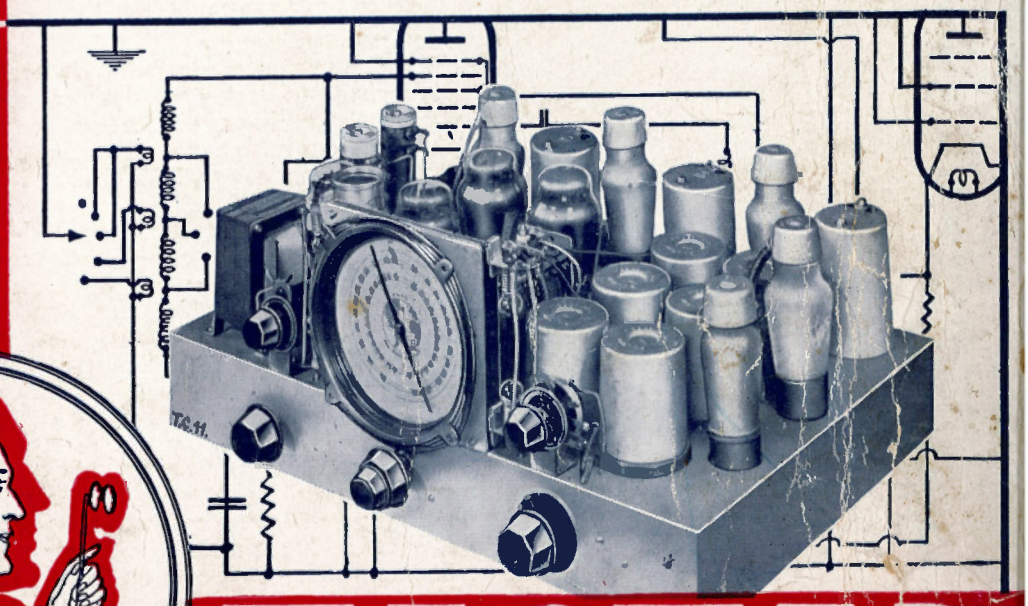
BULGIN

RADIO PROGRESS

NO. 3 ..... 1937/38

introducing



TESTED CIRCUITS

PRICE 1/0 COMPLETE

A. F. BULGIN & CO. LTD.

ABBEY ROAD, BARKING

TELEPHONE: RIPPLEWAY 3474 (PRIVATE BRANCH EXCHANGE).

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TEN TESTED CIRCUITS

No. 3

RADIO

BULGIN

The Choice of Critics

TEN TESTED CIRCUITS

No. 3

PROGRESS

Published by A. F. Bulgin & Co., Ltd.,
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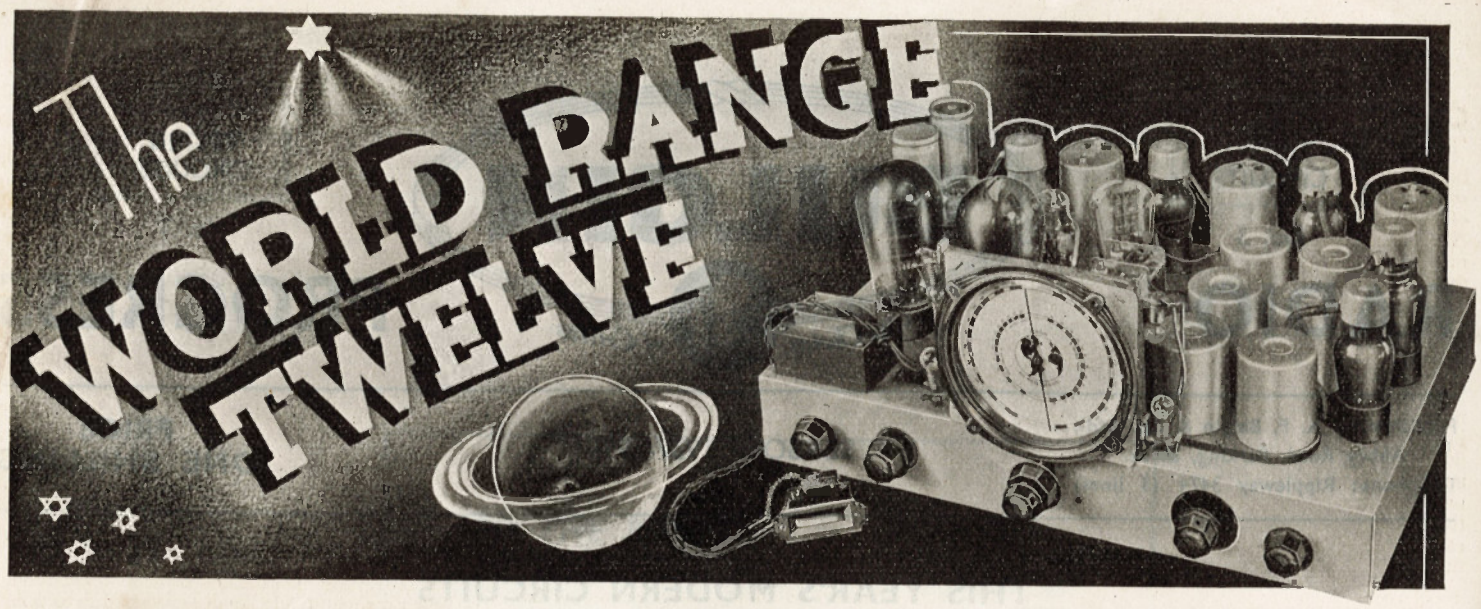
SEASON 1937-1938

PRICE ONE SHILLING

THIS YEAR'S MODERN CIRCUITS



FOUR WAVE BANDS FROM 18 TO 2,000 METRES
14 WATTS PUSH-PULL OUTPUT

TESTED CIRCUIT No. 21

VARIABLE SELECTIVITY
PRE-FREQUENCY CHANGER
H.F. STAGE. DELAYED Q.A.V.C.

THE steady spread of A.C. mains supplies is making the need for receivers of the "Universal" type less urgent than it was even a year ago. Last year, readers may remember, we offered what may be described as almost the last word in very powerful AC/DC domestic receivers. Improvement on this type seems hardly necessary, for it incorporated most of the modern features. This year we have decided to present a design for use on A.C. mains only, making full use of the possibilities opened up by that type of supply in the way of higher H.T. voltages.

Broadly speaking, the receiver to be described consists of a high-fidelity 12-14 watt amplifier combined on one chassis with a 4 band high efficiency receiving unit. Exceptional volume and quality are assured and the range may be truly described by that hackneyed term, "world-wide."

THE CIRCUIT.

Two PX25 valves are connected in push-pull to give 12-14 watts undistorted output, and are fed by a paraphase arrangement employing one valve for phase-changing. This enables resistance capacity coupling to be used throughout for the sake of quality, while the ample H.T. voltage available renders "de-coupling" by means of resistance-capacity filters quite easy and straightforward. Anti-parasitic resistances are included in the grid and anode leads of the output valves. The first L.F. amplifying valve, V8, is fed with signals obtained by rectification in a double-diode valve with its diodes connected together; this L.F. valve (V8) feeds V10, one of the PX25s, from the grid circuit of which signals are picked off by means of a potentiometer and applied to the grid of the phase-changer, V9, whose anode circuit passes on a signal in opposite phase to that at the anode of V8, but of equal intensity.

USING A PICK-UP.

Pick-up sockets are of course included in the design. To obtain the full 14 watts output, an input of only 0.5 volt R.M.S. is necessary. Should the receiver be made the basis of a radio-gramophone, its response is such as to justify the use of an extremely good pick-up.

VARIABLE SELECTIVITY.

On the H.F. side, the sensitivity has been maintained at a high level, and the noise-signal ratio kept low by the use of a stage of pre-mixer H.F. amplification at signal frequency. The frequency changer feeds the I.F. signal to two stages of I.F. valve amplification, each stage working comfortably within the limits of stability. The first I.F. Transformer is of the variable selectivity type: a third winding has a variable resistance across it and when this is at minimum, the absorption of power from the primary and secondary windings by the third winding effects a decrease in sensitivity (i.e., gain) and a broadening of the band of frequencies passed. Thus on local transmissions the finest quality can be secured, while for weak and distant reception tuning can be sharpened with a reduction in noise level and interference.

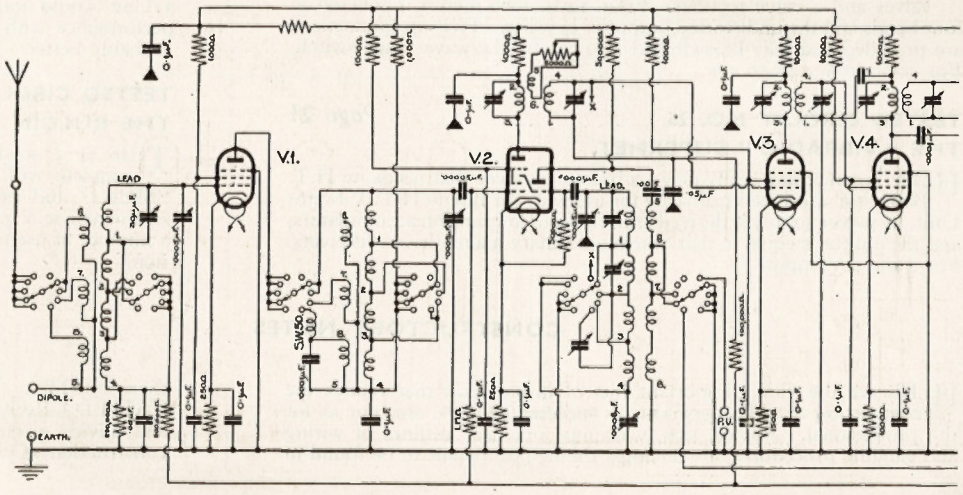
INGENIOUS Q.A.V.C.

Q.A.V.C. is effected by the diodes of a double-diode-triode valve, V7, the action of which is as follows:—

When no signal is being applied to the diodes (through a condenser to the anode of the 2nd I.F. valve, V4), the current passed by V7 and V8 combined is sufficient to set up across the 300 Ω cathode resistance a voltage that paralyses V8. The paralysing voltage can be controlled manually by the variable resistance in the anode of V7, so that any required degree of Q.A.V.C. can be obtained. When a signal above a predetermined strength comes through, the negative voltage obtained by the rectification at the V7 diodes lessens the current through V7 by its action on the control grid of this valve through a 1 MΩ resistance, which lowers the paralysing voltage across the cathode resistance, and in turn thus enables V8 to start functioning.

THE VISUAL TUNER.

Besides controlling the grid of V7, this A.V.C. voltage also controls the grid of V6, in the anode circuit of which is included a VT50 visual tuning meter, operated by changes of the anode current of V6. Two sockets are provided on the top of the chassis whereby connection to this meter may be readily made, enabling the instrument to be fitted at the most convenient point for easy



viewing. If dispensed with for any reason, its place in the circuit should be filled by a 5,000 Ω ½ watt resistor.

COMPLETE STABILITY.

Ample "de-coupling" arrangements have been incorporated in the H.F. anode circuits, so that no trouble is experienced with any form of instability despite the high overall gain. Also, there is very unlikely to be any trace of mains hum or mains borne noise, thanks to these complete anode-circuit de-coupling arrangements.

DOUBLET OR "L" AERIAL.

Three sockets are provided for aerial connections. If a doublet type of aerial is used, in order to obtain the best results on the short-wave bands, two of the sockets marked Aerial and dipole in the theoretical diagram can be used. If, however, an ordinary aerial is used, the Doublet socket should be earthed. This can easily be done either permanently under the chassis or by means of a short flexible link.

CONSTRUCTION.

Those who order the complete kit of parts for the construction of this receiver will receive a free complete set of full size blue-prints, which, in conjunction with a study of these instructions, will render construction somewhat easier than might appear from a casual glance at the diagrams.

The chassis is ready-drilled with the holes required for the mounting of the components. All the components may be mounted on the chassis before wiring up is commenced. But the rotary wave-change switch assembly should be left lying loose in its bush hole and not tightened home until the bottom tags, lying nearest the undersurface of the chassis have been connected up to their coil tags, etc. The slight amount of play so allowed will permit the easy access of the soldering-iron bit.

Valve holders are of course fastened to the underside of the chassis by means of 6 B.A. screws and nuts. In several places, it will be noted, soldering tags are placed under the nuts, for chassis connection purposes. It is advisable not to rely simply on the tension of the screw biting through the enamel on the top surface of the chassis, but to scrape away a little of the enamel from under the round head of the screws so that electrical contact is made to the steel of the chassis and the soldering tags are thus properly earthed.

It will also be necessary to leave the fixing of the slow motion tuning drive to the condenser until last thing, to avoid the warping and bending of the assembly while the chassis is upside down during the wiring up.

A perusal of CONSTRUCTORS' NOTES on Pages 39 and 40, will be found of assistance before starting the wiring up.

WIRING UP.

It is essential that the lay-out given in the practical wiring diagrams should be closely followed.

If the wiring is clumsily and carelessly disposed and/or jointed, the set will not function at its full efficiency, no matter how good the components may be in themselves. It may even refuse to function at all, being rendered hopelessly unstable by stray couplings due to untidy wiring.

AVOID BAD WIRING!

The following are to be eschewed:

(a) Not cutting the wire to the correct length to allow a component to lie in its proper position, but taking up slack in the wire simply by curling it up anywhere:

(b) Not troubling to have resistors and tubular condensers in their correct positions, but putting them anywhere where it seems to be convenient to put them and altering the wiring to suit these novel positions:

(c) Leaving odd lengths of wire uncovered by insulation:

(d) Using a thinner gauge of wire than that specified, which is mostly 18 S.W.G.: Bulgin "Quickwyre" is specified and is strongly recommended for use: using thinner wire to support small components will result in their sagging badly out of position, and probably short circuiting to each other and to the chassis.

TWO WIRING DIAGRAMS.

Two wiring diagrams are given. No. 1 diagram should be completed first. It forms a layer of wiring nearest to the undersurface of the chassis. If one can imagine the chassis to be sliced in half parallel to its top, the wiring shown in Diagram 1 would lie in the half including the top, and Diagram 2 would contain the wiring in the open half. Hence, first the wiring nearest the underside of the chassis surface should be done, and then that shown in Diagram 2 should be carried out. Carried out in this way, it is unlikely that very much difficulty will be encountered in following the lay-out fairly closely.

WIRING PROCEDURE.

As advised in CONSTRUCTORS' NOTES, on Pages 39 and 40, a definite procedure should be adopted when wiring up. The heater wiring is first laid down. It is twisted together, in order to neutralise the A.C. fields of these wires. Note that the four H.F. valves, the five L.F. and diode valves, and the two P.X.25 output valves, form three groups each supplied by a separate L.T. winding on the mains transformer. A heavy guage of wire—16 s.w.g.—should be used for these heater connections and the soldered joints to valve sockets should be made carefully and thoroughly, as a very little resistance here would prevent adequate heater current reaching the valves.

MAKING GOOD SOLDERED JOINTS.

It is particularly advisable to use the minimum amount of solder required for a neat, clean joint. If a great deal of solder and flux are used, the surplus will run down on to valve holders, and may cause serious trouble owing to the setting up of leakage paths. Not only does the solder form "icicles" that may be concealed from the constructor by components, but most fluxes, when overheated and slightly burnt by the hot soldering iron, make very poor insulators. Since there are a number of fairly high resistances used in the circuit, even comparatively small leakages due to poor insulation and the running of flux may seriously affect performance.

When the heater wiring has been laid down, the bus bars running right across the chassis may be soldered into position by the soldering tags provided. These bus bars, of course, do not need insulating covering, as they merely form convenient earthing for various components.

SWITCH WIRING.

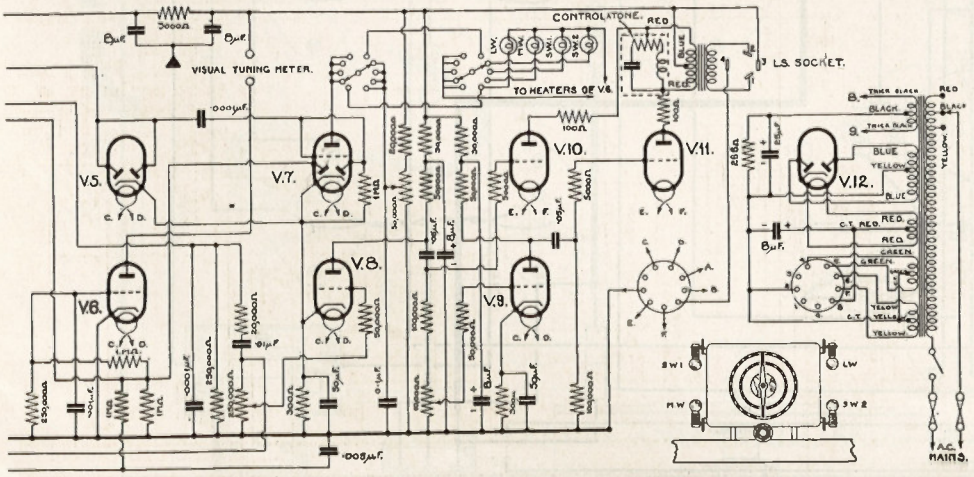
The bottom tags of the switches may next receive attention. A pair of long, thin-nosed pliers is useful for holding in position the wires connecting switch and coil tags while soldering is being done. Having been purposely left loose, the switches (slipped on to the square driver rod) can be moved a little to allow the bit of the iron to reach the tags nearest the chassis underside. These tags are tinned and take the solder very readily if both they and the ends of wire are reasonably clean and *very* lightly smeared with flux.

