T.R.F. "HAM" RECEIVER

Circuit Design from Eddystone

By exercising care in the selection of valves, coils and other components, it is possible to build a three-valve T.R.F. receiver, capable of an excellent performance on both the amateur bands and the short-wave broadcast bands. The present design is a typical example.

THE *Mullard* EF50 valve possesses a high value of mutual conductance and can be made to work well in all three stages—R.F. amplifier, detector and audio amplifier—of a T.R.F. receiver.

By

J. N. WALKER

Stratton & Co.,

Birmingham, Eng.

The coils are a new type recently introduced by Stratton Co. Ltd. and take up but little space, thereby lending themselves to a compact design. Yet, they possess high "Q" factors and are very efficient. Each coil has three windings (coupling, tuned circuit and reaction), and is therefore suitable for use in most positions in a receiver. One end of each winding is brought to a common earth pin, so that four pins suffice.

The three coils which cover 33 Mc/s (with a 140 pF tuning condenser) are wound on ribbed formers and have air cores. The remaining coils in the series are wound on a former fitted with an adjustable dust iron core, and are fully enclosed for extra protection.

Types are made covering the medium and long wave broadcast bands, and, if desired, the receiver can be used for occasional broadcast reception.

The tuning condensers have ceramic insulation, and again, being physically small, assist in the achievement of a compact lay-out, with short wiring.

It is primarily intended that the power supplies for the receiver be drawn from a small A.C. mains unit, but it may be noted that the consumption is sufficiently low to permit economical operation off batteries. The valve heaters draw 0.9 ampere at 6.3 volts. A 6 volt 20 ampere hour battery will therefore operate the receiver for up to 20 hours at a charge. The H.T. consumption is about 10 milliamperes—it varies slightly with adjustment of the gain control. The performance is quite good when

