kc/s—if the circuit is properly designed. The important thing is that the 100kc/s is as accurate and stable as the 1Mc/s. So we now have two frequencies of any required accuracy from one crystal. The process of frequency division is illustrated in Fig. 3b.

The crystal oscillator may also be designed to produce a vast range of harmonics. The crystal oscillator-multivibrator combination can, therefore, produce 1Mc/s signals or 100kc/s signals over a very wide band of frequencies.

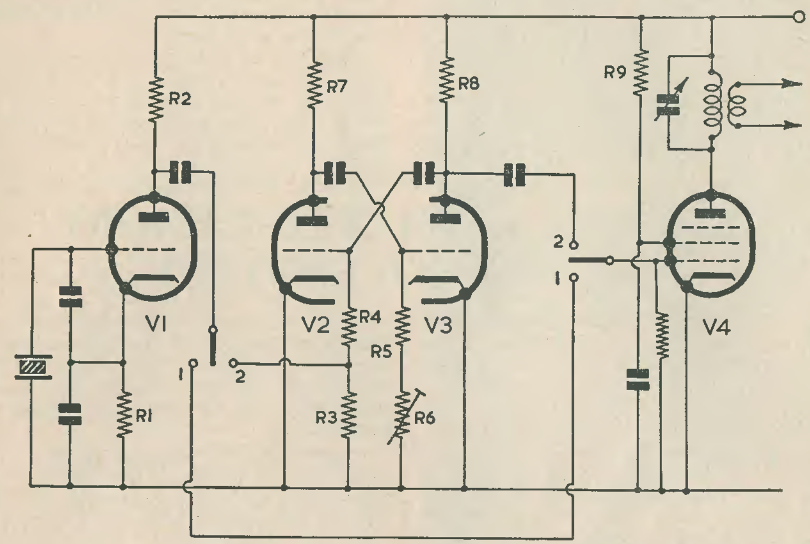


FIG.4. FREQUENCY STANDARD

Setting Up

To set up a system such as that we have described naturally involves a certain amount of work. Fig. 4 shows a typical circuit with a few refinements. V_1 is a crystal oscillator; V_2 and V_3 are the multivibrator valves. To vary the frequency of the multivibrator, R_6 has been made variable, and this is adjusted until the multivibrator falls into step with the crystal oscillator at the correct division ratio, say 10 : 1. Let us assume that V_1 is oscillating at 100kc/s. The multivibrator will therefore be oscillating at 10kc/s. The last valve, V_4, is used to combine the 100kc/s and 10kc/s signals if required. Its anode circuit is a tuned circuit so that the required harmonic may be selected.

Setting up can best be carried out with an oscilloscope. The waveforms to be expected are shown in Fig. 5. If such a luxury as a 'scope is not included in your inventory, an ordinary short wave receiver may be used. A short lead should be substituted for the aerial, and the lead should be placed near the frequency standard circuitry. With the multivibrator stopped (remove a valve or disconnect h.t.) tune over a few megacycles on the receiver. At intervals of 100kc/s a hiss should be heard. These are the harmonics of the crystal oscillator. Mark these points on the dial or take note of the dial readings. Start the multivibrator and allow a few minutes for it to settle down. Tune the receiver between any two of the 100kc/s

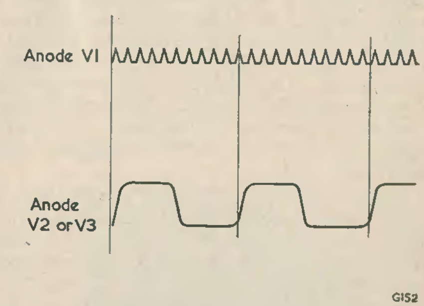


FIG.5. WAVEFORMS OF FIG.4.

points, and there should be nine points at which a hiss is heard from the receiver. If the number is short or more than this, R_6

should be adjusted until the correct number is obtained. The aerial may then be connected to the output terminals (Fig. 4) and the same result obtained, except that tuning the anode of V_4 will make the hiss louder.

Receiver Calibration

The above process may be used for accurately calibrating a receiver. The main difficulty arises in finding which harmonic the receiver is tuned to. If the receiver is completely uncalibrated, it would be necessary to find a station of known frequency. This point may then be marked temporarily on the receiver dial. The nearest 100kc/s point above and below this point may then be found by using the harmonics of the crystal as already described. Further points may be obtained by counting away from the established points as each 100kc/s harmonic is tuned in. When these points have been marked on the dial, the 10kc/s points may be marked by switching to the multivibrator and tuning to its harmonics.

There are, of course, many refinements to all these techniques, and very elegant measuring systems may be set up, but they nearly all rest upon the principles of wavemeters, reference oscillators, and crystal oscillators.

PORTABLE AMATEUR RADIO EQUIPMENT CONTEST

In an endeavour to increase interest in, and encourage development of, low-power and essentially portable equipment by radio amateurs, the QRP Society introduce "P A R E C," the

PORTABLE AMATEUR RADIO EQUIPMENT CONTEST

open to ALL licensed amateurs and SWLs, either as individuals or in club teams. The Society acknowledge with sincere thanks the valuable assistance offered by Data Publications Ltd., publishers of *The Radio Constructor*, in accepting responsibility for the provision of an unbiased panel of judges for the entries.

The contest will be divided into four classes, in which equipment will be eligible as follows:—

Class "A"—For "hand" portable (valve) gear. Open to receivers up to 3 lb weight, transmitters up to 5 lb weight, and transceivers up to 7 lb weight. All equipment in this class must be dry battery operated, but the weights quoted are *exclusive* of batteries, phones, key, antenna or any other ancillary equipment. The judges will give special consideration to economy of battery consumption, lightness, compactness, versatility, radio coverage, ease of handling and operation.

