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<td>16µfd, 450V</td>
<td>... ...</td>
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<tr>
<td>8µfd 450V</td>
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<tr>
<td>32 x 32µfd 350V</td>
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<td>0.001 µfd</td>
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<td>10 ohm to 10 meg</td>
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LANCE OSCILLATOR UNITS

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<td>Mk. 6</td>
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<td>6/9 ea.</td>
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<td>Set of Resistors 10/6</td>
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<td>3-WAVE BAND L.M.S.</td>
<td>£2.9.9</td>
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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 rework 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 in 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 tuning 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 hence has to be made to "peak" 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, therefore, 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 (R11 + R12) 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 R11 + R12, 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.

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


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 Wootton Road, Erdington, Birmingham 23.

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. Goldsworthy, G3PZW; Treasurer, Mr. P. J. Brown, G5QID; Secretary, Mr. F. A. E. Porter.

Meetings are held every fourth Friday at the "Jolly W peeled" in Chesterfield Road, and new members are welcome. The next meetings are on the 20th May and the 17th June (joint date). A Morse practice class has been started for beginners. Hon. Sec.; Mr. P. A. E. Porter, 38 Montague Road, Cambridge.

CLIFTON AMATEUR RADIO SOCIETY

The first DP contest in the 1955 series takes place on Sunday, 8th May, at 3 p.m. at the Clifton Club, the site of Badenoch House, Kent. The club station, G3JGH/A, will be operating portable between 11.00 hrs. and 16.00 hrs, on a frequency of 3,504 kHz and as long power will be used reports and QSO's will be welcomed.

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 supermarket, 828 New Cross Road, London, S.E.14, at 7.30 p.m. Details of membership may be obtained from the Hon. Sec.; Mr. H. Bullivant, GIDC; 25 St. Illiams Road, Catford, S.E.6.

If the milliammeter 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.

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, G3JYJ; Treasurer, L. Brown, G3HTL, Committee: G. F. Nottingham, G3DTA; P. S. Robin son, G3JYP; A. Horner, G3FTS; P. Dekker.

The meeting has been changed to Thursdays at 7.30 p.m. The club room is in Fitter 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 Bewley Street, Bishopshorpe 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.

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 unsuitable 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 television would also be prepared to say 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 television 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 short circuit or 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 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 deprivés him of the use of his R.1153 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. These 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. Similarly, 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

In May 1955

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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. As is the conventional 500 pF tuning condenser. If one is looking for optimum results it would probably be best to use a tuning condenser of at most, 350 pF.

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 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 and a secondary 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 voltage 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 by the receiver at which the switch 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 squeegging.

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 10 µF) 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-
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 consists 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 occurring along its route. A suitable procedure for constructing the i.f. stages would consist of getting them to function 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.

The R.F. Circuits
A typical frequency changer and r.f.

where the circuit lines are broken by circles. Alternatively, a coil turrent may be employed.

Many constructors would prefer to use a coil for the i.f. stage 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 incorporation into the circuit. In some instances, manufacturers may recommend 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 superhetś. 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 whistle 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 2 in. wide, by 1 in. thick. Another, which would be ideal for normal sound receivers (250 volts at 60mA, half-wave rectification), is 1 in. long, by 1 in. wide, by 1 in. thick. The baby of the bunch (250 volts at 20mA, half-wave rectification), has the same thickness, (1 in.), and is so small that it can almost be completely hidden under a postage stamp. I understand that this latter is already being used by 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-constructors. I know I shall be among the first to buy one of these little 20mA jobs!

Band III Photo

The photograph, taken by Mr. John Cura of "Tele-
Snap's" fame, shows the Belling-
Lee test card now being radiated on the commercial t.v. band, as actually received at Wands-
worth 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 4-element yagi, com-
pising 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 200 v. The attenu-
tion was used, as against 14dB employed for reception of the B.B.C. programmes. The contrast control was a quarter advanced. The receiver was an H.M.V. 1805 TRF, with an experimental 2-valve converter.

See also page 990

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

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 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

THE RADIO CONSTRUCTOR
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 (9n-2) will not only greatly increase the range but will also considerably increase the selectivity. The damping 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 n.b.f.m. 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 5 in. x 4 in. x 4 in., is supplied complete with a removable top in order to effect easy removal, and re-assembly, of the coils selected to cover the range of frequencies for which the receiver was designed. The Bandet 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. (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.

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.)