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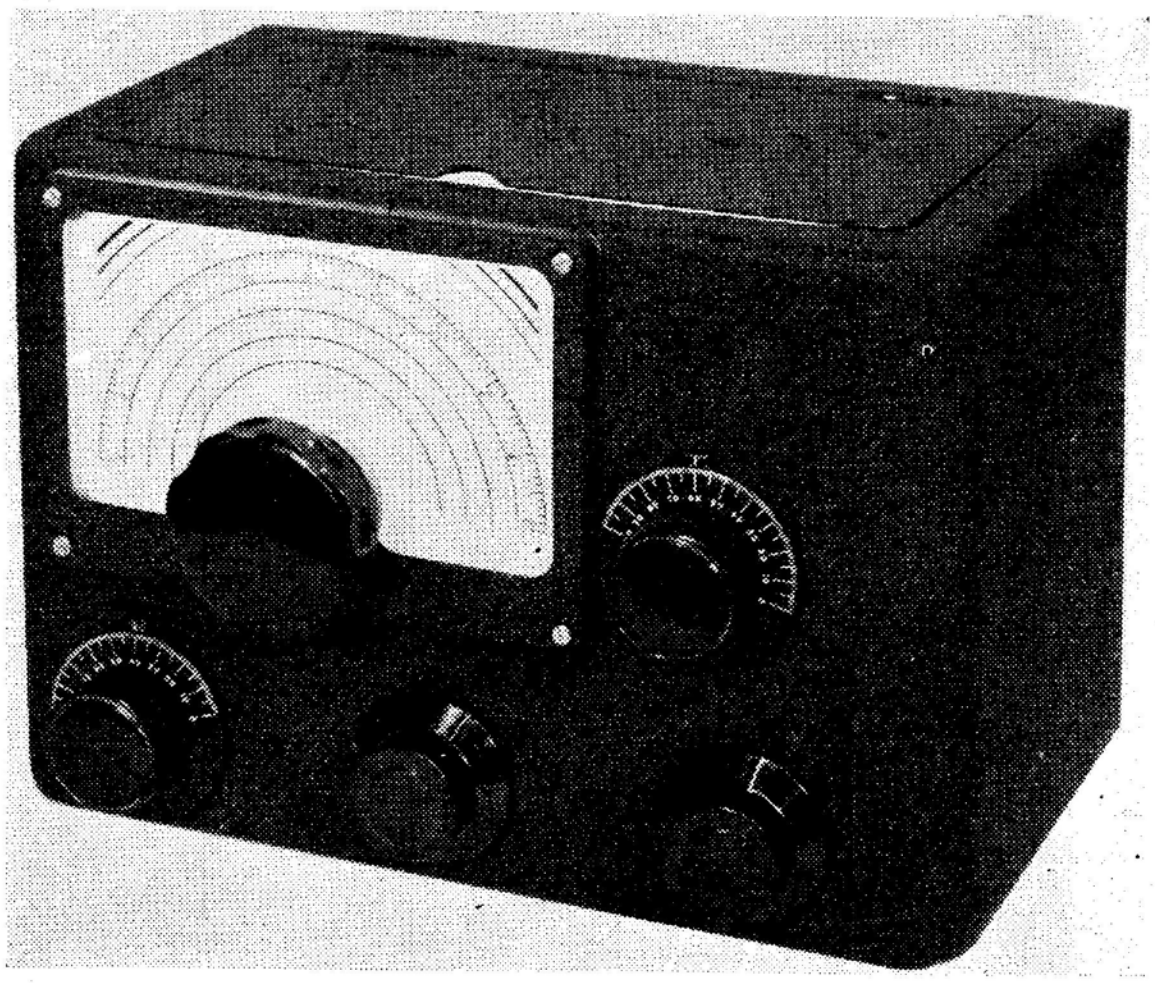
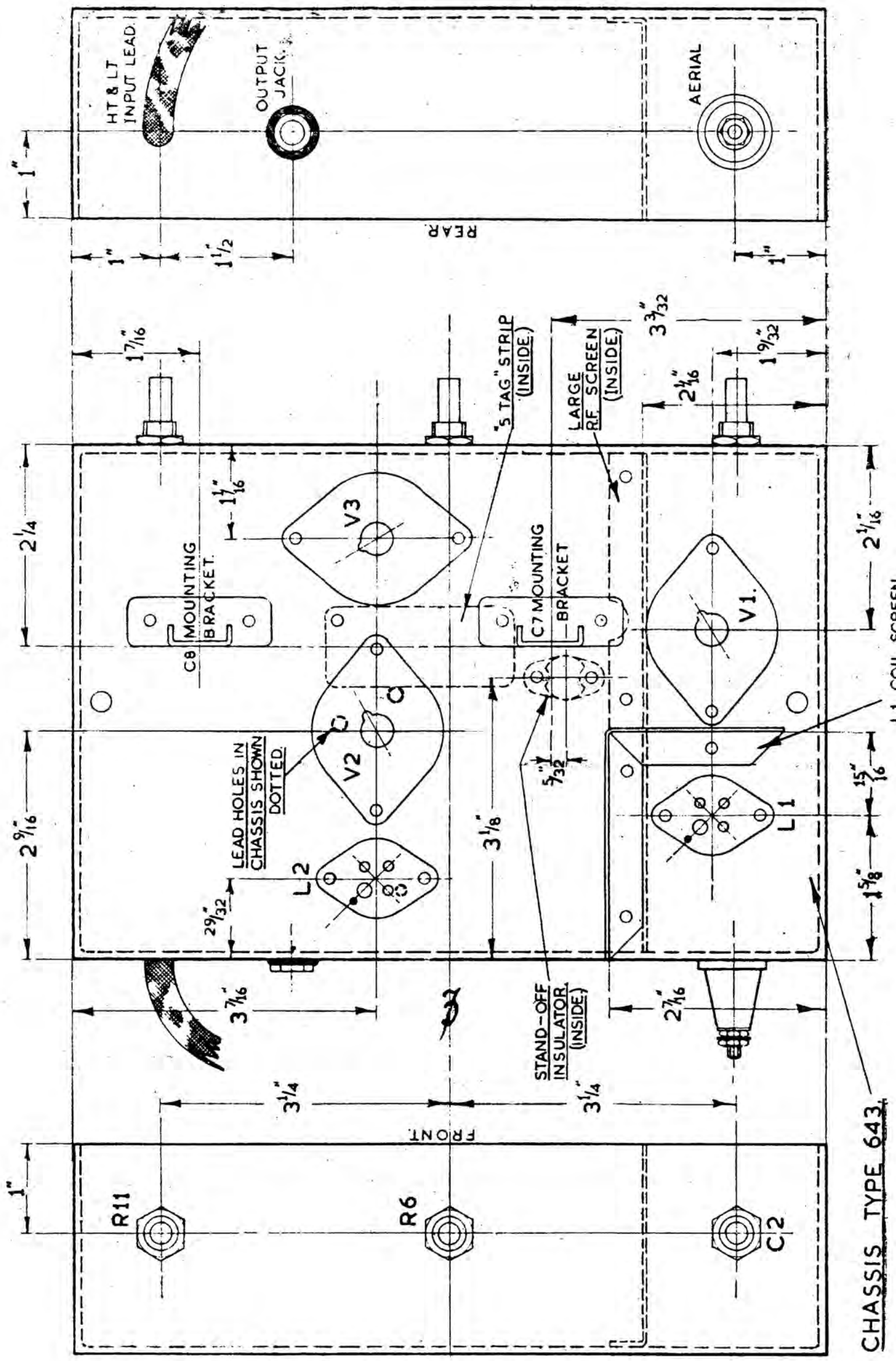


The finished Receiver.


REAR
HT & LT INPUT LEAD
OUTPUT JACK
AERIAL
1"
1"
1½"
1"
1 7/16"
3 3/32"
1 9/32"
2 1/16"
"5 TAG" STRIP (INSIDE)
LARGE R.F. SCREEN (INSIDE)
2¼"
1 1/16"
V3
V2
V1.
L2
L1
C8 MOUNTING BRACKET.
C7 MOUNTING BRACKET
LEAD HOLES IN CHASSIS SHOWN DOTTED.
29/32"
3 1/8"
5/32"
L1 COIL SCREEN
15/16"
1 5/8"
2 9/16"
3 7/16"
STAND-OFF INSULATOR (INSIDE)
2 7/16"
3¼"
3¼"
FRONT
R11
R6
C2
CHASSIS TYPE 643.

using a 120 volt battery (with one slight modification noted later).

Discussion on the Circuit

The complete circuit diagram is given in Fig. 1. The first valve is a straight R.F. amplifier, the gain being varied by adjustment of the screen voltage. Regeneration becomes evident when R6 is well advanced. If, as happens with some of the coils, actual oscillation occurs, R6 must be backed off a little. This regeneration is considered an advantage rather than a disadvantage. It gives an increase in gain, but, more important, it also improves the selectivity.

The R.F. grid circuit tuning condenser is independently adjusted. Optimum results are thereby obtained and the construction simplified.

At first sight, R1 may appear superfluous. It is included to prevent the grid of V1 being deprived of bias whilst the coil is being changed. The high value specified has no deleterious effect on the performance.