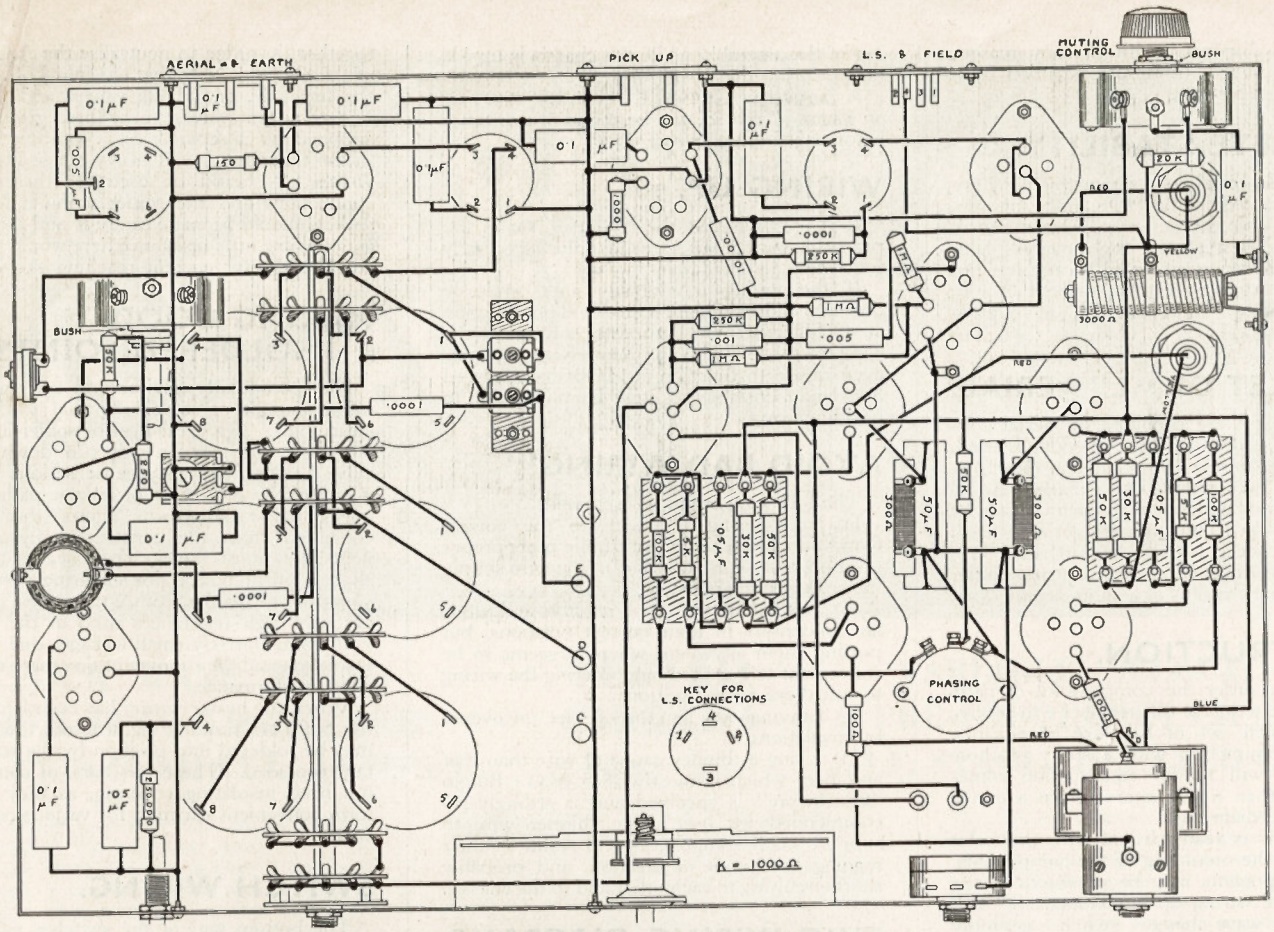
Before wiring up these switches, of course, care must be taken to see that all the contact units are in the correct positions relative to the locator unit and each other. Thus, if the locator unit knob is set to the middle contact, all the rotors of the contact units should be making contact with the middle tags.

Once the bottom tags (i.e. those nearest the coils) of the switches—shown shaded in the wiring diagrams—are connected to their coil tags, etc., the switches' supporting brackets can be screwed permanently home and the bush nut tightened to fix the driver-locator unit in the front of the chassis. The top tags of the switches are shown connected in Diagram 2 and need not be done until Diagram 1 has been completed.

COMPONENT POSITIONS.

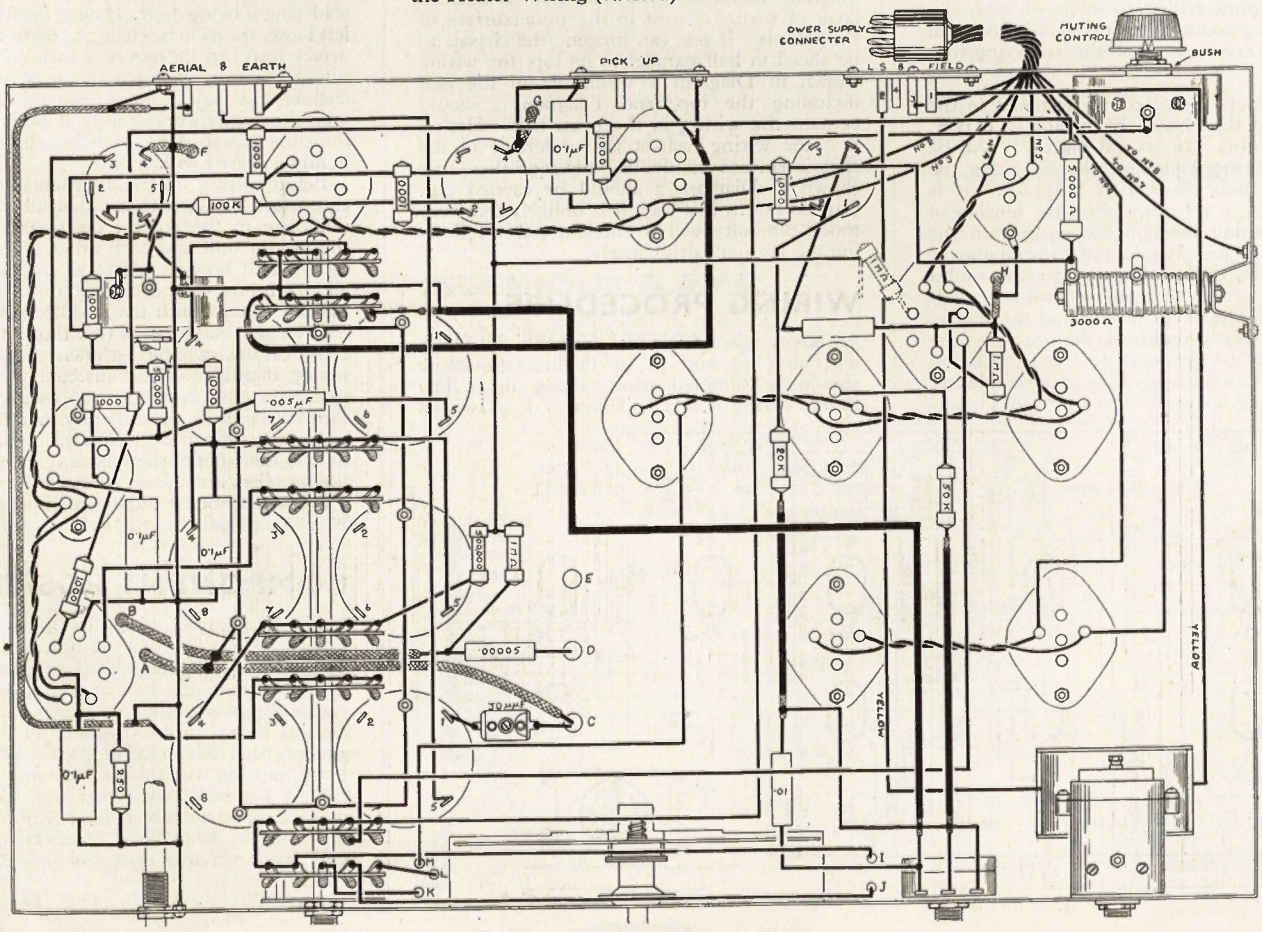
The best way of wiring in the resistors and tubular condensers that are not carried on the three terminal boards but are supported in the wiring, is to begin by connecting to suitable earthing points, either on the bus bars or to tags, as shown in the diagram, all those components that have one of their ends earthed. If the existing wire ends on them are not long enough to reach to the earthing points when these components are in their right positions, they may be lengthened by additions of wire and short pieces of systoflex slipped over the joint.





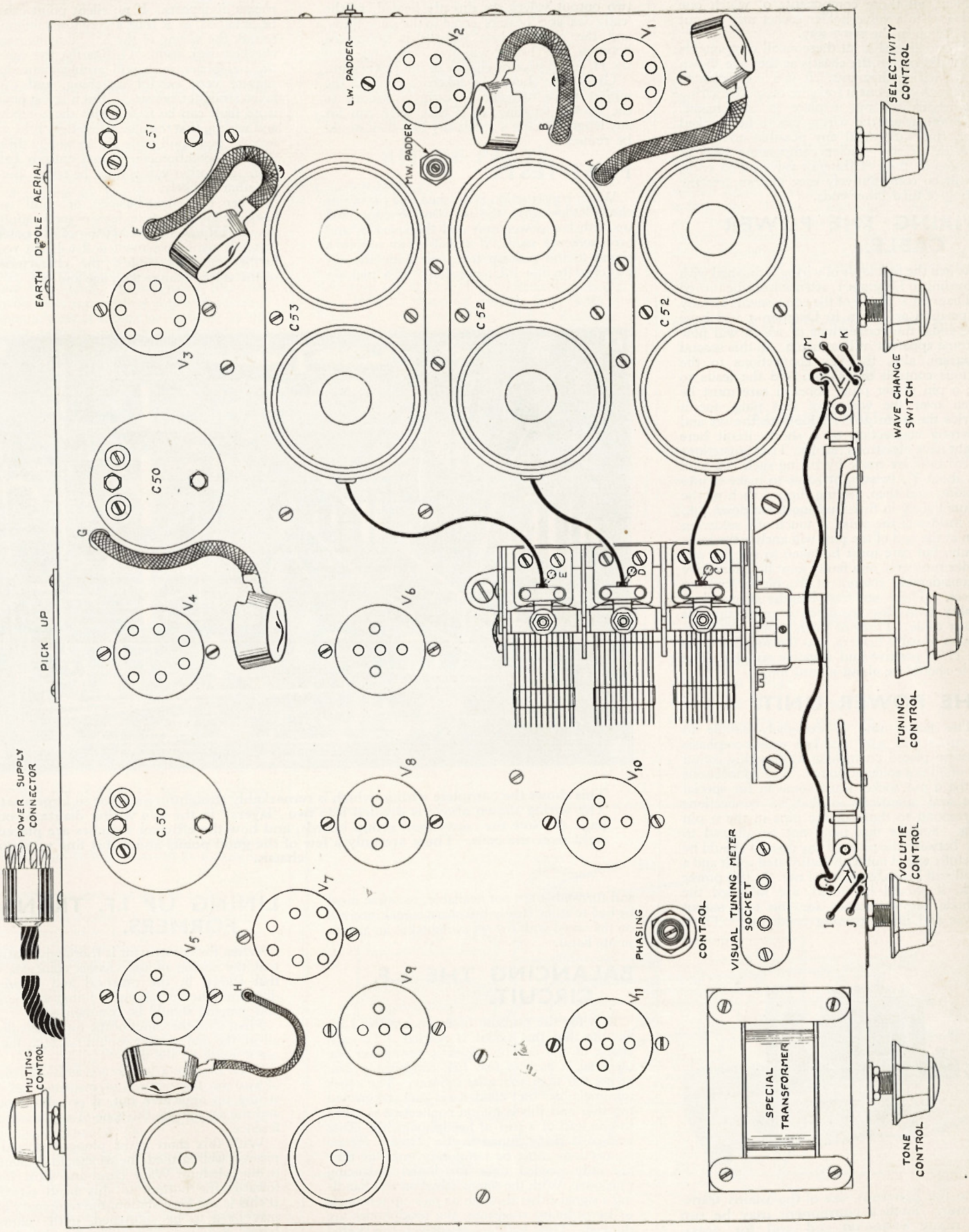
WIRING DIAGRAM No. 1

The wiring shown in this Diagram should be laid down first. Before doing this, however, refer to Wiring Diagram No. 2, where, for the sake of clearness, the Heater Wiring (twisted) has been shown.



WIRING DIAGRAM No. 2

When the wiring in Diagram No. 1 has been completed and the *twisted* wiring above, the remainder may be followed on this second Diagram.



PLAN OF VALVES AND COILS, SEEN FROM ABOVE.

Note the Visual Tuner sockets, and the Phase Balancing Potentiometer.

Next, all those components o which one end goes to a valve holder socket may be put in position in the same way.

This will enable all these small components to be laid out on the chassis as they are shown in the wiring diagrams. It is a good plan to mark each component and wire off on the wiring diagram as it is put in place in the chassis. Later on, when the wiring has to be checked over, this will reveal any possible omissions.

With all the smaller components held in position by their earthing or valve socket ends, it will be comparatively easy to complete the wiring of their other ends.

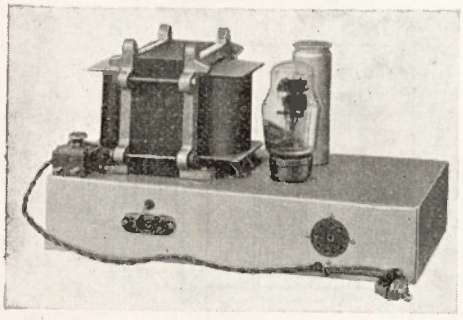
WIRING THE POWER CABLE.

When the first layer of wiring is finished with according to Diagram 1, attention can be turned to Diagram 2. Some of the components already in position as shown in Diagram 1 will have free ends, the connections of which will now become apparent in Diagram 2. In this second Diagram, also, the flex connections to the various controls are shown and the leads to the 9 pin power plug. Special care must be taken over the wiring of this plug, for it carries the main power supply to the set and a wrong connection or a short circuit here might have disastrous results. The connections to the pins are made by baring each flex wire for about ¾", twisting it so as to make it into a point, and then, having dipped each of the points lightly in flux, pushing them down into the insides of the pins. A touch of a soldering iron at the end of the pins will anchor the leads firmly, but care must be taken to see that the solder runs well, or a faulty joint here may give a considerable amount of trouble by causing noises. There are four lengths of excellent quality twin flex required to make up this power cable. Three of them supply the three groups of valve heaters, and the fourth carries the H.T. positive and negative supply. The cable should be about a yard long.

THE POWER UNIT.

The Power unit is extremely simple to construct and wire up, but again emphasis must be placed on making a throughly sound job of all the soldered joints. The connections to the 9 pin socket must come in for special care and attention, so that its connections correspond to those of the pins in the 9 pin plug. Surplus flux must not be allowed to flow between the pins. If any does, it should be carefully wiped out with methylated spirit and a small stiff brush, or piece of rag. In this power pack, it should be noted, are included the cathode bias resistance for the two output valves and its by-passing condenser. These two output valves are directly heated, so the 'cathodes' and 'heaters' come to the same thing, and the cathode bias resistor is connected between the heater-winding centre-tap and the H.T. negative or chassis of the power unit.

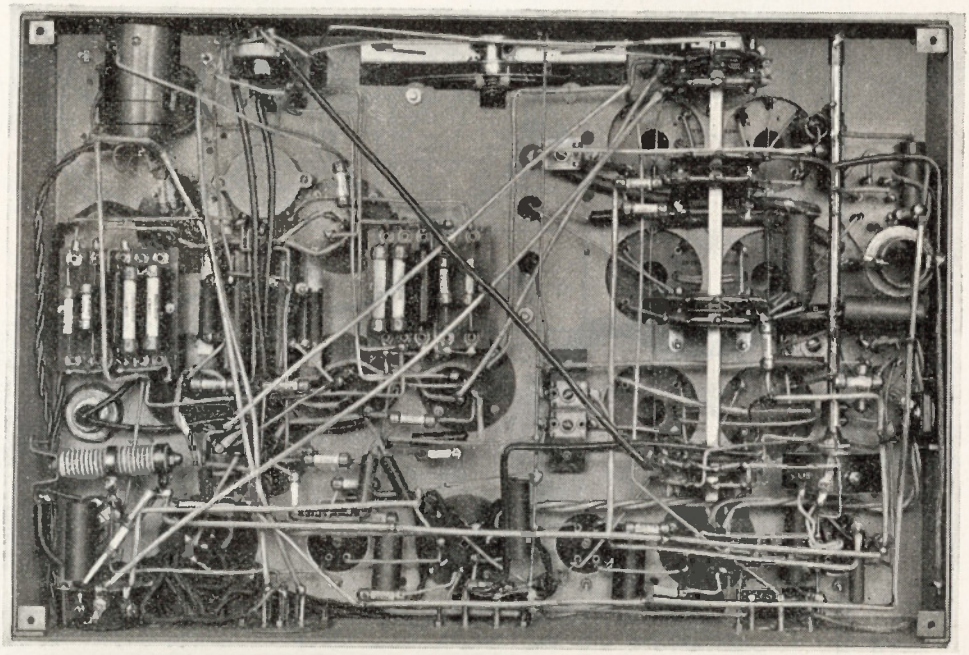
Great care should be taken to connect the output valve filament or cathode sockets to the correct winding, as if they were run for any length of time without any bias they would be ruined.