Assembling with under chassis wiring first, proceed as follows:

STEP No. 1. From aerial terminal to YEL-
LOW on coil holder.

STEP No. 2. From aerial terminal to BLUE
on coil holder.

STEP No. 3. From WHITE on coil holder to RED on condenser.

STEP No. 4. To RED on 3-way tag strip

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.

STEP No. 5. To RED on tag strip solder one end of R3 and R4.

STEP No. 6. Cover free end of R3 with

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systole, 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.

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

**Step 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.

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

**Step No. 11.** To YELLOW on 3-way tag strip solder length of BLUE wire and push through chassis backdop. (This wire is the h.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.

**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.

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

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

**Step No. 15.** To centre tag of potentiometer solder one end of R1. Other end of R1 to RED on valveholder. 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 I.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.

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**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 spoons slotted to facilitate rapid threading and other lengths of tape will shortly be available. The 1,200ft reel gives 32 minutes playing time at 7½ inches/second or 64 minutes at 3½ inches/second. Linear 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 calendared 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.”

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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 thinned 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 R.F. 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.
"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 333669.

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 x 10 feet.

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.

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 all equipment for every stage, so in the event of breakdown there will be a certain amount of unavoidable inconvenience.

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 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.

Suitable AC mains lamps and their values are listed in Table 1, together with their respective current ratings which on no
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., 0.5 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 similar 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 this, 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 chasses are desired, then a batten holder screwed to the cabinet interior would serve, being wired from the chassis underside via a gromet 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 that the heat dissipated by the lamp is removed from close proximity to the receiver components. — Editor).

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, 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 models 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 maintenance 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 energiser 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
5% whilst in some instances an actual voltage gain is indicated:

<table>
<thead>
<tr>
<th>Make</th>
<th>Type</th>
<th>Purpose</th>
<th>Input Volts</th>
<th>Output Volts DC</th>
<th>mA max</th>
</tr>
</thead>
<tbody>
<tr>
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<td>ZA-15046</td>
<td>HW</td>
<td>RMS</td>
<td>250</td>
<td>240</td>
</tr>
<tr>
<td>Westonhouse</td>
<td>HT-42</td>
<td>VD†</td>
<td>270</td>
<td>450</td>
<td>100</td>
</tr>
<tr>
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<td>HT-46</td>
<td>HW</td>
<td>250</td>
<td>240</td>
<td>120</td>
</tr>
<tr>
<td>Westonhouse</td>
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<td>HW</td>
<td>130</td>
<td>125</td>
<td>25</td>
</tr>
<tr>
<td>Brimar</td>
<td>RM1</td>
<td>VD†</td>
<td>125</td>
<td>140</td>
<td>60</td>
</tr>
<tr>
<td>Brimar</td>
<td>RM1</td>
<td>VD†</td>
<td>125</td>
<td>240*</td>
<td>60</td>
</tr>
<tr>
<td>Brimar</td>
<td>RM2</td>
<td>VD†</td>
<td>125</td>
<td>135</td>
<td>100</td>
</tr>
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<td>Brimar</td>
<td>RM3</td>
<td>VD†</td>
<td>125</td>
<td>270</td>
<td>100</td>
</tr>
<tr>
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<td>VD†</td>
<td>125</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
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<td>RM4</td>
<td>FW+</td>
<td>210-210</td>
<td>225</td>
<td>350</td>
</tr>
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<td>275</td>
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<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Brimar</td>
<td>RM5</td>
<td>VD†</td>
<td>250</td>
<td>550</td>
<td>300</td>
</tr>
</tbody>
</table>

† 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, while corresponding 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

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 useful surplus MR which the writer has employed on numerous occasions with ZA-15046. It is

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 continuous operation.

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

forms, 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

0.005 which equals 20H).

Fig. 5

Using an auto-transformer

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 x 16 or 32 x 32µF block).

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. 5). Resistor-capacitor smoothing is only really effective, however, where the load is comparatively light, as in midget receivers, test gear, etc.

The difficulty of obtaining HW trans-
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 not be allowed to come into contact with which it is normally protected. It sometimes happens that an MR for a particular voltage rating or type of smoothing circuit is un procurable; in this case, lower-voltage rectifiers may be used in series or in voltage-decreasing 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 for a 200V circuit). 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 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.