The output of V1 is shunt-fed to the coupling winding on the detector grid coil. In parallel with the latter are two variable condensers. The larger can be used for general purpose tuning, for which reason a slow motion dial is fitted, or as a band-set condenser. The smaller bandspread condenser is coupled to the full vision dial. The amateur bands are well spread out (details are given later) and fine tuning is possible on any of the short wave broadcast bands.

The detector valve is triode connected. Used as a pentode, smooth reaction control becomes virtually impossible and no improvement in signal strength is obtained.

Rather a lot of resistors and condensers appear in the anode circuit of the detector valve, but they all serve useful functions. In the main, the additional decoupling is inserted to make very sure that no radio frequency voltages reach the grid of the EF50 audio amplifier. It may not perhaps be generally realised that many minor troubles with a T.R.F. set—for example, threshold howl, hand capacity effects and "ploppy" reaction —are frequently due to the audio valve amplifying R.F. voltages, these then being fed back to the earlier stages. The EF50 gives considerable gain, and it is particularly important to filter out R.F. voltages. The small resistors and condensers cost but little and are well worth including.

Shunt feeding to the anode of V2 is necessary, and R9 performs this function. R10 is the anode load. The combination of C12, R13, C14 and R15 forms a very effective low-pass filter.

The value of C13 is given as 0.5 uF, and this is the minimum value that should be employed, to prevent noise being audible when rotating the reaction control R11. This value can, with advantage, be increased, and a 2 or 4 uF electrolytic condensor (200 or more working volts), if obtainable, should be substituted.

A resistor is used as the anode load of the EF50 output stage, and the output is entirely adequate for all normal needs, when using telephones, or even with a small speaker. If it is intended to use a speaker regularly, a pentode output transformer, with a ratio of 60 to 1, should be substituted for R18. C18 and the telephone jack can remain, the low impedance winding on the transformer being taken to a terminal strip, for connection to the speaker. In this case, the value of R17 should be reduced to about 10,000 ohms. These modifications will, of course, increase the H.T. consumption.

No audio gain control has been

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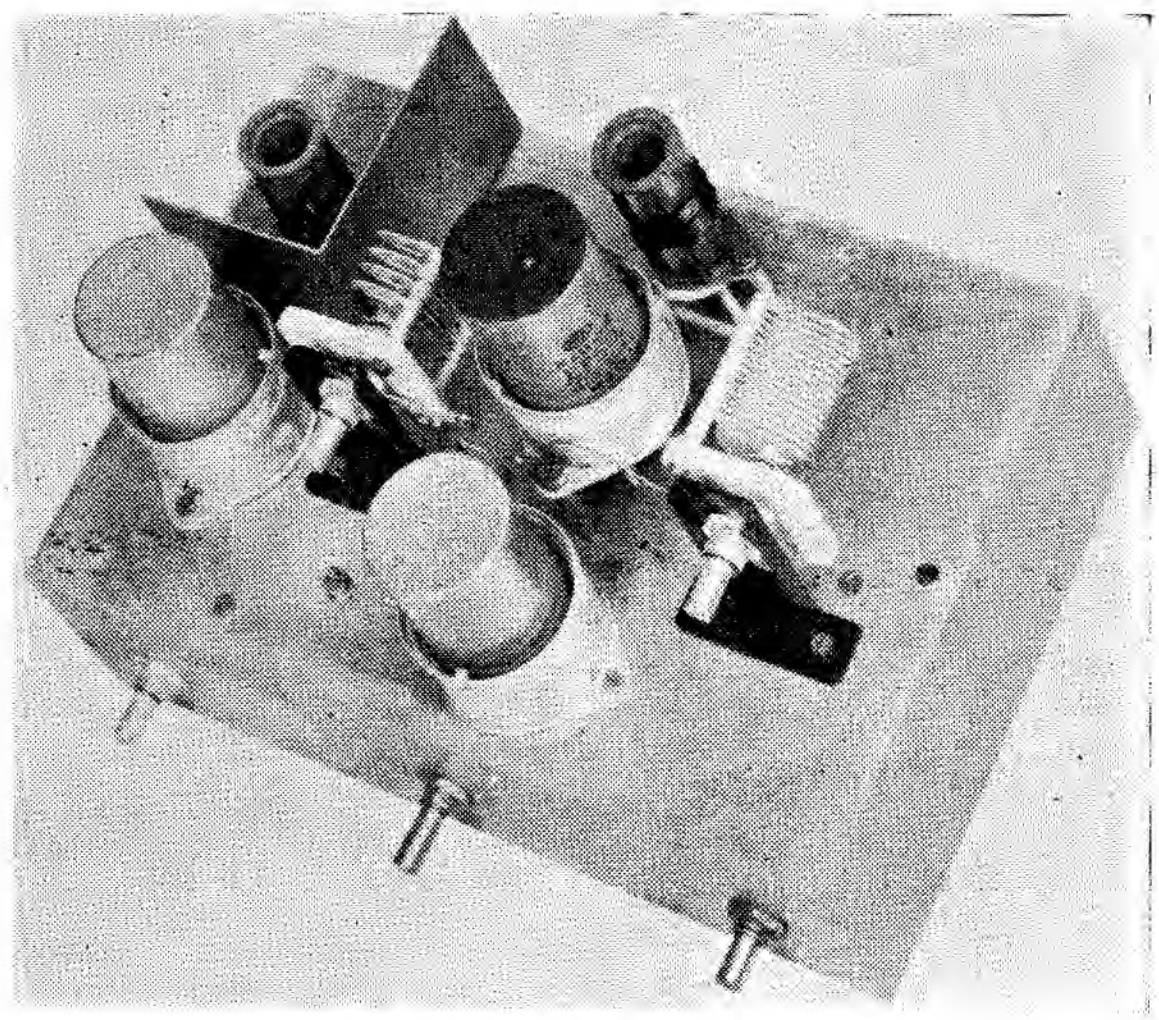


Top View of the Chassis.

found necessary, as the R.F. gain control permits a wide range of signal strength adjustment.