Note the generous size of the mains transformer. Such a component may be run for many hours on end and for years, without the least fear of breakdown or overheating. One amp. fuses will be ample safeguard.

FIRST TESTS.

When construction is finished *and the wiring checked thoroughly*, the set may be connected up with the power unit and the speaker, and arrangements made, if possible, to supply a signal to the pick-up terminals with the set switched to the P.U. position. If a pick-up and turn-table are not available, recourse must be had to some steady broadcast signal received on the aerial with the set switched to an appropriate band.



This shows the complete wiring, which is remarkably straightforward for so large a set. The wiring shown above is divided into two "layers" in the two wiring diagrams on page 4. Note the convenient group boards, and how the efficient switches are placed right over the coils. These are only a few of the good points about this fine receiver chassis.

BALANCING THE L.F. CIRCUIT.

It is for the purpose of balancing the L.F. circuits that this signal is needed. To each anode of the output valves is connected one terminal of each of two 1μF condensers *rated at not less than 500 volts working*. The other terminals of the condensers are connected together and this common connection is taken to one lead of a pair of headphones, the other lead of it being joined to the chassis. These connections must be temporary ones, as they are only needed once for initial balancing purposes. With the set switched on and handling a signal either through its pick-up terminals or by ordinary reception, the headphones are donned. Then with a screwdriver, the slotted shaft of the balancing potentiometer (10,000 Ω) set in the top surface of the chassis is turned this way and that *until the sound in the headphones disappears*. If no silent point can thus be obtained, or at least a very low minimum of sound, the wiring of the L.F. circuits must be checked over again. Ordinarily, the valves in the paraphase push-pull arrangement do not require very careful matching, and can be taken straight from stock, But it is just possible, if no fault can be found with the components and wiring, that the characteristics of the valves used in push-pull pairs are so widely different that the potentiometer cannot entirely balance them, and other valves must be tried. But this is rather unlikely.

When this silent-balance, or "null" point, has been found, the condensers and headphones may be removed. The setting of the potentiometer is semi-permanent and will not require further attention unless the characteristics; of the valves change with age and use.

LINING UP I.F. TRANSFORMERS.

When the constructor is thoroughly satisfied that the wiring of the chassis coincides with that shown in the practical and theoretical diagrams, the operations of lining up the I.F.s and ganging should be commenced.

First, with the vanes of the tuning condenser all-in, the dial pointer should be set at the 550 metre mark on the dial.

Then prepare a temporary aerial, consisting of two or three yards of insulated flex wire strung up anywhere but, if possible, both it and the set outside the zone of any local interference.

With this short aerial plugged in and the receiver well earthed, the set should be switched to the Medium Wave Band and some station towards the bottom of this band tuned in. If this is the local station, the temporary aerial may have to be shortened, until volume is barely audible. This is done to prevent the receiver's A.V.C. from coming into action. Receiving this station, the I.F. Transformer trimmers should be adjusted and set on the

peaks of volume obtained. Very little adjustment should be necessary *if the lay-out of the components and wiring has been done in close conformity with the scheme given* in the blue prints or wiring diagrams. If this lay-out has been ignored, the probability is that the scheme of the wiring and lengths of lead will be such that the trimmers are unable to compensate for stray capacities. The variable selectivity knob at the back of the chassis should be set fully clockwise, or fully anti-clockwise for maximum selectivity while the I.F. trimmers are being adjusted, so that sharp peaks of volume are heard.

GANGING PROCEDURE.

When the I.F. Transformers have been thus lined up—the operation should be done carefully and thoroughly, for it is upon this that the sensitivity of the receiver largely depends—the temporary aerial should be replaced by the permanent one, in order that this full sized aerial's constants may be involved when ganging the H.F. stages. The procedure should be adopted as outlined below:

(1) Tune in a station near the bottom of the M.W. band, and adjust T1 and T2 tuning condenser trimmers for maximum volume.

(2) Tune to a known transmission, such as the National on 261 metres, and note the dial reading obtained. Adjust the Oscillator trimmer (T3) of the gang condenser until the calibration for this station is correct.

(3) Then return to the first station obtained and re-adjust T1 and T2 tuning trimmers for maximum volume.

(4) Next, some station—for instance, Brussels No. 1 on 483 metres—at the top of the M.W. band should be obtained. The Oscillator Padding condenser (T7) should now be adjusted for best volume, "rocking" the tuning condenser slightly back and forth as the adjustment is made.

(5) Return, now, to the first station tuned in at the bottom of the M.W. band, and repeat operations (3) and (4).

This will complete ganging on the M.W. band, and the adjustments made *should not again be touched.*

(6) Switch the receiver to the Long Wave band and tune to 1500 metres as marked on dial.

(7) Adjust the L.W. Padding condenser (T8) until Droitwich is received at maximum volume.

This completes ganging on the L.W. band.

(8) Switch the receiver to S.W. 1 range and receive a short-wave transmission of known wave-length. Many amateur stations announce their wave-lengths and frequencies periodically, so if one of these is selected, it should be listened to until it gives its details. It should be in the neighbourhood of 20 metres. Bring it to its correct tuning position on the dial by means of the small oscillator-coil trimmer marked T5 in the wiring diagram and to maximum volume with T4.

(9) Next switch to the S.W. 2 band and, similarly tuning in a station of known wave-length, set it to its correct tuning mark on the dial by adjustments of T6.

It will now be necessary to go again over the trimming through the Medium and Long Wave bands, for the adjustments on Short Wave bands will have slightly altered tuning. These final adjustments on L. and M.W. trimmers should be only very cautiously made but they will make a considerable difference to the liveliness of the set on these two important bands.

This completes the ganging of the receiver on all bands. It should be borne continually in mind that upon this series of ganging operations will depend the sensitivity and accuracy of the receiver. No matter how good the components are and how carefully the wiring has been done, results will be inferior unless this part of the construction, though it may seem laborious, is properly and methodically done.

KIT OF PARTS.

COMPRISING:—

ONE BULGIN T.C.21. CHASSIS; Two H.W.1. Resistors, 250Ω; Three H.W.28 Resistors, .25MΩ; One H.W.31 Resistor, .5 MΩ; Nine H.W.3. Resistors, 1000Ω; One H.W.31 Resistor, .5 MΩ; Six H.W.33 Resistors, 1 MΩ;One H.W.19 Resistor, 20KΩ; Four H.W.23 Resistors, 50KΩ; Two H.W.37 Resistors, 100 KΩ; Two W.E.7 Resistors, 50 KΩ; Two W.E.5 Resistors, 30 KΩ; One W.E.1 Resistor, 5000Ω; One P.R.8 Resistor, 3000Ω; Two A.R.300 Resistors, 300Ω; One P.R.1 20-watt 300Ω Resistor; Two C.52 Aerial Coils; One C.53 Oscillator Coil; One C.51 I.F. Transformer; Two C.50 I.F. Transformers; One S.W.50 Filter Coil; Thirteen P.C.P.1 Tub. Condensers, .1μF; Four P.C.301 Tub. Condensers, .0001μF; One P.C.105 Tub. Condenser, .01μF; Four P.C.205 Tub. Condensers, .005μF; Three P.C.101 Tub. Condensers, .01μF; One P.C.405 Tub. Condenser, .00005μF; Three E.C.17 Electro. Condensers, 50 μF, 25 V.; Two E.C.8 Electro. Condensers, 8+8 μF; One E.C.12 Electro. Condenser, 8+8 μF. Surge Proof type; One Tuning Condenser, C.V.3; One C.P.3 Trimmer, .0003 μF; One C.P.4 Trimmer, .0006 μF; One S.W.100 2-way trimmer strip, .00003+.00003 μF; One C.T.5 Controlatone de Luxe; One V.S.62 Vol: Control with Switch; One V.C. 40 3-watt Potentiometer, 100KΩ; One V.C.36 3-watt Potentiometer, 50 KΩ; One V.C.29 3-watt Potentiometer, 5000Ω; One S.151 Driver-Locator Switch Unit; One S.154 Contact Unit; Three S.153 Contact Units.; Two S.W.42 Valve-holders, 7-pin; Three V.H.49 Valve-holders, 7-pin; Eight V.H.48 Valve-holders, 5-pin; One V.H.50 Valve-holder, 9-pin; One P.63 Cable Plug, 9-pin; One P.62 Mains Input Socket Strip; One P.51 *Unmarked* 2-way socket strip; One P.61 A and E socket strip; Five P.65 Screened Valve Cap Connectors; Two C.31 5-way Group Boards; One Shaft Coupling, ¼" bore; One 9" round brass rod, ¼" diam.; One Type C Panel Bush, ¼" bore; Four B.650 M.E.S. Pilot Lamps; One E.H.9 Universal Bracket; Ten 6 B.A. Tubular Washers; Five Q.W.B. Coils of "Quickwyre"; One and a half yards of W.S.2 Screened Flex Wire; One and a half yards of W.S.3 Low Capacity Screened Flex Wire; One Bulgin Special Mains Transformer; One F.18 Fuse-holder and Mains Connector; One Output Transformer; Sundries, screws, nuts, washers, soldering tags, twin flex wire, bakelite discs, insulating fibre washers, etc., etc., complete for the full construction of the receiver and power unit.

PRICE OF COMPLETE KIT,

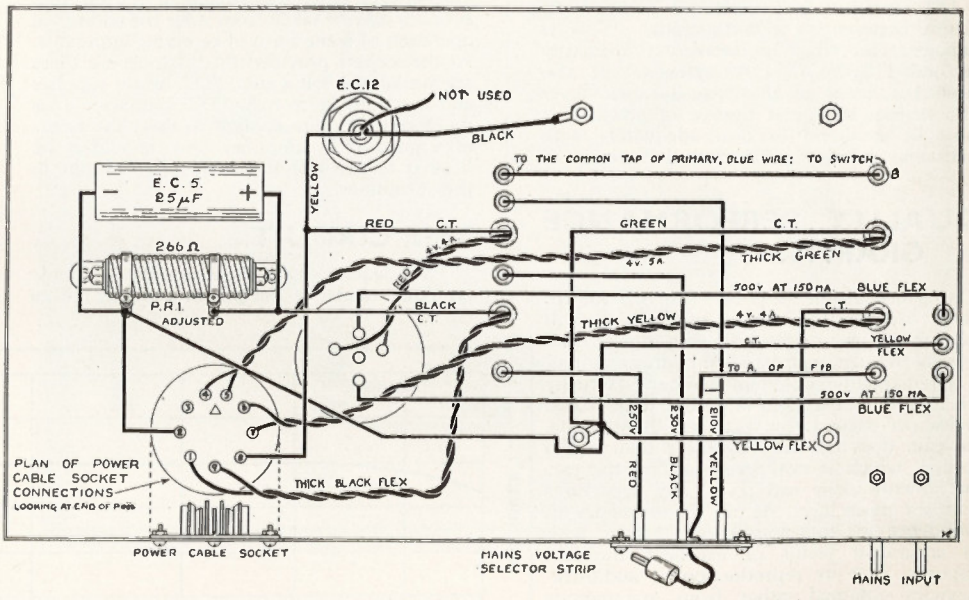
£15-5-0

ACCESSORIES.

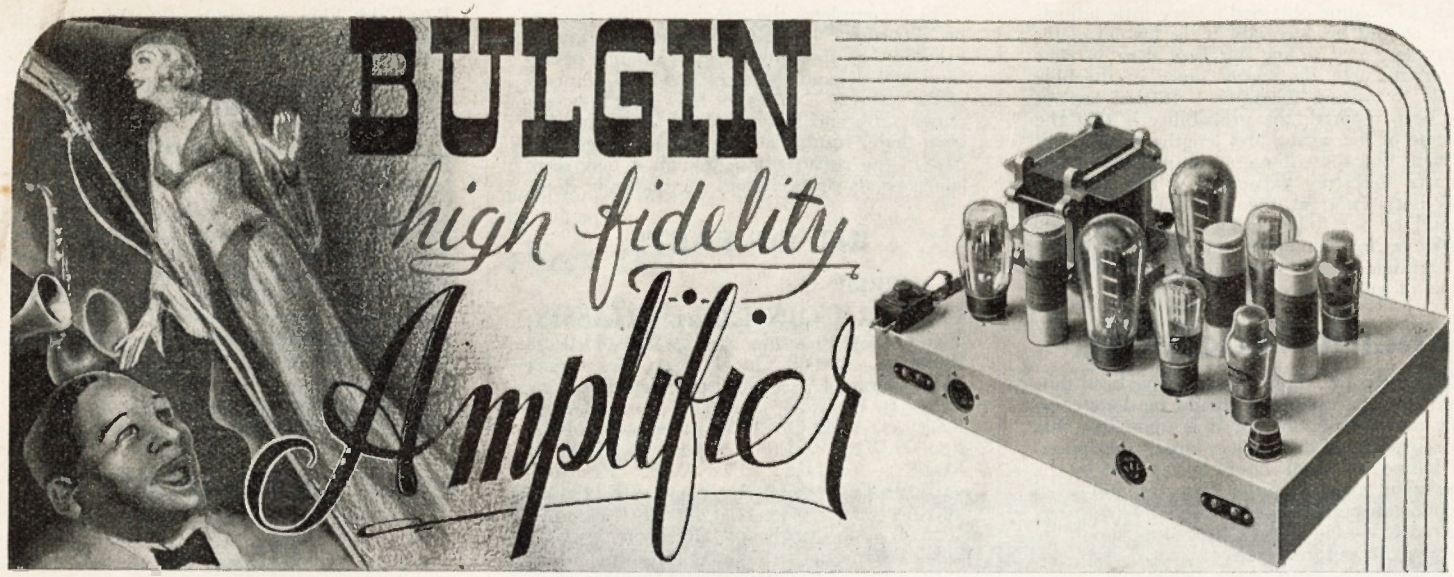
SPEAKER: The Rola G.12.M. 750Ω field. Less Transformer.

VALVES: as under.

V.1. Osram W42
V.2. Osram X41
V.3. Osram W42
V.4. Osram W42
V.5. Osram D41 or Hivac AC/DD
V.6. Osram MH41
V.7. Osram HD42
V.8. Osram MH41
V.9. Osram ML4 or Hivac AC/L.
V.10. Osram PX25 or Hivac PX5.
V.11. Osram PX25 or Hivac PX5.
V.12. Osram MU18.



The Power Unit is simple to wire, but, as high voltages and considerable L.T. heater current are involved, all connections must be thoroughly well made. Pay special attention to the cable socket connections.



THE PEAK OF QUALITY. 14-16 WATTS OUTPUT.

TESTED CIRCUIT No. 22

PARAPHASE PUSH-PULL R.C. COUPLED THROUGHOUT

IT is easy to design an amplifier that will make a loud noise. If volume alone is desired, it can be obtained by a mere combination of many valves and an ample power supply. It is entirely another matter, however, to ensure not only large volume but also the true representation of the sound originally made by the orchestra or speaker before the microphone. As everybody who has had any experience of sound amplification knows, this quality factor is the more important of the two—volume and quality—that are desirable in amplifiers. It is also more difficult to obtain.

12-14 WATTS OUTPUT.

The amplifier here described provides an output between 12 and 14 watts. This is sufficient for the requirements ordinarily demanded by small P.A. systems. It also meets the needs of the critical music lover who realises the great reserve of power that must be in hand to deal adequately with fortissimo passages in orchestral pieces.

QUALITY. PERFORMANCE GRAPHS.

A glance at the response "curve" shown, which includes the output transformer, will indicate that the whole scale of normally used musical frequencies is handled by this amplifier in a remarkably consistent manner. Actually the "curve" is a straight line from 30 to 10,000 cycles per second: for between these limits, the gain does not vary by more than half a decibel, which is not perceptible to the ear. Instruments alone can reveal any departures from the mean level. It may be claimed with confidence for this amplifier, therefore, with its additional factor of excellent transient response, that its reproduction of audio-frequencies obtained either from gramophone records, a broadcast receiving unit, or a microphone, is practically faultless, and that departures from fidelity will be caused only by the limitations of associated equipment.

SENSITIVITY.

To secure the full 14 watts of almost perfect reproduction, the input need be no more than .05 Volt R.M.S. This means that pick-ups and microphones may be used, of types that are designed for fidelity rather than for high output, without a stage of preamplification. If a broadcast receiving unit is employed, every device for ensuring good quality may be made use of without fearing loss in final output.

EXTRA POWER SUPPLIES.

The power pack used with this amplifier (incorporated with the chassis, not a separate unit) is very generously designed, in order that supplies may be taken from it for the additional operation of some form of receiving apparatus. At the sockets provided for this purpose there are available 4 volt 4 amp. A.C. heater supplies and 400 volts at 20 mA. D.C. supplies. This is, of course, quite enough to meet the needs of a good H.F. amplifier unit, should it be desired to use one to provide radio input to the Amplifier.