**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 MIND THAT I DEVISED A SIMPLER CIRCUIT WHICH WITH LITTLE EXTRA COST WOULD OFFER 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 in Fig. 1 of the circuit, 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, both calibrations can be obtained in one of two ways:

- By putting an additional scale on the meter,
- 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 a pair of rocker switches. VR2 is a wire-wound linear potentiometer which must be calibrated against some standard to the following formula:

**R3 = VR2**

**R4 = Standard**

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. All four of the 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 this is more than sufficient for use by the average experiment enthusiast.

VR1 is merely a tetrode limiting resistor, and its value must be determined by the method 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) S2b and S2c have no action. This means that the voltage resistors and current shunts do not affect the bridge.

It will be seen that connected directly to the positive voltage terminal is a single-pole cross-over switch. This is used to connect the terminals to either the voltage...
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 101D/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**

<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
<th>1mA</th>
<th>5mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Bridge Ratio Multiplier</td>
<td>100Ω 1%</td>
<td>100Ω 1%</td>
</tr>
<tr>
<td>R2</td>
<td>Bridge Ratio Multiplier</td>
<td>1,000Ω 1%</td>
<td>1,000Ω 1%</td>
</tr>
<tr>
<td>R3</td>
<td>Bridge Ratio Multiplier</td>
<td>10kΩ 1%</td>
<td>10kΩ 1%</td>
</tr>
<tr>
<td>R4</td>
<td>Bridge Ratio Standard</td>
<td>100Ω 1%</td>
<td>100Ω 1%</td>
</tr>
<tr>
<td>R5</td>
<td>Voltage Dropper 5V</td>
<td>5kΩ 1%</td>
<td>1kΩ 1%</td>
</tr>
<tr>
<td>R6</td>
<td>Voltage Dropper 20V</td>
<td>50kΩ 1%</td>
<td>10kΩ 1%</td>
</tr>
<tr>
<td>R7</td>
<td>Voltage Dropper 50V</td>
<td>200Ω 1%</td>
<td>200Ω 1%</td>
</tr>
<tr>
<td>R8</td>
<td>Voltage Dropper 100V</td>
<td>1kΩ 1%</td>
<td>1kΩ 1%</td>
</tr>
<tr>
<td>R9</td>
<td>Voltage Dropper 250V</td>
<td>5kΩ 1%</td>
<td>5kΩ 1%</td>
</tr>
<tr>
<td>R10</td>
<td>Voltage Dropper 500V</td>
<td>100Ω 1%</td>
<td>100Ω 1%</td>
</tr>
<tr>
<td>R11</td>
<td>Voltage Dropper 1000V</td>
<td>200Ω 1%</td>
<td>200Ω 1%</td>
</tr>
<tr>
<td>R12</td>
<td>Current shunt 10mA</td>
<td>1Ω</td>
<td>1Ω</td>
</tr>
<tr>
<td>R13</td>
<td>Current shunt 100mA</td>
<td>0.1Ω</td>
<td>0.1Ω</td>
</tr>
<tr>
<td>R14</td>
<td>Current shunt 1 Amp</td>
<td>1.0Ω</td>
<td>1.0Ω</td>
</tr>
<tr>
<td>VR1</td>
<td>Bridge Battery Limiter</td>
<td>Calculation</td>
<td>Below</td>
</tr>
<tr>
<td>VR2</td>
<td>Bridge Ratio pot/meter</td>
<td>To suit battery</td>
<td>To suit battery</td>
</tr>
<tr>
<td>MR1</td>
<td>Meter Rectifier</td>
<td>1.5kΩ for 1.5V</td>
<td>250Ω for 1.5V</td>
</tr>
<tr>
<td>Sw1</td>
<td>Rectifier Switch</td>
<td>1kΩ w/w 1%</td>
<td>1kΩ w/w 1%</td>
</tr>
<tr>
<td>Sw2</td>
<td>Range Selector Switch</td>
<td>4-way 2-position 1-pole</td>
<td></td>
</tr>
<tr>
<td>Sw3</td>
<td>Voltage/Current Selector</td>
<td>8-position, single-pole (4 wafers)</td>
<td></td>
</tr>
<tr>
<td>Sw4</td>
<td>Bridge Multiplier Switch</td>
<td>4-position, single-pole</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>2 Terminals, 6 knobs, 2 crocodile clips, wire, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Calculation of Current Shunt**

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

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?

\[ Rm = 100Ω \quad N = 10 \]

\[ Rs = \frac{100}{10-1} = \frac{100}{9} = 11.1Ω. \]

---

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

If G.K.N. anchor nuts are riveted 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 "Easy-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 "Easy-Build" was a t.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 construction 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 gain 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.