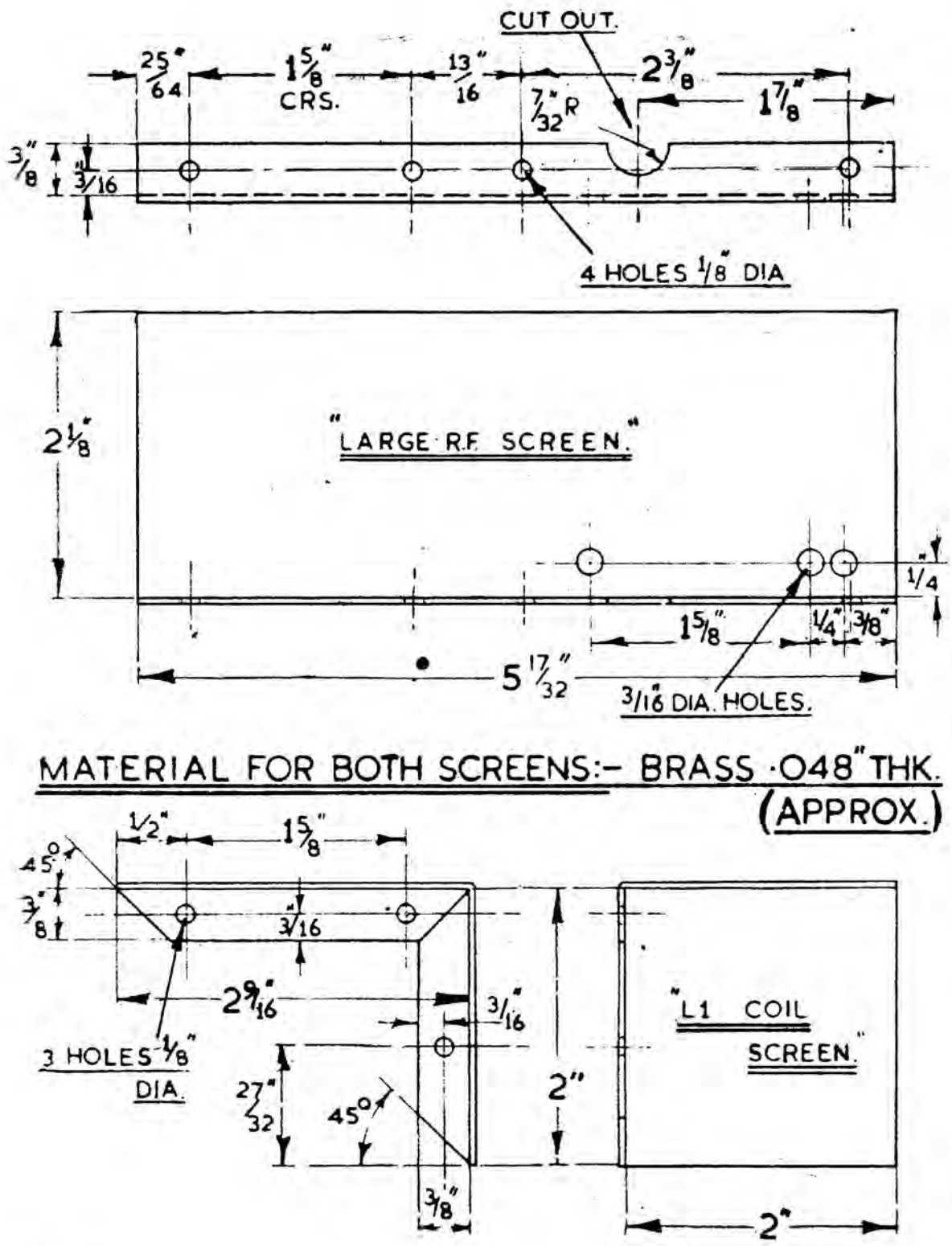
Points Regarding Frequency Coverage

As the coil data panel shows, coils are available covering frequencies from 33 Mc/s to 150 Kc/s. This is a wide range, and it is practically impossible to arrange the circuit constants to give optimum results over the entire possible coverage. The values recommended form a good compromise.

If the main interest lies in the higher frequencies—say, 7 Mc/s upwards—the value of C1 and C6 can well be reduced to 25 pF, and that of C10 to 100 pF. On the other hand, better results will be secured on medium and long wavelengths, if C1 and C6 are increased to 100 pF and an all wave type of choke (e.g., the Eddystone Cat. No. 1066) included in lieu of the 2.5 mH type specified.

Construction

The diecast aluminium chassis, on which the receiver is built, is easy to work, and, as comparatively large holes are required, the construction is fairly easy. Only two small screens are required, and they may be made of any metal available—brass or aluminium of about 18 gauge (.048-in. thick) is recommended. Details of the screens and of the holes in the chassis are given in Figs. 2 and 3.