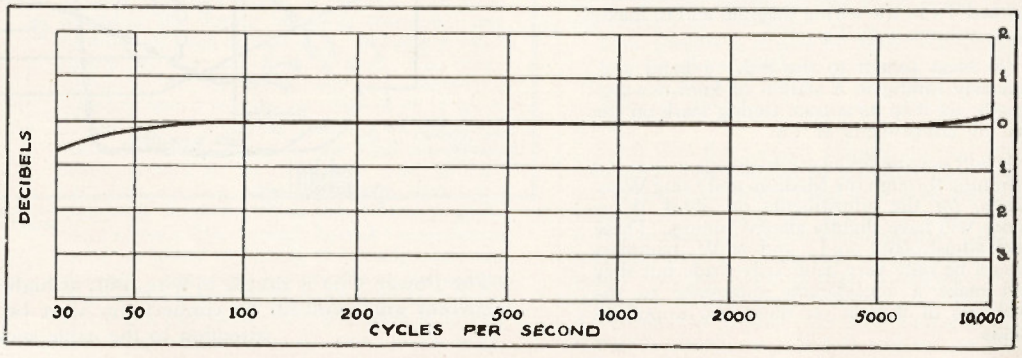
THE CIRCUIT.

The adequate high tension supplies available on A.C. render it simple to provide means for avoiding all the troubles occasioned by feed-back, while at the same time making use of the wide frequency response for which resistance-capacity couplings are noted. It will be observed, therefore, that the only transformer used (apart, of course, from the mains power transformer) is the output transformer, which is matched to the PX25 valves used in push-pull to feed speakers of 8 Ω speech coil impedance. This transformer is of good size, so that, in conjunction with the well-known fact that in Class-A push-pull the steady magnetic effects of the anode currents passing through the primary neutralise each other, the low D.C. resistance and high inductance enables bass to be well maintained —as is shown by the response curve. The remainder of the circuit is entirely R.C. coupled.

PARAPHASE PUSH-PULL.

It will be noted that a form of phase reversal is adopted known as "paraphase." Phase reversal may be obtained in several ways, of course; the commonest is by the use of split secondary transformers, but if R.C. coupling

Below:
Response Curve, including speaker transformer.



is desired, it is generally necessary to employ an "extra" valve to perform the reversing operation. In this circuit, this is done immediately following the input; part of the amplified signal from the anode circuit of V1 is fed to the grid of V2, wherein phase reversal and a restoration of gain takes place and a signal in opposite phase appears at the anode. Thereafter, the signals are handled in parallel, being amplified by V3 and V4 respectively and finally applied to the grids of the PX25s. In this way, amplitude and frequency distortion are almost completely avoided, since each valve is working well within the straight portion of its characteristic.

NO SPECIAL VALVE MATCHING.

Another advantage of the paraphase system of amplification is that carefully matched pairs of valves are not absolutely necessary. The effects of slight differences in characteristics and in the values of the practical forms of components used may be largely balanced out by means of the setting of the potentiometer by which part of the voltages on the grid of V3 are picked up and fed to the grid of V2. Of course, there are clearly limits to the amount of such difference, but they are normally outside the tolerances usually allowed in mass produced valves and components. Hence, it is not necessary to select special parts: all valves and components may be taken straight from stock, provided they are of the types specified.

THE SPEAKER.

Comfortably handling 15-16 watts, the speaker most suitable for use with this amplifier is the Rola G.12. It takes approximately 11 watts of power in the field coil, providing a very intense field in the gap. The cone is 10" in diameter and slightly curved for even response. A good baffle is of course eminently desirable. With a 750 Ω field, it is properly energised by being connected in series in the main H.T. positive lead, and also provides all the smoothing impedance needed.

USING TWO SPEAKERS.

The speech coil has an impedance of 8 Ω. Should the amplifier be required to feed two speakers, each speaker should have a speech coil impedance of 15 Ω and they should be connected in parallel. The field of the second speaker should be energised separately.

CONSTRUCTION.

A set of full size blue-prints is supplied free with each complete kit of parts. The construction is quite simple and with the blueprints no difficulty should be encountered during assembly and wiring.

All the components may be placed in position on the drilled chassis before wiring up is commenced. The lay-out is simple and fairly symmetrical.

WIRING.

When all the chassis mounted components have been placed in position, those holes in the chassis through which wires pass should be bushed with rubber grommets. It must not be forgotten that a potential of 500 volts is not to be treated lightly, and this is the voltage of the unsmoothed H.T. supply. It is bad practice to run wires through a hole in a chassis with no more protection against sharp edges of the hole than is provided by the normal nsulation of the wire, especially when this wire may be carrying several hundreds of volts. Rubber grommets are trivial in price and are easy to fix; they form a complete safeguard against short-circuiting through frayed insulation.

MAKING GOOD SOLDERED JOINTS.

Again, the constructor should remember that flux, although a passable insulator when cold and unused, becomes a very poor one when it has been heated and charred by a soldering iron. Hence, the least amount of flux should be used on each joint, so that there is very little surplus to run down and cause a partial short-circuit to the chassis. In fact, each joint should be neatly cleaned with methylated spirit and a small stiff brush to wipe off superfluous solder after it has cooled. High resistance leakages through charred flux soon develop into serious leaks, by the action of the small current forced through them by high voltages. Should it so happen in this resistance-capacity coupled circuit that such leaks existed between the grids of the valves and an H.T. point, the effects might be ruinous on both the quality of reproduction and the valves themselves.

It is best, perhaps, to begin by laying down the heater wiring first. This is twisted together to cancel out the A.C. field surrounding each wire, and the joints to the valve holder sockets should be extremely well made, as these wires carry a good deal of current and even small resistance would prevent the full power reaching the valves' heaters.

Two thick bare tinned copper wires run across the chassis to form convenient bus bars to which may be soldered several resistances and tubular condensers that are suspended in the wiring. There is plenty of room for all the components, so that the lay-out shown in the diagram or blue-print should be followed reasonably closely. The usual precautions must be taken to make, neat firm soldered joints. This particularly applies to the tags of the volume control. Unless soldering is done carefully here, "icicles" of solder may form and short-circuit all signals to the chassis.

THE VOLUME CONTROL, POSITION.

Although the volume control is shown as placed in a corner of the chassis, it may actually be taken to any convenient place away from the chassis, provided its connections are made with screened wire, the screening of which is thoroughly earthed to the chassis. For instance, if the amplifier is to be mounted in a large radio-gram chassis, or in some form of P.A. equipment, it would be quite in order to mount the volume control at some distance from the amplifier, provided that screened leads were used. Without screening, the leads would be liable, as with all sensitive amplifiers, to pick up mains hum or noise.

BALANCING ADJUSTMENTS.

The only adjustment to be made, when construction is complete and the amplifier is to be given its first trial, is that of the phase-changing potentiometer from which signals are fed to the grid of V2.

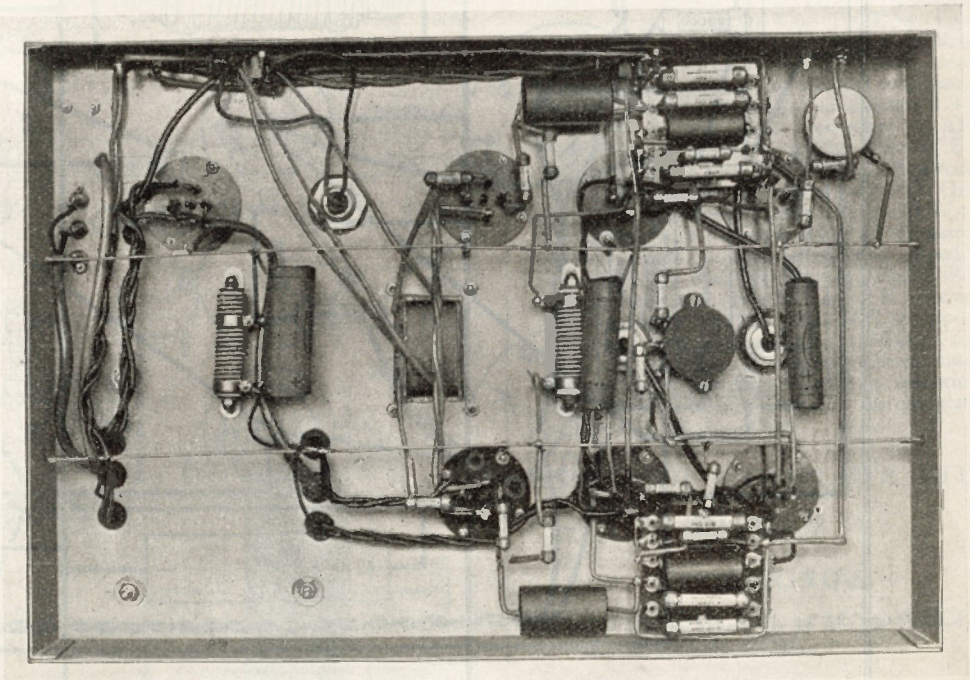
The procedure is as follows:

First, the amplifier is connected up with the speaker and the mains plugged in exactly as if it were desired straightway to reproduce from a gramophone record with a pick-up.

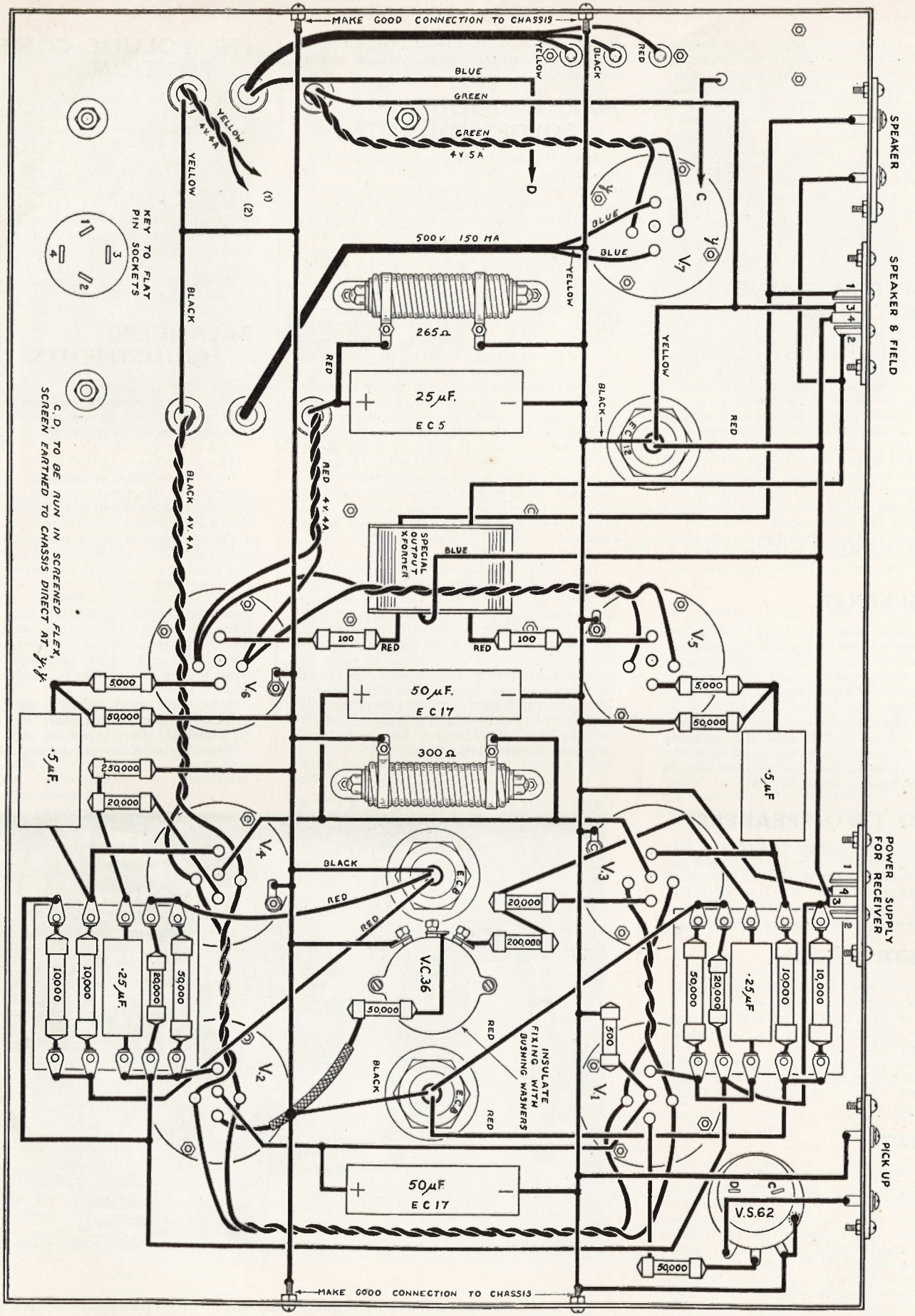
Before switching on the mains supply, however, two 1μF condensers of excellent quality and rated at *at least* 500 V. working potential are connected temporarily to the anodes of the PX25s. Of each condenser, one terminal is connected to an anode of a PX25. This will leave on each condenser one terminal free. These two terminals *are joined together* and taken to one lead of a pair of headphones. The other lead of the 'phones is connected to the chassis.

Next, some steady signal is applied to the amplifier's input sockets, either from a receiver or, preferably, from a pick-up and record.

Then the amplifier can be switched on.



The neat disposition of the components is clearly shown in this photograph of the underside of the chassis. Note the volume control in the top right hand corner. This may be placed outside the chassis, provided that its connections are made by screened leads.



Special note should be taken of the speaker connections. The field coil is connected across flat pins 3 and 4, and the speech coil across pins 1 and 2. The yellow 4 V.4A. heaters from the transformer should be taken to pins 1 and 2 on the socket supplying the power to external apparatus.

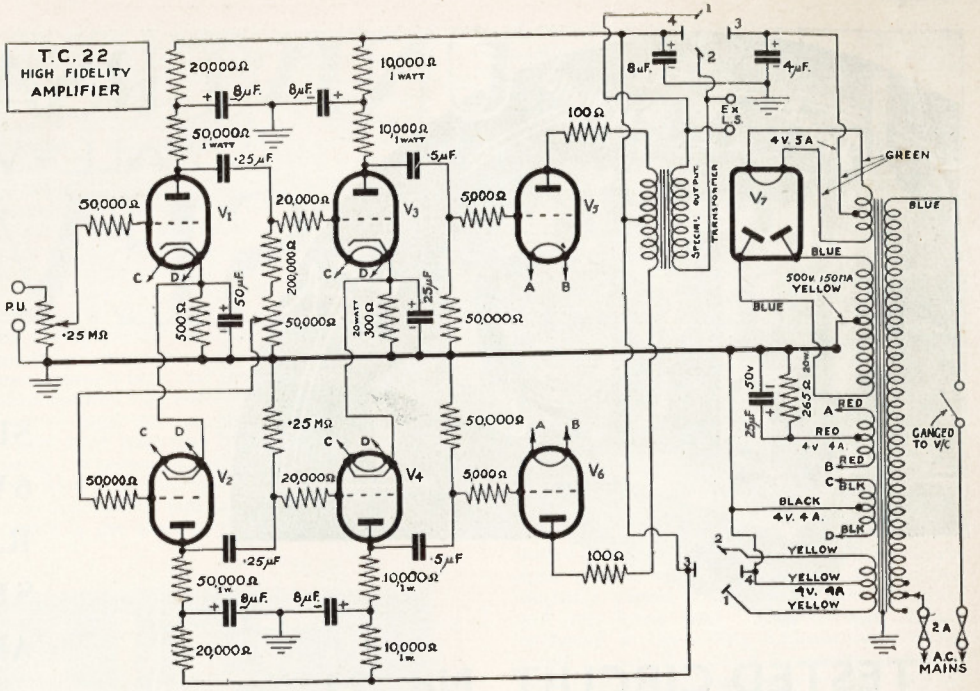
With the 'phones on the operator's head the volume control should be turned toward minimum at first, for the sound in the phones will probably be excessive. When it is conveniently lowered, attention should be turned to the phase-changing potentiometer. With a screw-driver, this should be turned one way and the other *until the signal in the phones' becomes inaudible.* Then the amplifier's volume control can be turned up again until the signal, if any now remains, can once more be heard. The potentiometer is again adjusted for *minimum* signals.

A very low, hardly audible minimum of signals should be obtainable, even with the amplifier's volume control turned to maximum. If the signal cannot be so reduced by adjustment of the potentiometer, it indicates that either the valves are too different in their characteristics for balance to be secured, or that there is some fault in the wiring—possibly a poorly soldered joint setting up unwanted resistance. The wiring and joints should be most carefully inspected and checked, and, if found beyond criticism, other valves may be tried. The intermediate pair, V3 and V4, are the most likely ones to require changing.

This is the correct and most accurate way of balancing the phase reversal circuit. But, of course, as much latitude is permissible as the operator's ear will tolerate when he listens to the loud-speaker. With reasonably well matched valves, however, the minimum obtainable in the phones when balancing up as above described will be very low indeed, and, when the amplifier is given its first real trial, the reproduction will be superb and no further adjustments will be needed. The condensers and phones used in balancing must, of course, be disconnected as soon as the balancing process has been completed.

DON'T BLAME THE AMPLIFIER.