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 "East-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 "East-Build!"

---

**Component List**

**Resistors (All ±20% unless otherwise stated).**

<table>
<thead>
<tr>
<th>Value (Ω)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1: 1k</td>
<td>250k, potentiometer, log law, screened, without switch</td>
</tr>
<tr>
<td>R2: 1k</td>
<td>1M, 1/4 watt</td>
</tr>
<tr>
<td>R3: 2k</td>
<td>220k, 1/4 watt</td>
</tr>
<tr>
<td>R4: 2k</td>
<td>220k, 1/4 watt</td>
</tr>
<tr>
<td>R5: 3k</td>
<td>33Ω, 1/4 watt</td>
</tr>
<tr>
<td>R6: 2k</td>
<td>220k, 1/4 watt</td>
</tr>
<tr>
<td>R7: 6k</td>
<td>680Ω, 1/4 watt</td>
</tr>
<tr>
<td>R8: 1k</td>
<td>100k, 1/4 watt ±5%</td>
</tr>
<tr>
<td>R9: 3k</td>
<td>33k, 1/4 watt</td>
</tr>
<tr>
<td>R10: 1k</td>
<td>100k, 1/4 watt ±5%</td>
</tr>
<tr>
<td>R11: 4k</td>
<td>47k, 1/4 watt, ±10%</td>
</tr>
<tr>
<td>R12: 4k</td>
<td>47k, 1/4 watt, ±10%</td>
</tr>
<tr>
<td>R13: 6k</td>
<td>680Ω, 1/4 watt</td>
</tr>
<tr>
<td>R14: 2k</td>
<td>250Ω, 1 watt, ±5%</td>
</tr>
<tr>
<td>R15: 2k</td>
<td>250Ω, 1 watt, ±5%</td>
</tr>
</tbody>
</table>

**Capacitors**

<table>
<thead>
<tr>
<th>Value (µF)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1: 0.25µF</td>
<td>350V wkg; T.C.C. Type C482L (with Clip No. S.2372)</td>
</tr>
<tr>
<td>C2: 250µF</td>
<td>Ef86, Mullard</td>
</tr>
<tr>
<td>C3: 220µF</td>
<td>ZT29, Osram</td>
</tr>
<tr>
<td>C4: 220µF</td>
<td>Also 600µF, Brimar, see text.</td>
</tr>
<tr>
<td>C5: 220µF</td>
<td>EBC90, Mullard</td>
</tr>
<tr>
<td>C6: 220µF</td>
<td>DH77, Osram</td>
</tr>
<tr>
<td>C7: 220µF</td>
<td>Or 6AT6, Brimar</td>
</tr>
<tr>
<td>C8: 220µF</td>
<td>V3, V4, 6V6GT, Brimar.</td>
</tr>
</tbody>
</table>

---

**Valves**

- V1: EF86, Mullard
- V2: EBC90, Mullard
- V3: 6AT6, Brimar
- V4: 6V6GT, Brimar

**Valves**

- 1B9A, plain, McMurdo type BM9/U
- 1U7G, plain, McMurdo type BM7/U
- 2 Int. Octal, McMurdo type B8/U

**Transformer**

- 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-way, centre earthed, length 1"in.
  (R. Davies, Swansea)

**Chassis**

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

**Sundries**

- 2 Grommets. 1 in.  
  Connecting wire, sleeving, etc.
- 4-way power cable

---

**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 "East-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 cathode Followers, 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 windings for impedance matching from 1Ω to 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 special care has been taken to ensure that the h.t. rail is adequately decoupled. For instance C3, which is half of a 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
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 he 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 16V4 reservoir condenser. A 200-0-200V transformer, on the other hand, will provide an h.t. voltage in the same circuit of about 200V. 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 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 6BR7. However, the pin connections of the 6BR7 differ from those of 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.21A Tuner Amplifier manual, or circuit diagram, which I could borrow or purchase.—H. Shannon, 1 Oreades 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 BC38/4 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 SIR.—Over the past three years I have tried to obtain data for my Romac TV139 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. Halve, 16 Fleetswood Road, Norbston, Kingston-on-Thames, Surrey.

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, AHI and AFT. Full cash sent.—R. Clapp, 16 Market Hall, Kington, Hereford.