EDDYSTONE COILS

Coil Type.	*Frequency Coverage.*
706/LB	33-15 Mc/s.
706/Y	16-6.7 Mc/s.
706/R	7.5-3.1 Mc/s.
706/W	3.3-1.35 Mc/s.
706/P	1.4 Mc/s.-720 Kc/s.
706/G	750-300 Kc/s.
706/BR	370-150 Kc/s.

The R.F. Stage

The R.F. stage is a compartment formed on three sides by the chassis walls and on the fourth by the screen. The latter is fitted close up to the valveholder, which must be fitted as indicated in Fig. 2, so that the length of anode lead actually in the R.F. compartment is very short. This compartment houses C1, C2, C3, C4, R1, and R2. Resistor R4 is soldered to the centre tag of the gain control potentiometer, as also is C5.

Condensers C3 and C4 are mounted across the valveholder in an upright position, to provide a measure of screening between the grid pin (No. 7) and the anode pin (No. 3). The screen above the chassis shields the coil from other parts of the receiver. The lead-through insulator, used as the aerial terminal, is fitted to the rear of the chassis and projects into the R.F. compartment. Alongside this insulator is a 4BA bolt for an earth connection.

The Detector Stage

Coupling condenser C6 and the R.F. choke are supported, at the anode end, by a miniature stand-

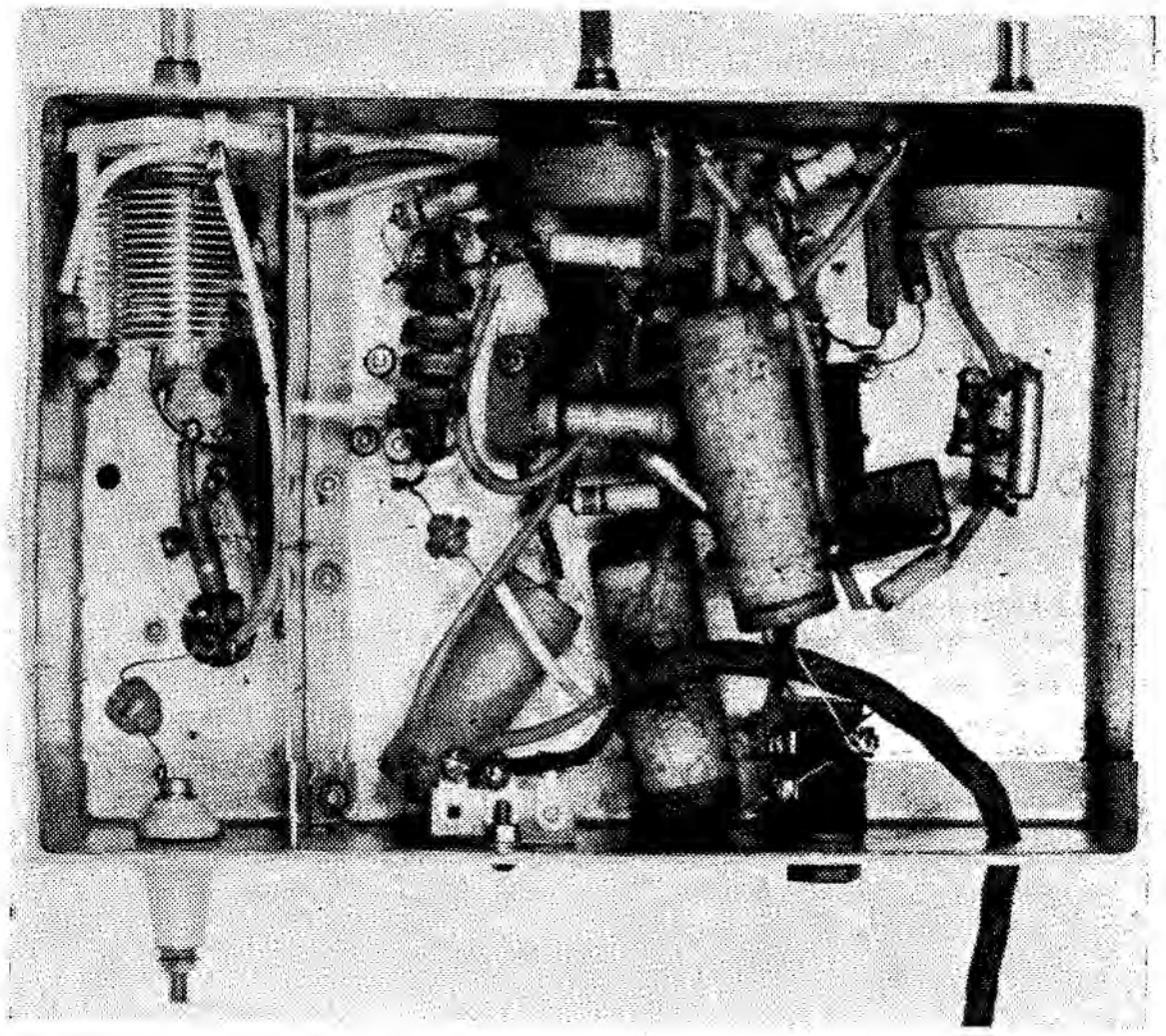
(Continued)

off insulator. The other end of C6 goes direct (through a hole in the chassis) to the coil holder. The other end of the R.F. choke is held by a two-way tag strip, which also takes R3.