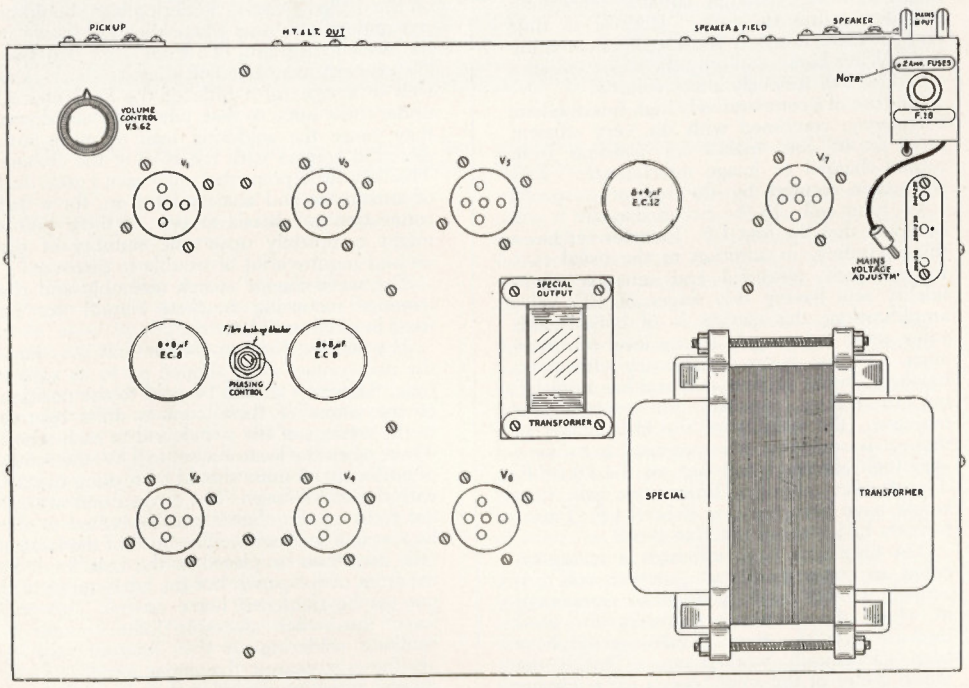
A final word on the subject of trials will not be out of place. The operator should not be in too much of a hurry to blame the amplifier itself if he does not find that reproduction is up to his expectations. The defects are much more likely—if he finds he has been able to obtain a nice balance as above described—to exist in his input signal source than in the amplifier. The microphone, or pick-up, or receiving unit, may be introducing distortion, or producing an excessive signal. This amplifier will faithfully reproduce whatever signal is put in to its input terminals—so faithfully that faults that may have passed unnoticed with other amplifiers will show up with this one at once. The signal source must be impeccable if the finest results are to be obtained from an amplifier of this power and fidelity.



PLAN OF COMPONENTS.

(Looking at top of Chassis),

Valve Holders should be held to *underside* of chassis by 6 B.A. screws and nuts. Note fibre-washer insulating-bush of phasing control.



THEORETICAL CIRCUIT.

Note especially the colour coding of the mains transformer leads. Wrong connections may ruin the output valves.

KIT OF PARTS.

COMPRISING:—

ONE BULGIN T.C.22 CHASSIS; One Bulgin Special Mains Transformer; One Bulgin Special Output Transformer; Seven V.H.48 Valve-holders, 5-pin; Two P.84 chassis sockets; One T.10 pick-up screw strip; One T.10 speaker screw strip; Two C.31 5-way Group Boards; One P.C.P.25 Tub. Condenser, .25 μF; One E.C.3 electro. condenser, 50 μF; One E.C.17 electro. condenser, 50 μP; One E.C.5 electro. condenser, 25 μF; Three E.C.8 electro: condensers, 8 +8 μF; Two P.C.P.5 Tub: condensers, .5 μF; Four H.W.19 Resistors, 30KΩ; Two W.E.7 Resistors, 50 KΩ; Four W.E.2 Resistors, 10 KΩ; One H.W.27 Resistor, 200 KΩ; One W.E.10 Resistor, 500Ω; Four H.W.23 Resistors, 50 KΩ; One H.W.28 Resistor, .25MΩ; Two H.W.10 Resistors, 5000Ω; Two H.W.37 Resistors, 100Ω; One P.R.8 Resistor, 20-watts, 3000Ω; One P.R.1 Resistor, 20-watts, 300Ω; One V.C.36 Pot'r, 50,000Ω; One V.S.62 Pot'r, .25MΩ; Four Coils of "Quickwyre"; Sundries, screws, nuts, washers, fibre insulating washers, soldering tags, tubular washers, etc., etc., for complete construction of Amplifier.

PRICE OF COMPLETE KIT,

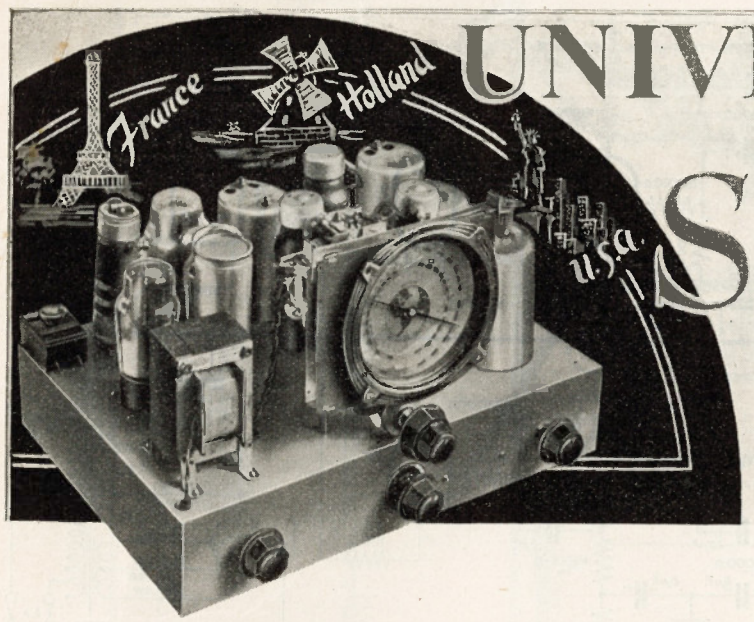
£9 - 0 - 0

ACCESSORIES.

SPEAKER: ROLA G. 12 M. 750 FIELD, 8Ω SPEECH COIL.

VALVES.

V.1 and V.2 Osram MH4 or Hivac AC/HL,
V.3 and V.4 Osram ML4 or Hivac AC/L,
V.5 and V.6 Osram PX25 or Hivac PX5.,
V.7 (rectifier) Osram MU18.



UNIVERSAL MAINS ALL-WAVE SEVEN

SUPERB QUALITY FROM 6 WATTS PUSH-PULL OUTPUT
R.C. COUPLED L.F. STAGE
SELECTIVE - SENSITIVE
ALL MAINS. DELAYED A.V.C.
SHORT WAVES 18-55 METRES

TESTED CIRCUIT No. 23

READERS of previous issues of "Radio Progress" will remember that we designed some very successful "universal" receivers at the time when the change-over from D.C. to A.C. mains supplies was presenting a serious problem to listeners in many parts of the country. The urgency lessens as A.C. spreads, but there still remain many people who cannot be sure of the nature of their mains supplies for some time to come. For these, we are offering this year a really efficient AC/DC receiver that they can construct with the comfort of knowing that it will not make the least difference to their listening if they are changed to other mains supplies, while the modernity of the circuit will prevent it becoming obsolete for several years to come. Further, AC/DC construction lowers cost, but not efficiency.

THE CIRCUIT.

Starting at the speaker end of the circuit, there are first two tetrodes of the critical-distance anode type connected in push-pull. These provide 5-6 watts of excellent quality output even with the comparatively low voltages available. Each valve has 100 Ω resistance in its anode circuit to prevent possible oscillation, the voltage drop across this small resistance being negligible. Tone control is made possible by the use of a Controlatone component. This is not a mere luxury. In addition to its use as a means of modifying quality to suit various types of sound—from the "edgy" upper notes that give crispness to speech, to the deep modulation of bass orchestral instruments—it also serves the very useful purpose of enabling listeners to reduce to inaudibility those annoying heterodyne whistles that are inevitably liable to interfere with reception, when a powerful and sensitive receiver has to deal with present-day overcrowded etherial conditions. Discreet use of the tone control will add considerably to the pleasure of listening for any length of time. In the grid circuits of these two valves are found two more anti-parasitic oscillation resistances of 5000 Ω each.

The output valves are fed by the triode part of a D.D.T. valve arranged in a "phase splitting" circuit, so that each output valve has applied to it only one half cycle of the signal. The two resistors of 20,000 Ω each, in the anode and cathode circuits of V4, across which the half-cycles are developed, will be noted—for reference, if necessary, when wiring up the connections of this part of the circuit. Between these two resistors is found a normal R.C. coupling handling L.F. signals produced as a result of rectification by the linked diodes of V4.

Automatic Volume Control is effected by feeding a part of the I.F. signal through a .0002 μF. condenser to the diodes, which are connected together, of a plain double-diode valve, V3. The D.C. voltages caused by rectification across a 250,000 Ω resistor are applied to the grids of the I.F. and the Frequency Changer valves through suitable smoothing and decoupling resistors. Control is thus very effective even on the rapidly fluctuating Short Wave band, and only the worst varieties of fading will seriously affect volume.

The use of a comparatively high Intermediate Frequency, combined with the very efficient aerial input coil, makes for freedom from second-channel or image interference. This is further secured by the use of a special L.W. filter coil. In the circuit diagram it will be noted that the first I.F. Transformer has a third winding, in addition to the usual two. In extremely powerful and sensitive high-fidelity sets having two stages of I.F. valve amplification, this device is of considerable value when listening to strong local transmissions. Its use is an unnecessary refinement, however, in the present case and has been left out to reduce expenses for constructors; moreover, the stability of the H.F. stages of this set is such that it is permissible to use a very high efficiency coil such as the C51 I.F. Transformer, giving a little more gain than would have been the case if both I.F. Transformers had been of the C50 type.

The Oscillator Coil, although it is represented on paper merely as "another coil", is actually a most carefully designed component in which the constants necessary for good tracking over the three bands covered have been scientifically worked out. This is the raison d'etre of the small .00003 μF trimmers across each coil.

Again, the Aerial Coil may seem simple enough on paper, but in its practical form it is so designed and made that it provides that amount of selectivity necessary to avoid interference from other stations on adjacent wave-lengths, without loss of signal strength.

CONSTRUCTION.

Please read carefully through CONSTRUCTORS' NOTES, on Pages 39 and 40, before starting the construction of the set. These Notes contain advice, information and warnings, attention to which may save the constructor time, money and disappointment.

Most of the chassis-mounted components may be placed straightway in their positions on the drilled chassis. Soldering tags should be put under those nuts where they are shown in the wiring diagram. To make sure that they are properly connected to the chassis, it is as well to scrape off a little of the hard enamel under these nuts, so that, when screwed down, they cause the soldering tags to make firm electrical contact with the steel of the chassis. This is a little point that may save a great deal of annoyance and anxiety later on, for a bad connection to chassis at one of these points might completely upset the stability of the set and require a lot of trouble to discover.

The wave-change switch assembly and the trimmer mounting brackets should not be fixed in place until later on.

The switches' driver-locator unit may have the two contact units slipped on to its square rod. Attention should be paid to the position of the rotors of these contact units relative to the settings of the switch and to each other. Thus, when the locator is set to S.W. the rotors of both contact units should be making contact with the middle tags. The contact unit nearest the front of the chassis can be bolted to the locator unit forthwith. The bush of the locator unit may then be placed in the hole for it in the front of the panel: but the bush nut should not yet be tightened home on it. This will leave the switch assembly loose enough to facilitate soldering to the "bottom tags"—i.e. the tags nearest the under surface of the chassis, which are shaded in the wiring diagram.

The trimmer strips should be mounted on

their brackets by means of the screws and washers provided, but the brackets should not be mounted on the side of the chassis until the rest of the wiring of the switches is finished. This will make it easy to reach soldering points under them with the hot bit. Note that one trimmer strip has only two small trimmers on it, separated by about an inch. Between them is placed the .0003 μF trimmer (this is *not* the same as the 30 micromicrofarad trimmers, which in other terms are .00003 μF each), whose fixing nut also attaches the strip to the bracket. When these trimmer strips and their brackets have been assembled, they can be put on one side until the wiring is nearly completed.

WIRING UP.

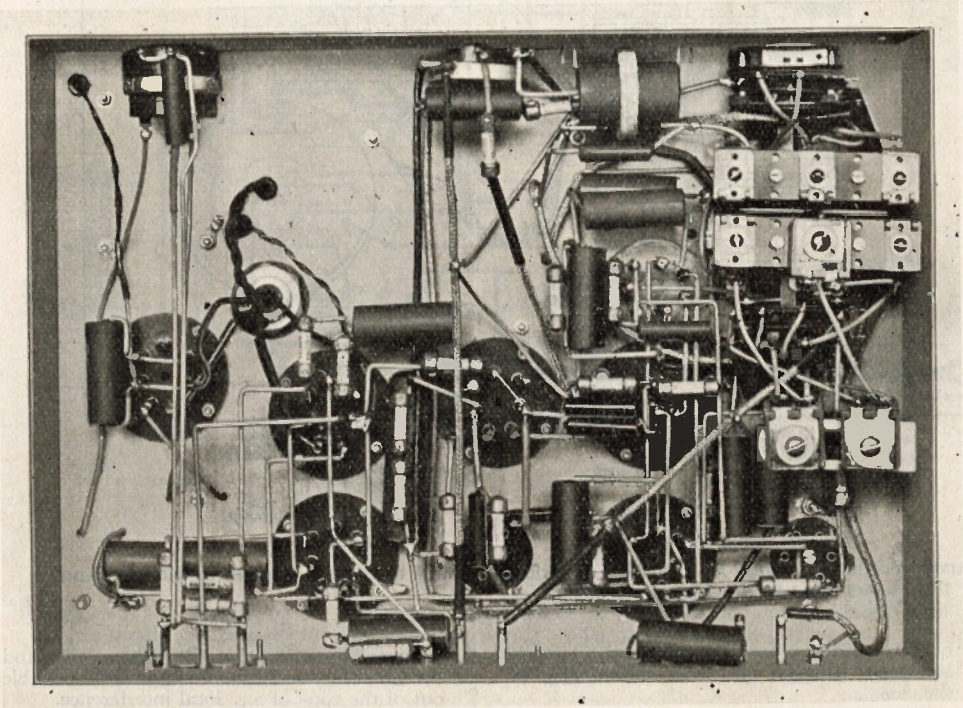
Adhere as closely as possible to the lay-out for the resistors and tubular condensers that is given in the wiring diagram. It only needs a little care and patience to do this and it may save you endless trouble when you come to give the set a working trial. Read through CONSTRUCTORS' NOTES, on Pages 39 and 40, to find out why this is so.

The wiring itself should follow the diagram very closely. This is an "all-wave" set, and on the short wave band, operation can be completely upset by departures from the positions of the wires and components as they are shown.

There would be no point in the laborious care expended on the design of Bulgin rotary wave-change switches, if it did not matter how long leads were in the H.F. stages of a receiver. It *does* matter. This point cannot be too strongly emphasised. Every extra inch of wire adds to the stray capacities for which trimmers have to compensate. If this stray capacity exceeds a certain value, it cannot be compensated by the trimmers and the performance of the set falls off badly. It may even lead to hopeless instability. Bulgin Rotary Switches have been carefully designed to minimise these sources of loss, while at the same time ensuring perfect contact through thousands of operations. It is surely foolish to nullify the benefits of their design by clumsiness in wiring.

The matter is not *quite* so important, of course, on the L.F. side of a receiver. But even here, departure from the lay-out given for L.F. components may necessitate alterations in the positions of the H.F. components, in order to accommodate all the parts in the chassis. So even on the L.F. side, it is extremely desirable to keep to the positions of components as they are given in the diagrams. These positions have been found to be the best by long and careful experiments and it is doubtful if they can be bettered.

The best way is to follow the procedure outlined in CONSTRUCTORS' NOTES. Begin by laying down the heater wiring. Then, all those components of which the ends go to earth should be wired into place by soldering their earthed wire ends to appropriate earthing points—tags, etc.—as shown in the diagram. Their other ends may be left free for the time being. If necessary, extra lengths of wire may be added to those already forming their ends so that they can be laid fairly accurately in their places in the chassis.



Here the trimmer strips are shown in their positions over the switches, on the right hand side of the photograph.

Fairly stiff wire, of about 18 gauge, should be used. "Quickwyre" is of this gauge and is thoroughly suitable. If thinner wire is used, the components are apt to sag out of position and may thus cause short circuits to the chassis and to each other.

Next, all those components—resistors and tubular condensers—having ends connected directly to valve holder sockets may be put in position—again if necessary with soldered additions of wire to the existing wire ends so that they can be placed and held by the wire in their correct positions. Then there are components and wires, especially screened flexible leads, to be connected to the volume control and led out through holes to the anodes and grids of valves on the top side of the chassis.

All such screened flex wires must have their screen covering thoroughly earthed by soldering to the nearest chassis points. This screening covering consists of tinned copper and is very easily soldered by a comparatively cool iron without damaging the insulation within. Particular care should be taken with the cut ends of such screened flex wire. This is rather apt to fray unless gently handled, and many a disastrous short-circuit has been traced to such a frayed end making contact with some H.T. point.