Class "B"—For "mobile" equipment—transmitters, receivers or transceivers of 10 lb maximum weight. Equipment in this class may be powered by dry or wet batteries, or vibrator units. The maximum weight is *exclusive* of batteries and ancillary equipment, but is *INCLUSIVE* of any necessary vibrator unit. The judges will give special attention to soundness of design, compactness, mechanical and electrical strength, versatility, radio coverage and ease of operation.

Class "C"—For transistor sets of a maximum weight of 2 lb, exclusive of ancillary equipment. The judges will look particularly for radio versatility, coverage, robustness and cleanliness of design and construction.

Class "D"—For portable test gear of any type (as, for example, wavemeters, signal generators, etc.) without restriction except that all entries must be battery operated and TRULY PORTABLE. The judges will especially consider size, weight, versatility, soundness of construction and design and accuracy of performance.

Apparatus for P A R E C need not be specially built for the contest, as existing gear will be eligible if it meets the above specifications, but ALL ENTRIES MUST BE AMATEUR BUILT EQUIPMENT.

How to make your entry.—A description of the entry, laid out as follows, should be sent to the Hon. Secretary, QRP Society (J. Whitehead, 92 Rydens Avenue, Walton-on-Thames, Surrey), and should be written as clearly as possible (or preferably typewritten) on foolscap paper, using one side of the paper *only*.

Sheet 1, the title page, should contain the following information ONLY: "QRP Society, P A R E C" (in the top left corner); Name, call (if any) and address of sender (top right corner); Title of gear submitted (centre, above middle of page). The bottom half of the sheet should be left blank for judges' comments.

Sheet 2: Theoretical diagram and components list ONLY.

Sheet 3: Layout sketches. Photographs may be attached but are not essential for initial consideration. (The judges *may* request photographs at a later date.)

Sheet 4 upwards (as necessary): Detailed description of the apparatus, which should be carefully checked to include ALL information relative to the gear and its performance. AT THE TOP OF SHEET 4 the following information should be clearly tabulated: Type of apparatus; power consumption; weight; overall size; band coverage.

Entry forms, set out as above, will be scrutinised by a Selection Committee of the QRP Society (who may ask the entrant to furnish further information where necessary). This committee will assess the best three entries in each class, and to each of these twelve entrants A SPECIAL CERTIFICATE (13 in by 8 in) will be awarded by the QRP Society. The twelve entrants thus selected will be invited to forward the apparatus itself to the Editor of *The Radio Constructor* (c/o Data Publications Ltd., 57 Maida Vale, London, W.9), who has kindly offered the services of his staff to give their unbiased judgment in the selection of the final winners of each class and of the contest as a whole.

Apparatus should not be sent in BEFORE a date to be notified to the finalists upon receipt of their certificates. Great care should be exercised in providing sufficiently protective packing. Return packing and postage will be paid for by the QRP Society. All possible care will be taken of apparatus while in the hands of Data Publications Ltd., but no responsibility can be accepted for any loss or damage sustained either then or during transit.

Prizes (the nature of which will be announced at a later date) will be awarded to each class winner, and also for the best entry by a QRP Society member. There will, in addition, be a prize for the best entry by a club team.

A detailed article on the winning entry will be published (and paid for at usual rates) in *The Radio Constructor* as soon after the conclusion of the contest as possible. The QRP Society retain the right to publish in their Society Journal "*QRP*" full accounts of any or all of the equipment submitted.

Overseas Entries will be particularly welcomed and a certificate (as detailed above) will be awarded to the best overseas entry in each of the four classes. Since, however, it will obviously be impossible for overseas participants to send in the actual apparatus itself, they will not be asked to submit gear for the final judging and will not, in consequence, be eligible for the finalists' prizes (other than QRP Society certificates).

Closing Date for receipt of entry forms by the Hon. Sec., QRP Society, will be **30th September, 1955.** Entries ready prior to this date should be submitted as soon as available in order to avoid any "last minute rush."

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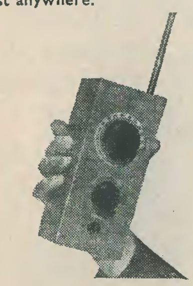

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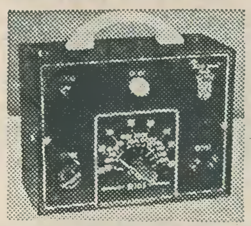

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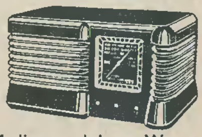

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[continued on page 639

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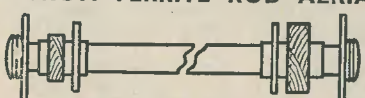

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continued from page 637]

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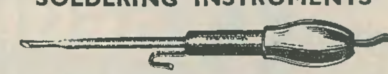

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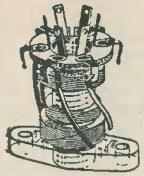

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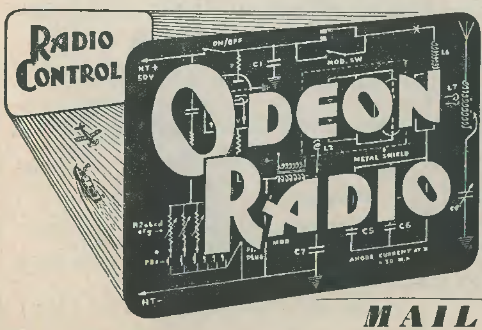

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