Several advantages obtain from mounting the detector valve and coil on pillars, well away from the chassis. Construction is simplified, leads are kept short and stray capacities are minimised. The pillars used for the coil holder are 1 in. long, and those for the valveholder 1 in. long. If any difficulty is found in purchasing suitable pillars, they can easily be made by sawing off lengths of small diameter tubing, the centre hole of which is large enough to take a 6BA bolt. Before permanently mounting, wires of appropriate length should be soldered to the coil holder sockets and all connections made to the valveholder, including the fitting of C9, C10, R8, and R9.

Tuning Condensers C7 and C8 are positioned with the spindle 1 inch above the chassis. The rotors are earthed, by the large tags provided, to a soldering tag fitted beneath the nearer fixing bolt of the V2 valveholder.

The audio stage is straightforward and calls for no particular comment, except perhaps to mention that the grid stopper (R15) is fitted very close up to tag 7 on the valveholder.



The Underside Wiring.

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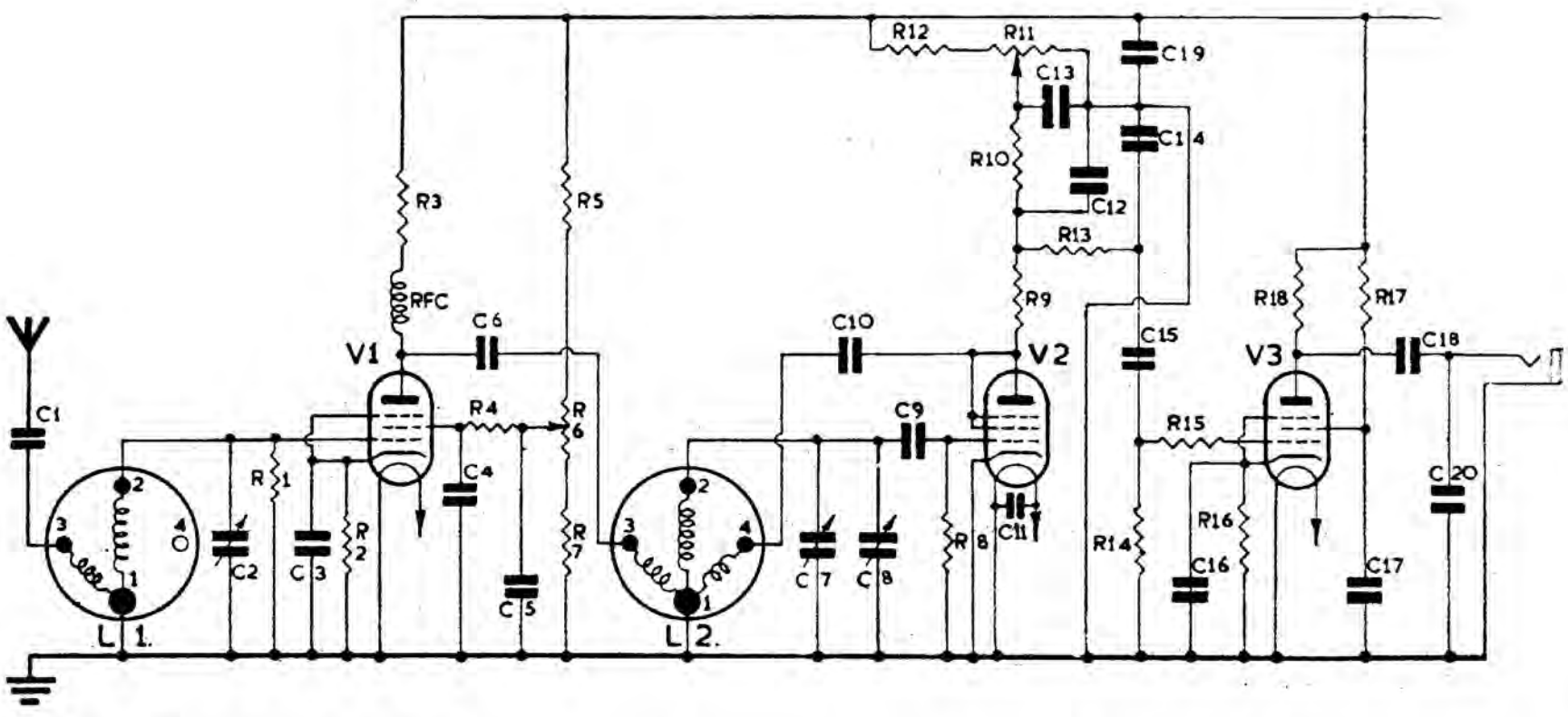

T.R.F.

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The power lead takes the form of a three-way cable, anchored to a three-way tag strip.

Fitting the Chassis to the Cabinet

Holes are provided in the chassis and cabinet to enable the two to be fitted together, a 2¾-in. length of 2BA screwed brass rod being required for the purpose.

When coming to the holes in the front of the cabinet, a smear of vaseline or other compound should be placed on the spindle of the centre potentiometer (R11), so that, when the chassis is pushed up against the panel, a mark is left on the latter. A pilot hole is drilled out and further pilot holes made at the appropriate distances to right and left of the first hole, for the spindles of C2 and R6. The pilot holes are then enlarged to ¾-in. diameter, either by means of a punch or by drilling a number of small holes and filing clean.

The same procedure is followed for the two 13/16-in. holes required for the slow motion dial heads. Care should be taken to mark the holes correctly, at least in the horiontal plane. Errors in the vertical plane can be taken up by up and down movements of the tuning condensers.

A little difficulty may be found fitting the index to the dial on C2. A 6BA tapped hole is necessary, and, if a tap is not available, it will be as well to leave out the index, since accurate readings of this dial are not necessary. Set condenser C2 to full mesh before finally fixing the chassis inside the cabinet.