This procedure will enable at least half the wiring to be neatly carried out, each resistor and tubular condenser being laid in its proper place. There will remain the rest of the wiring, particularly that of the switches.

THE SWITCHES.

Since the switches have been left loosely in position, it will be easy to get the hot bit of the soldering iron down on to the bottom soldering tags, to make sound connections thereon. The tags are tinned and, if clean, they will take the melted solder very easily. The lengths of wire from the tags to the coils are often very short, so that a pair of long, thin-nosed pliers will come in very handy to hold these short lengths in position for soldering. When the bottom tags have all been wired up, the switch assembly can be bolted home. The bushing nut is turned down tight and the rear contact unit is fixed to the chassis by means of its bracket, 6 B.A. ½" screws and nuts being used. The top tags, shown unshaded in the wiring diagram, can now be wired up, and the rest of the wiring, connecting up the components already in place, may be completed.

THE TRIMMERS.

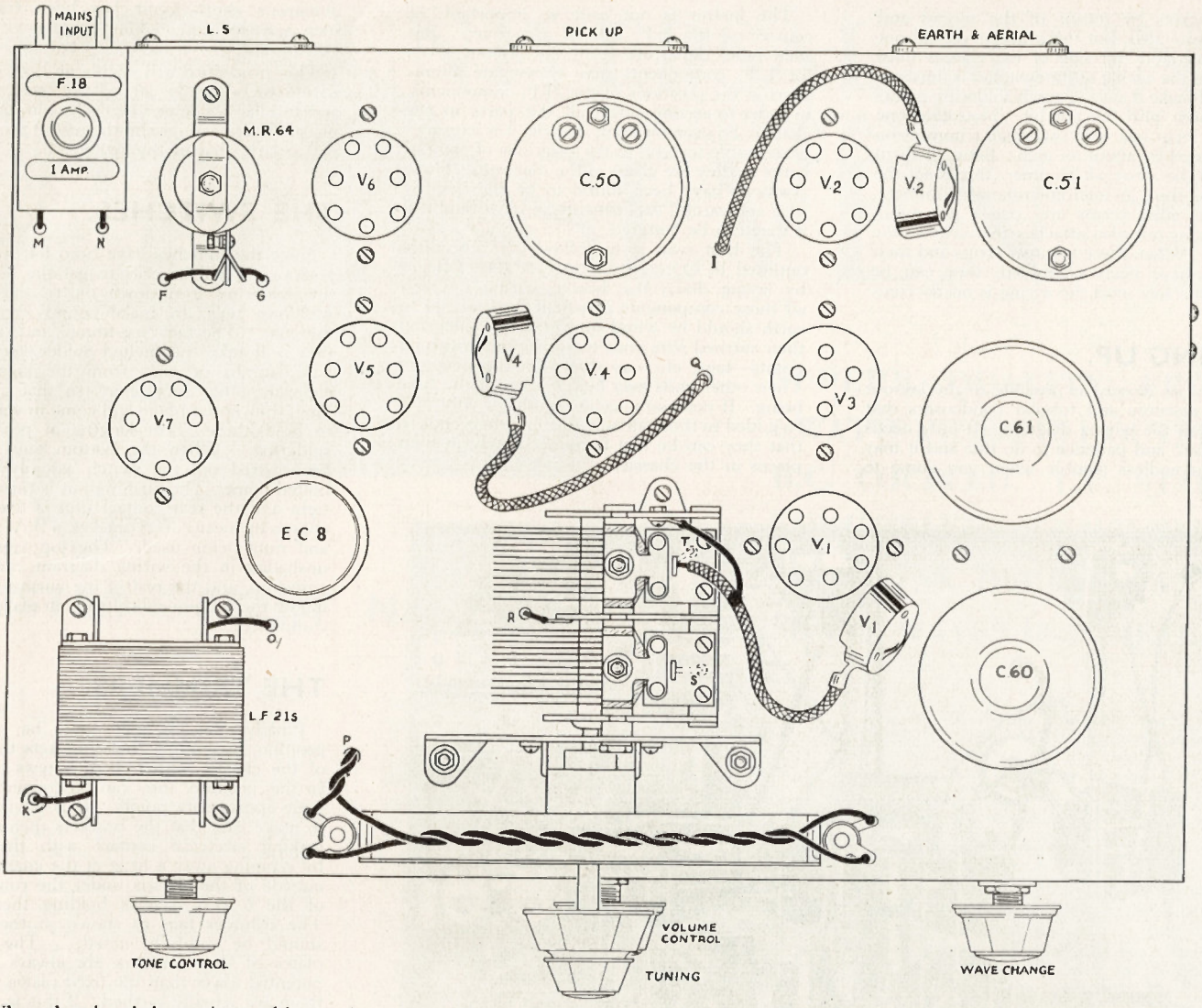
Finally, the trimmers may be placed in position, by bolting their brackets to the side of the chassis with 6 B.A. screws and nuts. In this position, they can be connected up to their appropriate points. It is advisable here to make sure that the brackets themselves are making electrical contact with the chassis, by scraping away a little of the enamel on the outside of the chassis under the round heads of the 6 B.A. screws holding them down. The trimmer tags as shown in the diagram should be carefully noted. The movable plates of the trimmers are always put at a potential lower than the fixed plates. Some of them are actually earthed. If this is not done, and the "live" side of the trimmer is movable, difficulty will be found when trimming is undertaken, for the small screwdriver used for trimming will introduce "hand capacity" effects and may even upset stability.

Particular attention must be paid to the speaker socket connections; care must be taken here, about soldering, for it is not very difficult to create a nasty short-circuit of the H.T. to chassis through "icicles" of dripping solder and charred flux. Soldering should be done neatly and firmly. The flex wire used to connect the speaker to the set, too, should be of excellent quality, for it must not be forgotten that it will be at a high potential in respect to earth. Cheap flex usually suffers from perished rubber insulation and thin outer cotton braiding, which soon fails to perform its function of insulating.

FIRST TRIAL TESTS.

When you think you have finished the whole of the construction, do not promptly plug in mains and speaker and gaily switch on. Unless you are lucky, you have an excellent chance of spending the next few hours dismally disarranging the neat wiring you have done and ruining laboriously made soldered joints in endeavours to discover why the set does not work.

This is not the best way of finding the mistakes you have made in the wiring. The best way is to check and re-check your wiring and



When the chassis is put in a cabinet, adequate ventilation should be provided around the mains resistance—shown in the left hand top corner next to the fuse-connector.

then secure the services of a friend to check it independently. This takes time and may be annoying when you are impatient to hear the set working. But it may save a good deal of time and temper in the end.

Now, this is not in the nature of a criticism of the constructor's wiring abilities. Many amateur constructors who make rather a hobby of it can turn out wiring jobs of which any professional would be proud and which is much neater than the mass production work found in many commercial receivers. But the most highly skilled and experienced of wiremen know that mistakes, often perfectly absurd mistakes, inevitably creep in. For that reason, they never neglect the work of checking over their wiring. In radio receiver factories, the work of the wirers is constantly under supervision and is checked stage by stage with instruments, although most of the wirers have probably been wiring up sets of all exactly the same type and make for many years. Nobody need think it beneath his dignity to have his wiring thoroughly checked over. He will only be following the best orthodox practice.

When the constructor, however, is satisfied about the correctness of his work, the speaker leads may be plugged in to the three sockets provided in the speaker panel of the chassis, the valves placed in their right sockets—make sure about this point: a valve wrongly placed may be destroyed in a few minutes—and the earth and aerial plugged into their socket strip in the chassis.

The set may require half a minute or more to warm up. By this time the valve heaters will be seen to glow redly. If there is no sound at all from the speaker, switch the set to the "Gram" position and touch first one and then the other of the pick-up sockets with a finger or a screwdriver blade. There should ensue a hum or click in the speaker. If this does not happen, the mains plug should be reversed. A faint rustle in the speaker will indicate that the set is lively. While it is still switched for "Gram", a record can be tried out with a pick-up and turn-table, if they are handy. This will show that the L.F. side is working properly.

Next, switch the set to the Medium wave band and try to tune in the strong local station. If this is obtainable, even at rather poor volume, we may proceed with ganging.

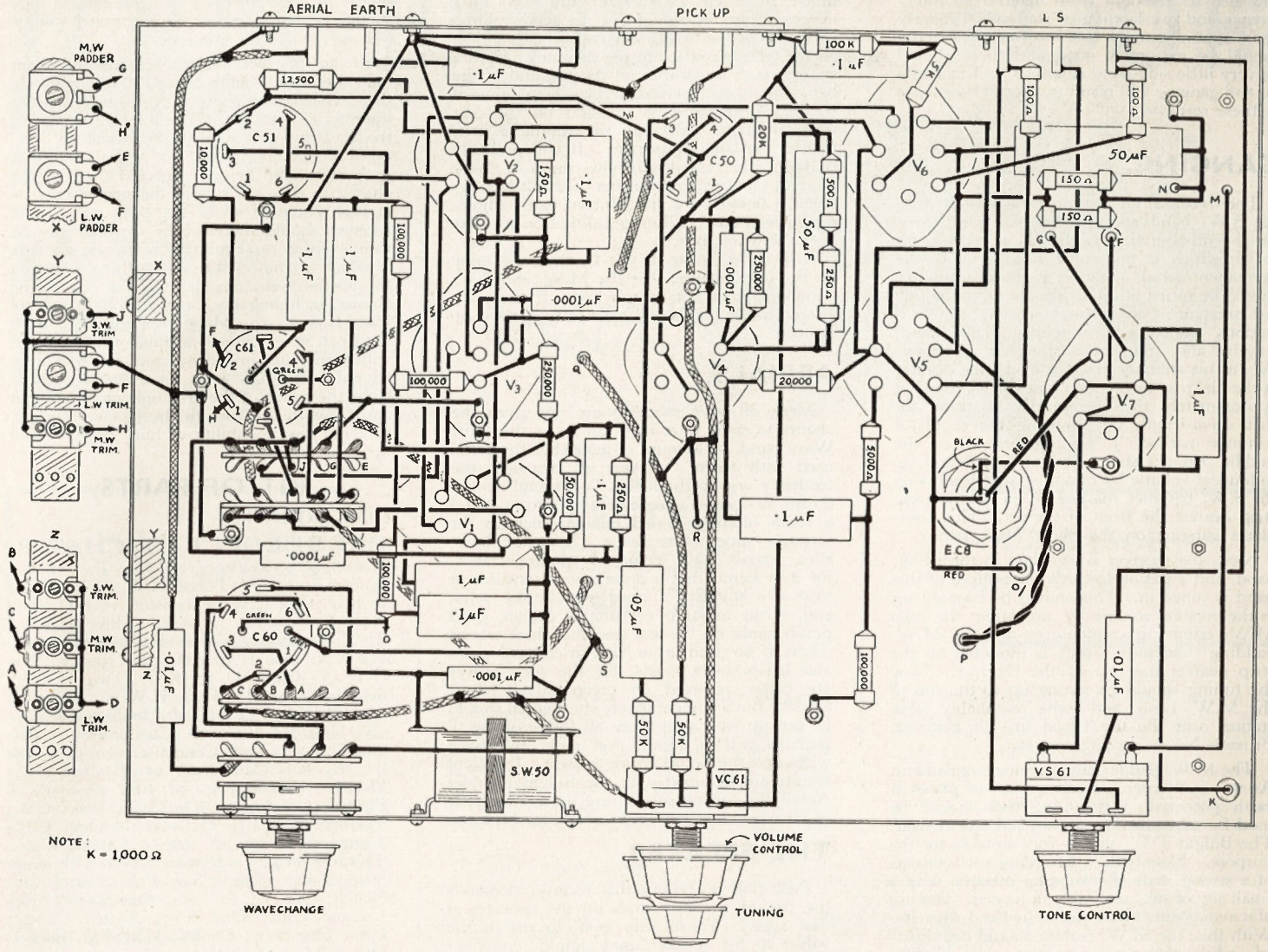
GANGING. LINING UP.

For lining up purposes, it is necessary to employ a short temporary aerial—unless use is made of the proper instruments, which are described in CONSTRUCTORS' NOTES, Page 39. This short aerial may consist merely of a few yards of insulated flex wire hung up anywhere convenient. This should be plugged into the receiver's aerial socket and a good earth line into the earth socket. Both the receiver and the temporary aerial should be as far as possible out of the zone of any local interference.

The receiver, switched to the M.W. band, should be tuned to a station towards the bottom of this band. It may be the local station. It should be very weakly received, and if even with the short aerial it seems somewhat loud, the temporary aerial should be shortened still more by cutting lengths off it, until even the local station is only just audible. This is done in order to prevent the receiver's A.V.C. from coming into action.

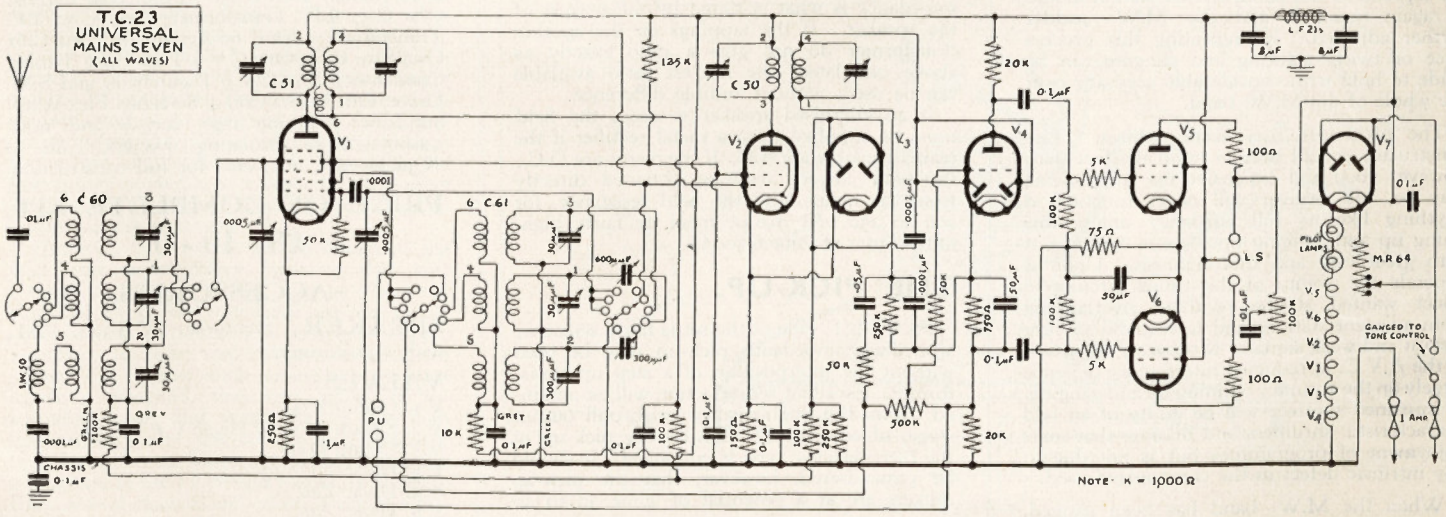
Then the trimmers in the tops of the I.F. Transformer cans should be adjusted, by means of a suitable screwdriver. The aim should be to find peaks of volume as these trimmers are turned. On a peak of volume each trimmer should be finally set. It may be mentioned in this connection that the human ear is a bad judge of the intensity of sound. It would be far better to make use of some form of modulated signal generator (such as the V.T.17 Neon I.F. Liner, described in CONSTRUCTORS' NOTES) and a Neon Output Unit, type V.T. 19, of which the glow will vary in brightness with the power of the signal and so accurately indicate a peak. It is extremely important that the I.F. stages of the receiver should be very accurately lined up, for it is upon this that the

(*continued on page 16*)



ABOVE:— The wiring in the diagram shown above should be carried out methodically, as described in the text. The trimmer strips shown on the left should not be fixed in place until the wiring under them has been carried out. The shaded tags of the switch contact units are nearest the undersurface of the chassis, the blank tags are opposite them.

BELOW:— In the theoretical circuit below, special note should be taken of the phase-splitting circuit involving the double-diode-triode valve.



sensitivity of the receiver largely depends, and also its freedom from heterodyne interference and overlapping of stations. Properly lined up and ganged, this receiver's selectivity should be extremely good and there should be very little side-band splash. Careless lining up and ganging will result in poor performance in these respects.

GANGING.

The receiver should now be switched to the S.W. band and the full size permanent aerial substituted for the short temporary aerial, which is no longer needed. On the permanent aerial, a station at about 40 metres should be tuned in. This should be preferably an amateur transmitting speech, as such stations periodically announce their wavelengths and frequencies for test purposes. When this announcement is made, the pointer of the dial may be made to tune the station in at approximately the correct dial marking for that wave-length by adjusting the oscillator trimmer marked "J" on the diagram on the middle trimmer strip. It may be brought up to loudest volume by means of adjustments on the S.W. trimmer marked B, on the trimmer strip nearest the front of the set. This completes ganging on the Short-Wave band.

Next, the receiver is switched to the M.W. band, and a station towards the bottom of this band is tuned in. This should be brought up to the greatest volume by adjusting the two M.W. trimming condensers—not the M.W. padding condenser, which is mounted on the strip nearest the rear of the receiver. Now the tuning should be swung up to the top of the M.W. band, and some reasonably weak station near the top tuned in—for instance, Brussels No. 1, on 483 metres.