DEAR SIR,—I am having trouble with the pickup in the cloudburst All-World Eight” battery communications receiver, please? J. Heinrich, 21 High Street, Annan, Dumfriesshire.

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, 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: 15µF, 12V (Bias)
- R11, 12: 1MΩ, ¼ watt
- R13, 14: 500kΩ, ¼ watt
- R15: 1kΩ, ¼ watt
- One Osmor Coil type QA9
- One Osmor Coil type QO6
- One WX6 Metal Rectifier (V6)
- One IO Valveholder
- One 6S7H (V7)
- One 2-pole, 2-way Yaxle type switch

The recommended padding condenser for this coil is 1µpF. 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 6S7H 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 5 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.

Commencing next month . . .

A HIGH QUALITY ALL-WAVE TUNER

Suitable for addition to quality amplifiers

THE RADIO CONSTRUCTOR

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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.

![Circuit diagram of the Crystal Controlled Transmitter](image)

Fig. 1. Circuit of the Crystal Controlled Transmitter

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 L2 and capacitor C4 in its anode circuit being designed to tune to 27Mc/s. This 27Mc/s output is fed to the second valve via capacitor C6, being amplified up to a worthwhile signal.

The first section of V1 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 L2C4, 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 L2C4 and L4C8 are operating at the same frequency, these two tuned circuits must be carefully isolated from each other. This is done by dividing the chassis in which the unit is built into two compartments by a metal screen, the components constituting L2C4 being in one of these compartments, and the components forming L4C8, together with those associated with V2, 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 C3 and C4 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

![Rear view of complete Transmitter](image)

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.

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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 sleeves where possible. Twist all battery leads together and keep short.

Coil Data

Coils should be constructed as already indicated in previous articles. L2 consists of 10 turns of 16 s.w.g. tinned copper wire wound on a 3/4″ diameter former, the winding extending about 11/2″ long; L4, 11 turns 16 s.w.g. tinned copper wire on 3/4″ former, length of winding again being 11/2″. The aerial link coil L5 should consist of two turns of insulated wire around L4, 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 L4.

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 3/4″ diameter, 11/2″ 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 V1 if all is well. To check that this is happening, place the loop of a lamp-loop over the end of L1. 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, L4C6 must be tuned to 27 Mc/s by means of a wavemeter as described before. Once this circuit is functioning properly the final circuit L4C6 can be similarly tuned, the aerial not being connected to start with. Tuning L4C6 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 30 mA, 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, Eric
C2 100pF ceramic, Eric
C3 0.1pF 350V, T.C.C.
C4 5–50pF air-spaced trimmer
C5 50pF 350V mica
C6 100pF 350V mica
C7 0.01pF 350V T.C.C.
C8 5–50pF air-spaced trimmer
R1 33kΩ type 9, Eric
R2 47kΩ type 9, Eric
R3 2.2kΩ type 9, Eric
R4 33kΩ type 9, Eric
X1 9mΩ, crystal
V1 3A5 (Mullard DL939 direct equivalent)
V2 3A4 (Mullard DL939 direct equivalent)
L1 2.5mH R.F. choke
L2 10 turns, see text
L3 2.5mH R.F. choke
L4 10 turns, see text
L5 Aerial loop, 2 turns around L4

Fig. 3. Front view of Transmitter, taken before the front panel lid was fitted. The dimensions of the case are 11 1/2″ high, 9 3/4″ wide, and 6 1/2″ 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 3/4″ x 4 1/2″, the panel fitting in from underneath, and it is covered by a metal lid. The front opening measures 5 3/4″ x 5 3/4″ deep, also covered by a metal lid, and the panel of insulating material fits from inside. The aluminium angle is 3/8″ x 3/8″. The meter is part of the built-in wavemeter. Underneath it is the dial and knob of C6, and to the right those of C4.
Radio Miscellany

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 of 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 a story 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 unnessary reports.

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 "Rib," manufactured by Multicore Solder Ltd.

All over the Place

In previous years I have confessed to a seasonal 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 see that the Editor has sampled every sort of crinkle finish there is, and the fancy came over me for some of the lustrous unfinishable 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 man who uses it.

I have for some time been the owner of a double-action foot-pump—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 body jobs and I was soon 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 have some proficiency in the matter of marksmanship.