Operation

A well smoothed power unit delivering a voltage between 150 and 250 volts is suitable for the H.T. supply. As mentioned earlier, a 120 volt day battery may be used, in which case R12 should be omitted. No switch is included in the receiver itself, as it is assumed that one will form part of the power unit. If an H.T. battery is used, means should be provided for breaking either the positive or negative lead, to prevent the small drain through R5, 6 and 7 and R11, during periods when the set is idle.

Any type of aerial may be employed—good results have been obtained on a short length of wire, but, as with any other receiver, the better the aerial, the better the results. If a long aerial is used—that is, over 66 feet long—it may be desirable to reduce the size of the condenser C1 in series with the aerial coupling winding.

Slight microphony may be found with some EF50 valves. If it occurs, the valves should be changed. round, paying particular attention to freedom from microphony in the detector valve.

Particulars of the approximate settings of the dials for the various amateur bands are given in the accompanying table and, provided the specified lay-out is adhered to, fairly close agreement should be found with the figures shown.

All the coils are wound to close tolerances and, in the case of the higher frequency coils, the read-

(Continued on page 42)

Components List

1 Diecast Chassis Cat. No. 643.
1 Metal Cabinet Cat. No. 644.
2 Ceramic Microdensers 140 pF (C2, 8) Cat. No. 586.
1 Ceramic Microdensers 12.5 pF (C7), Cat. No. 580.
2 Coil Bases. Cat. No. 707. Coils as required (see panel) Cat. No. 706.
3 Valves type EF50.
3 Ceramic Valveholders B9G. List L500.
3 Retainer Rings and Bases. L568.
2 Metal Brackets Cat. No. 708.
2 Flexible Couplers Cat. No. 529.
2 Slow Motion Drives 2-in. Black Cat. No. 597.
1 Full Vision Dial. Cat. No. 598.
1 Direct Drive Dial 2-in. Black Cat. No. 595.
2 Skirt Knobs Cat. No. 2416.
1 Lead-through Insulator Cat. No. 695.
1 R.F. Choke 2.5 mH. Cat. No. 737.
1 Miniature Stand-off Insulator. Cat. No. 1019.
2 Potentiometers 100,000 ohms (R6, 11), type SG.
1 Telephone Jack.
5-way tag strip, insulating sleeving, etc.

Resistors

(All except R16 are ½ watt).
R1, 2 megohms.
R2, 220 ohms.
R3, 4, 7, 10,000 ohms.
R5, 12, 33,000 ohms.
R8, 4 megohms.
R9, 13, 22,000 ohms.
R10, 15, 47,000 ohms.
R14, 0.5 ohms.
R16, 560 ohms.
918, 25,000 ohms (1 watt).
R17, 100,000 ohms.

Fixed Condensers

C1, 6, 50 pF Ceramic (see text).
C3, 4, 5, 11, .002 uF Moulded Mica.
C9, 100 oF Silvered Mica.
C10, .00003 uF Moulded Mica.
C12, 14, 20, .0005 uF Moulded Mica.
C13, 17, 0.5 uF Paper (see text about C13).
C15, 18, .01 uF Metalmite (TCC).
C16, 50 uF 12v. Electrolytic.
C19, .01 uF Moulded Mica.

Converting That Prop Motor

MANY hams have purchased Douglas aircraft variable pitch prop motors for rotary beams and other uses. This very excellent motor is ideal for this purpose, because it will operate off 25 volts D.C. or A.C., and has a tremendously high reduction ratio, in the order of 3000 to 1, which permits the motor to develop high power and turn the heaviest beam mechanism with ease.

The motor, as it is received, carries a magnetic clutch, which must be removed for ham use. About an hour's work is all that is necessary to do this.

The technique of conversion is first to remove those two bolts holding a small plate into the throat of the gear box just below the mounting plate and withdraw the plate to which a small plug is integral. This plug operates stops in the gears and should be sawn off to keep the hole closed, but to miss engaging stops.

Next, the light metal cover should be withdrawn from the motor itself and the assembly on the extreme outboard end of the motor should be completely removed. This is a friction brake which is normally hard on and which can be released only magnetically at the expenditure of considerable current. The first step is to undo a little screw with a screw-driver which you will find holding a slip of metal to lock two turrets on the end of the motor casing. Without undoing the three bolts round the edges this end turret can be screwed right out. The composition disc which is held on to the motor shaft by the big sprocket can then be lifted out. The motor will then turn over, but it turns much more freely if the sprocket is removed from the shaft by undoing the turret nut on the end of the shaft and lifting the sprocket off. The bottom section of the brake can then be removed by taking off three nuts which you will see between the lower brake plate and the magnetically operated flexible plate.

With this gear removed the motor runs like a dream on about 25 volts A.C. The actual shaft power on the motor is surprisingly small—at that pressure very much less than a vacuum cleaner motor—but the torque on the output shaft is terrific and would turn a locomotive on a turntable. I don't quite know what the motor connections are, but, to my surprise, only three leads instead of the four needed on the standard series motor are necessary to reverse the job. This is, of course, a big practical advantage and only a simple single pole two-way switch is necessary for reversing.

Eddystone Catalogue

SINCE the earliest days of the radio the well-finished products from the English Eddystone factory have enjoyed unrivalled popularity with those radio enthusiasts who can afford the best.