The M.W. padder now requires adjustment. As this condenser has not one set of plates at earth potential, a trimming tool should be used for adjustments, not a metal screwdriver. The Bulgin T.T.1 tool is very suitable for the purpose. Essentially a trimming tool consists of a strong shaft of insulating material with a small slip of steel set firmly in its end. The use of it avoids difficulties caused by hand-capacity. With this, the M.W. padder should be adjusted, while the tuning condenser is slightly "rocked" over the tuning point, until the loudest volume is obtained. When this has been done, a return should be made to the station near the bottom end of the tuning scale and further adjustments of the M.W. trimmers made, for maximum volume. This will have slightly altered the tracking up at the top end of the band, so that station should be again tuned in and the M.W. padder further adjusted. By repeating this process once or twice, tracking and ganging can be made to hold with considerable accuracy over the whole of the M.W. band.

The procedure may seem tedious. The constructor should bear in mind the fact that, however good and expensive his components may be, his receiver will never function at anything like its full efficiency unless this lining up and ganging business is carried out with great care and thoroughness. Upon it depends the ability of the tuned circuits to select wanted stations without overlapping from adjacent stations and to respond to very distant and weak signals. Moreover, the action of the A.V.C. in reducing interference depends largely on the accuracy of lining up and ganging. A mistuned receiver will be guilty of an odd characteristic shrillness and hissing, that mars enjoyment of programmes but is not due to any intrinsic defect in the components used.

When the M.W. band has been ganged, the receiver may be switched to the L.W. band and a station towards the bottom of the band tuned in—such as Luxembourg, on 1304 metres. This is brought up to good volume by means of the two L.W. trimmers, as shown on the trimmer strips in the diagram. Then a station, such as Huizen, at the top end of the band should be received, and tracking adjusted by means of the L.W. padder on the rear trimmer strip, "rocking" the tuning a little to find the best adjustment. It will probably be found that Droitwich now comes in nicely at 1500 metres, but further alternations between Luxembourg and Huizen, with adjustments each time, will make calibration accurate over the whole band.

It must be borne in mind, when trimming on the long Waves, that the M.W. and S.W. trimmers must not be touched. If these are altered, those bands will have to be ganged up again.

AERIALS.

Many all-wave receivers are not given the chance to show what they can do on the Short Wave band, on account of neglect of the aerial used with them. A year or two ago, the tendency was to think that "anything" would do for an aerial—a piece of wire strung round a room often provided enough pick-up for sensitive superhet receivers. Recently, however, aerials have returned to importance, for it is found that a decent aerial ensures at least two things: a good signal-noise ratio, and, if the aerial is of suitable design, good performance on the less tractable short waves. There is no need to go back to colossal poles and lattice work masts, for the short waves are better received on comparatively short aerials. But a comparatively short aerial should be put up well away from all forms of metal, such as gutters, pipes, iron roofs, telephone wires and the house wiring system. Excellent results are obtained with the Bulgin Doublet Aerial Kit, which can be erected on the side of a house and is weatherproof and unobtrusive.

THE SPEAKER.

Push-pull output in this receiver demands the use of a transformer on the speaker, of that type. Those who wish to match the valves to the speaker used should remember the formula

$$R = \frac{\sqrt{\text{Optimum Valve Load}^*}}{\sqrt{\text{Speech Coil Impedance}}}$$

where R is the ratio required, and the optimum load is double that given by the makers for one valve (because two valves are used in push-pull in this case) and the speech coil impedance is what is stated by the makers of the speaker. If the tappings on the speaker transformer do not give a ratio exactly as above calculated, the nearest ratio available can be used, without audible difference.

If an energised speaker is used, the field must be supplied from a metal rectifier if the mains available are A.C. If the mains are D.C., the field current may be obtained directly from the mains, and the field resistance, for 200 to 250 volt mains, must be fairly high, of the order of some 6,500 Ω.

THE PICK-UP.

As the L.F. side of the set is fairly sensitive, a medium impedance pick-up may be used without the interposition of a step up transformer. Excellent reproduction will be obtained from the high-quality push-pull output stage, of course, if a high-fidelity pick-up of the piezo-electric type is employed. It should be remembered, however, that the pick-up sockets are at a potential of some 30 to 40 volts above the chassis. Hence, insulation should be good for the pick-up leads and they should be shrouded in flexible metal that is well earthed to the chassis.

Should this receiver be used as a radiogram unit, the volume control may be placed outside the chassis at any convenient position, but the leads to it should be of flexible screened wire, the flex being well earthed. As with all AC/DC types of receiver, it must not be forgotten that such screening, being connected through the chassis to the —ve side of the mains, may be at high potential above the earth wire. The receiver should therefore be earthed only by means of the .1 μF. tubular condenser, one side of which is connected to the earthing socket on the inside of the chassis. All the rest of the chassis, including any screened volume control leads from it, should be kept insulated from the earth wire. Should a transformer be used with a medium impedance pick-up, it will be advisable to place it as far away as possible from the motor of the gramophone equipment and to earth the core to the receiver chassis, to avoid any possibility of hum being picked up.

*Anode to anode.

KIT OF PARTS.

COMPRISING:—

ONE BULGIN T.C.23 CHASSIS; Five H.W.25 Resistors, .1 MΩ; Two H.W.1 Resistors, 250 Ω; Three H.W.23 Resistors, 50 KΩ; One H.W.15 Resistor, 10 KΩ; One H.W.16 Resistor, 12,500 Ω; Three H.W.38 Resistors, 150 Ω; Two H.W.28 Resistors, 250 KΩ; One H.W.2 Resistor, 500 Ω; Two H.W.19 Resistors, 20 KΩ; Two H.W.37 Resistors, 100 Ω; Two H.W.10 Resistors, 5,000 Ω; Five P.C.301 Tub. Condensers, .0001 μF; Nine P.C.P.1 Tub. Condensers, .1 μF; One P.C.101 Tub. Condenser, .01 μF; One P.C.105 Tub. Condenser, .05 μF; Two E.C.3 Electro. Condensers, 50 μF; One E.C.8 Electro. Condenser, 8 + 8 μF; Two C.P.3 Trimmers, .0003 μF max.; One C.P.4 Trimmer, .0006 μF max.; One S.W.101 Trimmer Strip, 3-way; One S.W.100 Trimmer Strip, 2-way; One V.S.61 Vol. Control with Switch; One V.C.61 Pot'r; One S.150 Driver Locator Unit; One S.154 Switch Contact Unit; One S.153 Contact Unit with Bracket; One S.W.42 Short-Wave 7-pin valve holder; One V.H.48 valve holder, 5-pin; Five V.H.49 valve-holders, 7-pin; Three E.H.9 Universal Brackets; One P.51 A and E socket strip; One P.53 Pick-up Socket Strip; One 3-way Speaker Socket Strip; One L.F.21 Choke; One F.18 Fuse-holder and Mains Connector; Three P.56 Valve Cap Connectors; Three K.48 Knobs; Two B.650 M.E.S. Dial Lamps; One C.51 I.F. Transformer; One C.50 I.F. Transformer; One C.60 Aerial Coil; One C.61 Oscillator Coil; One C.V.2 Two-Gang Tuning Condenser; One C.V.6 Escutcheon and S.M. Drive; One W.S.2 Coil of Screened Flex Wire; Sundries, soldering tags, screws and nuts, washers, fibre insulating washers, coils of "Quickwyre", etc., etc., for full construction.

PRICE OF COMPLETE KIT,

£8 - 10 - 0

ACCESSORIES.

SPEAKER: Stentorian W.B.38S, P.M., with transformer.

VALVES:

V.1. Osram X31.
V.2. Osram W30 or Hivac V.P.13.
V.3. Osram D41.
V.4. Hivac DDT13.
V.5. Hivac Z26.
V.6. Hivac Z26.
V.7. Osram U30 or Hivac U26.

FOUR-BAND A.C. FOUR

FOUR VALVE A.C. SUPERHET

TESTED CIRCUIT No. 24

FOUR RANGES AND PICK-UP

SHORT Wave reception is sometimes, unfortunately, regarded as an "extra", to be added to an existing long and medium wave design more as a novelty than as a source of real entertainment. This is the wrong attitude to take up towards the short-wave bands. Careful design can make short-wave reception an integral and important part of the function of a domestic receiver, so that it greatly extends the perfectly normal performance of the instrument even in the hands of the comparatively inexperienced.

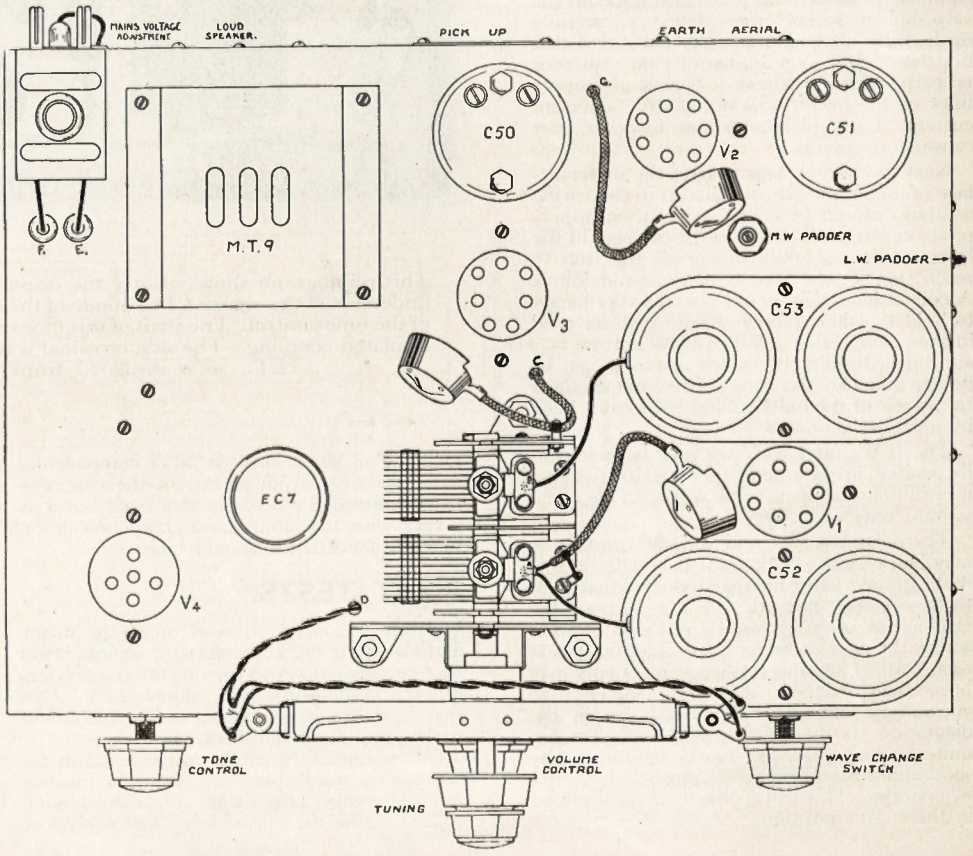
THE CIRCUIT.

Use is made of an output valve of one of the new critical-distance anode tetrode types. This type of valve possesses the sensitivity of a pentode without the slight defects in quality that pentodes sometimes exhibit, and will give 3½ watts output of good quality. This valve is fed with signals from the triode portion of a double diode triode valve, of which one diode acts as signal rectifier while the other provides automatic gain control for the H.F. valves—more commonly known as A.V.C.—which is applied to both the frequency changer and the I.F. pentode. The control is extremely efficient, and is so designed as to come into action before the output valve is fully loaded; this means control adequate to cope with the fading that inevitably occurs on the short wave transmissions, without restricting the maximum output of the receiver.

However, it is mainly in the design of the coils and wave-change switches that this receiver is superior to the average all-waver. Coils on paper as curly lines are one thing: coils in practical form are another. Again, switches—anybody can indicate a switch on paper, but unless such switches are most carefully designed, they can introduce intolerable losses and instability on the high frequencies. The use of the comparatively high intermediate frequency of 465 kilocycles per second in the I.F. stages makes for freedom from second channel and other forms of interference. Further security is obtained by the use of a Long Wave filter coil when operating on that band.

Pick-up sockets are of course provided. It will be advisable to use a pick-up with a fairly large output if this is to be connected directly to the pick-up sockets. But if only a medium impedance pick-up is available, it will be best in the interests of volume to provide a little extra voltage step up by the use of transformer coupling between the pick-up and the set—for which purpose the Bulgin L.F.33 Transformer is to be recommended.

The receiver has been designed to use a 2,000 Ω speaker field coil for H.T. anode current smoothing. The W.B. Stentorian E.M. 2 speaker is strongly recommended.



CONSTRUCTION.

It is advisable to follow the procedure outlined as follows, when constructing this receiver.

First, mount on the chassis by means of the 6 B.A. screws and nuts provided all the components except the tuning condenser, the L.W. filter coil and the wave-change switches. The tuning condenser is apt to be bent and warped if it is put on at once, and the set has to rest on it upside down for wiring.

Next, slip the contact units of the switch assembly on to the square driver rod. Put the bush of the locator unit into the hole for it on the front of the chassis but do not yet screw home the bush nut. Doing this will leave the switch assembly loose enough to allow a little play that will make easier the access of the soldering iron's bit to the bottom tags of the switch contacts.

READ THROUGH "CONSTRUCTORS' NOTES," ON PAGES 39 AND 40, BEFORE GOING ANY FURTHER. THIS MAY SAVE YOU TIME, MONEY AND TEMPER.

Do not neglect to put soldering tags under those nuts that are shown as having them in the wiring diagram. They are for earthing various small components to the chassis and they are put in those positions for the sake of ease of wiring and shortness of leads. A little of the chassis enamel should be scraped away from under the nut or the round head of the screw, where these soldering tags are used, so that good electrical contact is made with the steel of the chassis.

WIRING UP.

First of all, read through CONSTRUCTORS' NOTES, on Pages 39 and 40, if you have not already done so.

Method pays, in wiring up radio receivers. It will be best to begin by laying down the heater wiring, which is twisted together to eliminate possible hum pick-up. Joints to the valve-holder sockets must be very carefully made, with the minimum of solder and flux but thoroughly soundly, because no resistance is permissible in these low voltage supply lines or the valves will not receive sufficient current. Large blobs of solder, however, may cause short-circuits.

Next, the switch tags nearest the undersurface of the chassis, shown shaded in the wiring diagram, should be connected to their appropriate coil tags. There is sufficient play in the loose switch assembly to permit the iron to reach the bottom tags to make sound joints. A pair of long, thin-nosed pliers is very handy to hold the short pieces of wire that are used in these connections. When these bottom tags are finished with, the switch assembly can be bolted home to the chassis, the contact units by means of the brackets and the locator bush by means of its nuts.

The L.W. filter coil may now be bolted to its position at the side of the chassis. Leaving it until now has made access easier to the aerial switch contact unit tags.

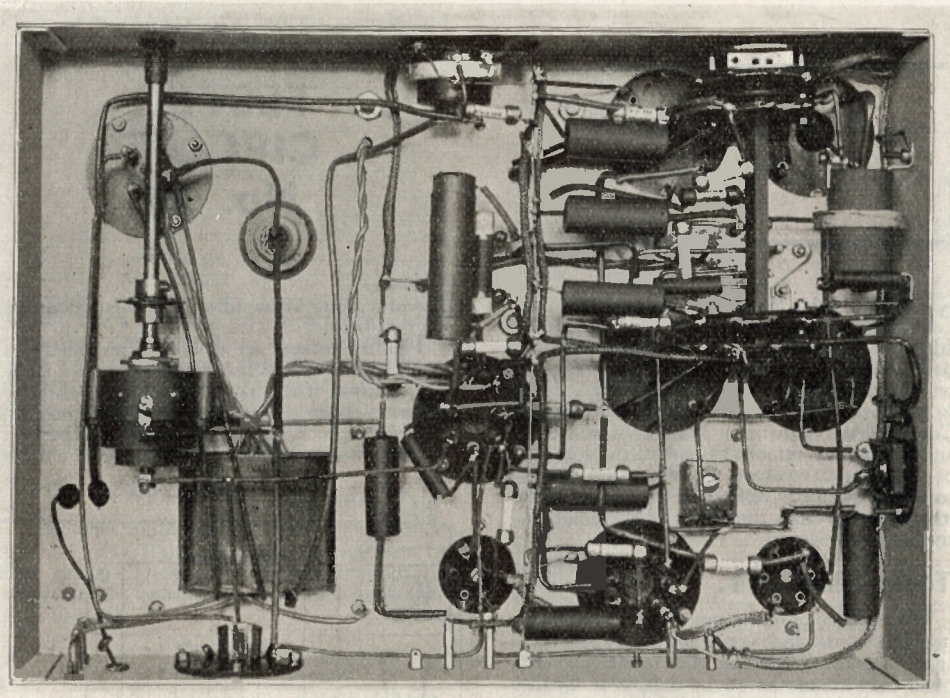
Then the resistors and tubular condensers may be put into position. It is best to do this by beginning with those components that have their wire ends earthed. For this purpose, the chassis bus bar may first be put into position across the chassis, fixing it to soldering tags at each end. Then the earthed components may have their earthed wire ends soldered to appropriate chassis points, as shown in the diagrams. If the existing wire ends are not quite long enough, they can be lengthened by short additions of wire, the joints being covered by systoflex. This will enable them to be placed in their right positions.

Next, solder to the valve holder sockets all these components directly so to be connected, again lengthening the existing wire ends if they are not long enough.

By now, the greater part of the wiring will have been done. There will remain the connecting up of the free ends of the components in place.