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 said to 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 number 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 protruding 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 possibility of a design of television receivers. Any form of mechanical system, of course, we dismissed out of hand. CRT projection methods received some support, but we vetoed them 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. The "receiver" was taking the form of a specially prepared surface consisting of a mosaic of a million or so spots which, when electrically energised, will glow in three different colours in the proper lineal (and colour) sequence. But, seriously, development on lines of this sort is well within the bounds of early possibility. Indeed the early beginnings of television (from the disc scanning of thirty years ago) it 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.

CENTRE TAP talks about CUTTERS SPRAY GUNS NO-AERIAL TV

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621 www.americanradiohistory.com
INDoor TRANSMITTING AERIALS

by O. J. RUSSELL, B.SC.(HON.) G3BHI

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 bleak. However, as in the case of unavoidable ORF 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. That a few words on this subject are in order is evident from the fact that a resonant length of wire is also of some help as a discrimination against harmonics, and centre-fed systems have other advantages. It is 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 to those who would be tempted to 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 landlord, 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 to 80 metres, and having a 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 doublings with suitable feeder length, should try a series tuned aerial feeding circuit for 80 metre operation. Having used powers from ½ 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

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?

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. 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

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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 on ground for the inner side, the radiation efficiency is equivalent to a normal dipole. Naturally, for indoor operation, the efficiency will be affected by proximity effects, partial shielding, etc., so that full outdoor efficiency is not to be 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. 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 circuit. So far so good, but due to space limitations, even this may not be fully practical. The following solution has been adopted at GB3JF/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 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 hearken thoughts 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 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 1.5kW a.c., output H.T. 120V d.c., bias 3V and 2V, smoothed and stabilised, with SU4G valve and VS110 stabiliser, 12V 1A metal rectifier, etc. I wish to run the R1224 receiver with same, and wonder if any reader could give the parts to re-wire, etc., I should be most grateful for a reply help received. — J. L. Murray, 21 Highfield Road, Winchmore Hill, London, N.21.

Dear Sir, Can any reader fill 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, and in each half there are six slots or cut-outs, etc. 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, "Villelle," 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, G2DHY, 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 to illustrate the necessity of a good theoretical classification to the radio man. We have already seen how the first category applies to the measurement of supplies (h.t., Lr, 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 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 a 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 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 find a monitor 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 increase the oscillator frequency, 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 it 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 various 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 on 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 50kcs at 5Mc/s without a noticeable change in meter reading, we could not hope to read to better than 50kcs 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 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 particular 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 100kcs, 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.
Fig. 2. It consists of two valves, V1 and V2 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 V1 causes the voltage at the anode of V1 to drop. This drop in voltage will be passed to the grid of V2 via C1. As the grid voltage goes negative, the current in the valve will decrease, and the standing voltage drop across the anode load R4 will also decrease. The anode of V2 will become more positive. This increase in volts will be passed to the grid of V1 via C2, which will cause V1 to pass more current, and the voltage at the anode will drop even more. This regenerative process will continue until V2 is cut off, that is, passes no current. In such a condition, V1 is passing current heavily and V2 is cut off. The circuit remains in this condition until C1 has discharged through R3, which will cause the grid of V2 to move positive again. When the grid is sufficiently positive to allow current to start flowing in V2, the anode of V2 will drop. The drop will be passed via C2 to the grid of V1 and the whole process will continue until V1 is cut off and V2 is conducting.

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 waveforms 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 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.

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. V1 is a crystal oscillator; V2 and V3 are the multivibrator valves. To vary the frequency of the multivibrator, R6 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 V1 is oscillating at 100kc/s. The multivibrator will therefore be oscillating at 10kc/s. The last valve, V4, 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 is 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 readings. Start the multivibrator and allow a few minutes for it to settle down. Tune the receiver between any two of the 100kc/s readings.

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, R6
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 acknowledges with sincere thanks the valuable assistance given 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 transmitters up to 7 lb weight. All equipment in this class must be 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, waveforms, 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.

Equipment 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). It is essential that the sheet should be left blank for judges' comments.

Sheet 2: Theoretical diagram and components list.

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 about 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 three entries in each class, and to each of these twelve entrants a SPECIAL CERTIFICATE (with in 8 by 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 Maid 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 by the QRP Society. All portable gear will be taken of apparatus from 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 as after the conclusion of the contest as possible. The QRP Society retains the right to publish it 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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<th>Rating</th>
<th>Price</th>
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<td>9&quot;</td>
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<td>15&quot;</td>
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**Small Advertisements**

Continued from page 671

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