The latest catalogue of Eddystone parts, recently supplied to us by R. H. Cunningham & Co., of 420 William Street, Melbourne, is full of interest. A number of new items have been listed in the latest catalogue, among them two which should be of special interest to many of our readers.

Catalogue number 678 is a modulation level indicator for experimental transmitters, that may be used as a phone monitor and field strength meter. It reads percentage modulation direct, and will show poor qualities, such as downwards modulation, etc., and finally, it makes an excellent neutralizing indicator.

Items numbers 709 and 717 in the new catalogue are 145 mcs. tuning assembly and beam aerial kits, respectively. They should be of considerable interest to Australian "hams," as no similar line has been offered before in Australia.

The range of transmitting and receiving microdensers has been expanded and will interest experimenters working on up to 500 mcs., and higher.

Eddystone components are available in Melbourne from J. H. Magrath & Co., and in Sydney from Geo. Brown & Co., and Price's Radio.

Rumour from England indicates that the new Eddystone model 680 communications receiver is one of the finest and most modern 15-valve receivers ever produced, having variable i.f. selectivity, voltage stabilized oscillators, and many other advanced features. Samples are expected in Australia shortly.

Speedy Query Service

Conducted under the personal supervision of A. G. Hull

C.T.H. (Heidelberg) enquires about a kit of parts for a small mantel model.

A.—It is rather out of place for us to make a firm recommendation in these columns, but the offer by Magraths in last month's issue is something quite out of the box, and one which we would point out to you as a grand proposition. This is a kit for four-valve mantel model, complete with valves and moulded bakelite cabinet for ten guineas. We know that this set builds up into a fine little performer which will do all you want. Fitting the dial cord and one or two trifles may make you scratch your head for a minute or two, but you'll soon work them out. The finished set is in every way equal to the factory-built sets costing from 18 guineas to £25. The offer holds good only for the month of April, so you will need to rush it.

P.H. (Horsham) asks about a rotary converter.

A.—Yes, although the rotary converter was originally designed for 12-volt operation, you should be able to run it quite well from a 6-volt car-type accumulator. The output voltages will be halved, but this should suit you quite well, as 150 volts is quite enough for the early amplifier stages, and 250 right for the output stage. The current drain on the battery will depend on the current drain taken from the output of the converter. Limit to current you can draw will be the voltage drop on heavy load, or the heating up of the converter in operation. Output will need filtering for the early amplifier stages, but you might get away without filtering for the final.

HAM-GEN.

(Continued from page 27)

thick, and you would pay £'s for it. There is so much scope these days in the radio field that all spheres cannot be covered in any one journal, and hence the need for specialisation. *Radio World* serves a great number of readers here and abroad, and I'll bet they all have interests in common. My job is to develop the ham and would-be ham material. Therefore, I would be grateful if anybody who has read this far would drop me a line and make some suggestions as to the type of articles they would be interested in.

Later on I hope to produce such stuff as a course in radio for the A.O.P.C. aspirants. How would that be? For next month I have some good articles coming up. In Adelaide recently I saw one of the best V.F.O.'s in VK to-day. I have the circuit of it and all the dope on making it up. Secondly, I have been playing with the V.H.F.'s of late, and find that one of the most useful gadgets—and I'll say, one of the most indespensible, gadgets is a grid dip oscillator for locating the bands and for checking the frequency of a condenser inductance combination. My good friend Jerry Walker, G5JU, has sent me out an excellent article on how to build one of these devices. That will appear also next month.

It is hoped that this section will not only be technical, but also topical, and carry an atmosphere of personalities. I think it is very interesting to read how the other person lives and operates. To this end we would like some contributions in the form of Station Descriptions from readers.

BARGAIN CORNER

Advertisements for insertion in this column are accepted free of charge from readers who are direct subscribers or who have a regular order placed with a newsagent. Only one advertisement per issue is allowed to any subscriber. Maximum 16 words. When sending in your advertisement be sure to mention the name of the agent with whom you have your order placed, or your receipt number if you are a direct subscriber.

WANTED: FS6 vibrator pack. Send particulars to L. P. Smith, Dunsborough, West Australia.

WANTED: To get in touch with cabinet maker who can supply blonde cocktail cabinets for radio gramophone. J. Petrie, Radio Dealer, 75 Macarthur Street, Ultimo, Sydney.

FOR SALE: Two Type P26 ASV receivers, 6-EF50, £4½ each. Wavemeters to suit, £1 ea. Two Bendix 28 v. type MP10G, power units, 1050 v. at 400 ma., and 230 v. at 100 ma., never used, £5 ea. P. W. Butler, 1 Darley Road, Randwick, N.S.W.

FOR SALE: Valves 6 x 6K7, 2 x 6K8, 1 x 6B8, 1 x EF50, 1 x 807, 2 x 6V6, One Saxon 8" permag, one 4-gang tuning condenser, 3 x 465 Kc. i.f.'s, and sundry parts out of a No. 19 transceiver. All good. £7 the lot. M. R. Shaw, Christmas Hills, near Yarra Glen, Vic.

T.R.F.

(Continued from page 36)

ings on the dials of C2 and C8 will be similar, allowing for the effect of the bandspread condenser C7.

On the lower frequencies, the position of the dust core will affect the coverage of any given coil. To begin with, the core should be well down inside the former. If, with the tuning condenser at maximum, it is then found that the frequency is too low, the core can be brought nearer the top of the former.

The core of the R.F. coil is adjusted so that resonance occurs with identical dial readings of C2 and C8. The tuning range of C7 will be small on the lower frequencies, and tuning will normally be carried out with C8.

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