Finally, various connections must be finished off, such as the screened leads through the chassis to the valve caps and the leads to the tuning condenser tags. The screening of the screened flex leads *must* be well earthed. It consists of tinned copper braiding which will take solder very readily without injuring the insulation beneath it.

Where wires pass through holes in the chassis it is very advisable to bush the holes with rubber grommets. Another useful precaution is to cover the resistors entirely with short pieces of 8 millimetre systoflex, so that their metal caps are protected against possible touching of the chassis or other components. This covering is not shown in the diagrams on account of the need for clearness, but it is a very wise and simple and cheap precaution that the constructor should take.



This photograph shows clearly the disposition of the components and wiring on the underside of the chassis. The anode of the output valve is connected to the end terminal of the tone control. The shaft of this tone control is connected to the extension rod by an insulated coupling. The side terminal is taken to H.T. +ve and the bush is "live" to H.T., so is insulated from the bracket by fibre washers.

FIRST TESTS.

Before connecting the set up to the mains and switching on, *check over the wiring.* And then re-check it. And then secure the services of a friend for a final independent check. This may be delaying, but it may also save hours of worry and disappointment.

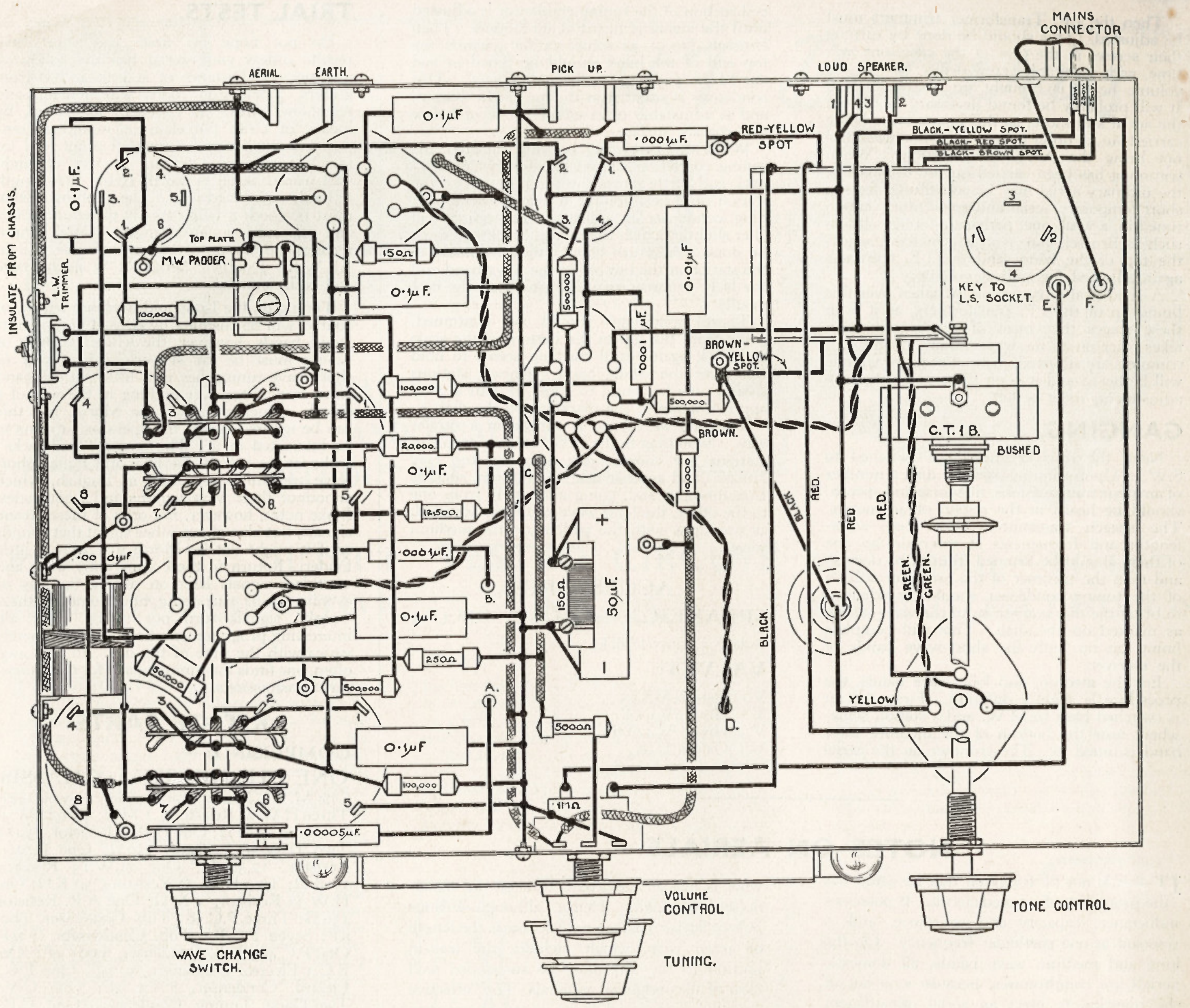
When the constructor is satisfied about the wiring, the valves may be placed in position and the speaker plug ('ware connections here!) placed in the flat pin socket. The mains can be plugged in and the set switched on, when it should take a few seconds to warm up and the valve heaters be seen to glow redly. First switch to the "Gram" position and touch one or the other of the pick-up sockets with the blade of a screw driver. A hum or a click should be heard in the speaker—the volume control is of course turned to maximum. That will show that the L.F. side of the receiver is in good order. Next the earth and aerial plugs should be put into their sockets.

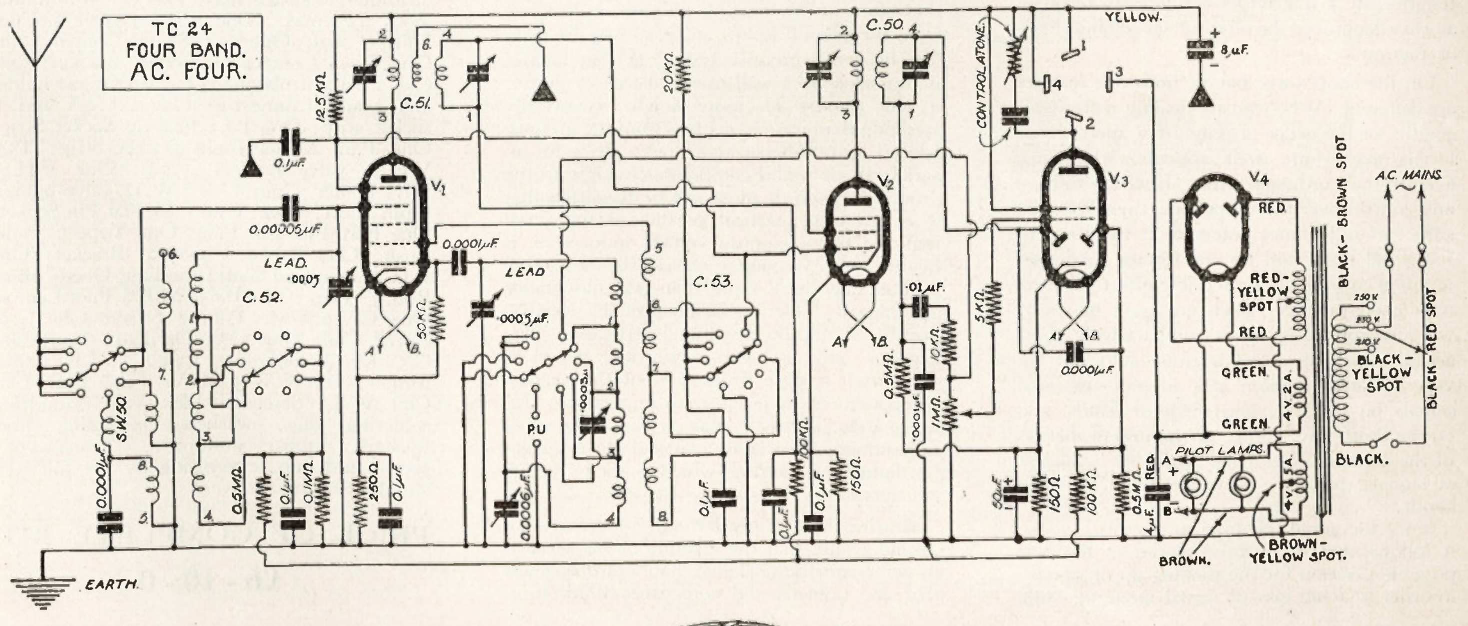
LINING UP.

We may now proceed with the lining up of the receiver's tuned circuits. To do this, it is best to have a temporary aerial consisting of only two or three yards of insulated wire hung anywhere convenient.

First, switch the set to the medium wave band and set the vanes of the tuning condenser all-in. With the vanes in this position, set the dial pointer at exactly 550 metres. Next tune in the local station. Even on the short temporary aerial, it will probably be received too strongly for our purposes, so it will be necessary to make the aerial shorter still, by cutting pieces off it until even the local station is only very weakly received. This is necessary to avoid having the ganging operations upset by the action of the set's A.V.C.

Of course, this lining up and ganging business is rendered very much easier and more accurate if a signal generator of some sort is on hand. The enthusiastic constructor would do well to consider the Bulgin series of Neon Signal Generators, which are very much cheaper than modulated test oscillators and extremely accurate.


MAINS CONNECTOR
AERIAL.
EARTH.
PICK UP.
LOUD SPEAKER.
INSULATE FROM CHASSIS.
L.W. TRIMMER.
0·1µF.
TOP PLATE
M.W. PADDER.
100,000
O·1µF
150Ω
O·1µF.
·0001µF.
RED-YELLOW SPOT
BLACK-YELLOW SPOT.
BLACK-RED SPOT.
BLACK-BROWN SPOT.
0·01µF
500,000
·0001µF.
KEY TO L.S. SOCKET.
BROWN-YELLOW SPOT.
100,000
500,000
BROWN.
20,000
O·1µF.
C.T. & B.
BUSHED
12,500
·0001µF.
RED.
GREEN.
BLACK
·00 01µF
O·1µF.
150Ω
50µF.
250Ω
50,000
500,000
5000Ω
O·1µF
100,000
1MΩ
·00005µF.
YELLOW
WAVE CHANGE SWITCH.
VOLUME CONTROL
TUNING.
TONE CONTROL


TC 24
FOUR BAND.
AC. FOUR.
0.1µF.
0.00005µF.
12.5KΩ
C.51.
V1
LEAD. ·0005
C.52.
0.0001µF.
LEAD ·0005µF.
50KΩ
S.W.50
0.0001µF
0.5MΩ
0.1µF.
0.1MΩ.
250Ω
0.1µF.
EARTH.
20KΩ
C.53.
P.U
0.0005µF.
C.50.
V2
·01µF.
0.5MΩ.
10KΩ.
1MΩ.
·0001µF.
100KΩ.
150Ω.
CONTROLATONE.
YELLOW.
8µF.
V3
5KΩ.
0.0001µF.
50µF.
150Ω.
100KΩ.
0.5MΩ.
V4
RED.
RED-YELLOW SPOT
GREEN.
4Y2A
PILOT LAMPS.
4V1.5A
BROWN.
BROWN-YELLOW SPOT.
BLACK-BROWN SPOT
A.C. MAINS.
250V
BLACK-YELLOW SPOT
BLACK-RED SPOT
BLACK.

Then the I.F. Transformer trimmers must be adjusted. This should be done by turning their screws in the tops of the cans, one at a time, with a suitable screw-driver, so that the volume heard is brought up to the loudest. It will probably be found necessary to shorten the aerial still more, as this operation is being carried out, in order to keep reception weak and not bring the A.V.C. into action. When trimming has been carried out by this means, the ordinary aerial may be substituted for the short temporary aerial and some other station tuned in, a weak one, perhaps a foreign station such as Brussels No. 1 on 483 metres towards the top of the band, and the I.F. trimmers again adjusted for loudest volume.

A good deal of care must be taken over this lining up of the I.F. transformers, as it is in these stages that most of the amplification takes place on all the wave bands. As the I.F. trimmers are adjusted, distinct peaks of volume will be heard and it is on these peaks that the adjustments must be left.

GANGING.

Next, the receiver should be switched to S.W.2. Upon running over the dial, a number of amateur transmissions, in Morse and speech, should be heard in the region of 40 metres. The speech transmitters give their wave-lengths and frequencies at intervals, so one of them should be listened to until he does so and then the trimmer of the oscillator section of the tuning condenser should be adjusted to bring the dial pointer on to the wave-length as marked on the dial. This will complete lining up on both the short-wave bands of the receiver.

For the medium and long wave bands, the procedure is slightly different. First, the set is switched back to M.W. and a station somewhere near the bottom of the medium wave band is tuned in. The trimmer on the aerial coil section of the tuning condenser is adjusted until the signal is heard at its loudest. Then Brussels No. 1 or some station towards the top end of the band should be tuned in and the M.W. padding condenser adjusted. This condenser is situated in the top of the chassis, and is adjustable from either above or below the chassis surface.

While this condenser is being adjusted, the tuning condenser should be slightly "rocked" back and forth across the tuning point of the station until best volume is heard: as the padding condenser is adjusted, the tuning will alter slightly, which is why this "rocking" must be done. A return should then be made to the station at the bottom of the wave band and the H.F. trimmer again adjusted for the best results.

These operations should be continued, going from the top to the bottom of the scale and back again, until tracking seems to hold well over the whole band. Known stations should now be found to come in with a good approximation to the markings on the dial.

The long-wave band is ganged in a similar way. Switching to the L.W. band, a couple of stations are chosen, one near the top (say Huizen) and another near the bottom, such as Luxembourg, and, going alternately from one to the other, the long-wave padder is adjusted, as was done with the padder on the medium waves.

ACCESSORIES.

SPEAKER: Stentorian W.B. E.M.2, or Rola F.5., 2000 Ω field.

VALVES:

V.1. Osram MX40.
V.2. Hivac AC/VP.
V.3. Hivac AC/ZDD.
V.4. Osram U12.

TRIAL TESTS.

Do not hope for first class short-wave results unless your aerial has the following qualities: (1) Distance of at least 20 feet from gutters, pipes, iron roofs, wire fencing and telephone wires: (2) Excellent insulation, by means of clean porcelain or moulded composition fixtures and a weather-proof lead in: (3) Not excessive length: 30 feet of high, well-placed aerial is worth treble that length of badly positioned wire. The earthing system must be good: it helps greatly to reduce noises and increase signal strength. We cannot recommend anything better than the Bulgin All-Wave Doublet Aerial: it is inexpensive and easily erected.

Tuning on the Long and Medium bands, of course, will be customarily easy. On the Short Wave bands, however, the whole business of tuning must be far slower. The secret of short-wave tuning lies in a little patience and extra care. Pass over nothing in the way of a signal. Much of it will be Morse, but this can be ignored unless the operator happens to be interested in it. The strong "landmarks" will soon be heard—German and Italian short wave transmissions, often in English, which announce their wave-lengths and frequencies. Make notes, however, not only of these strong signals, but also of *any* other signal that sounds as if it might not be Morse if it were a little louder. Return to these apparently weak and worthless signals later on during the day or evening: it is surprising how some of these "weak" signals turn out to be, after all, interesting programmes whose strength merely varies with the time of the day. In this way, often, one finds the tuning points for the American transmissions.

KIT OF PARTS

COMPRISING:—

ONE BULGIN T.C.24 CHASSIS; One M.T.9. Mains Transformer, 60-watt type; Three H.W.25 Resistors, .1 MΩ; Two H.W.31 Resistors, .5 MΩ; One H.W.1 Resistor, 250Ω; Two H.W.38 Resistor, 150Ω; One H.W16 Resistor, 12,500Ω; One H.W.15 Resistor, 10 KΩ; Two H.W.23 Resistors, 50 KΩ; One H.W.33 Resistor, 1 MΩ; One A.R. Resistor, 150Ω; Three P.C.301 Tub. Condenser, .0001 μF; Seven P.C.P.1 Tub. Condensers, .1 μF; One P.C.405 Tub. Condenser, .0005 μF; One E.C.3 Electro. Condenser, 50 μF; One E.C.7 Electro. Condenser, 8 +4 μF; One C.V.2 Two-Gang Tuning Condenser; One C.P.4 Trimmer, .0006 μF. max.; One C.P.3 Trimmer, .0003 μF. max.; One S.150 Driver Locator Unit, 6" shaft; One S.154 Switch Contact Unit; One S.153 Contact Unit with Bracket; One C.T.2.B Controlatone; One F.18 Fuse-holder and Mains Connector; One P.51 A and E socket strip; One P.53 Pick-up Socket Strip; One P.62 Mains Input Socket Strip; Two V.H.49 valve holders, 7-pin; One V.H.48 valve-holder, 5-pin; One S.W.42, valve-holder, 7-pin Short Wave; One P.84 Flat Pin Socket; One P.81 Flat Pin Plug; One Type C Panel Bush; One E.H.9 Universal Bracket; One E.H.16 Insulated Shaft Coupling; One 6" Brass Rod, ¼" diam.; Two B.650 M.E.S. Pilot Lamps; One C.V.6 S.M. Tuning Drive; One C.52 Aerial Coil; One C.53 Oscillator Coil; One C.51 I.F. Transformer; One C.50 I.F. Transformer; One S.W.50 L.W. Filter Coil; One Coil W.S.2 Screened Flex Wire. Sundries, soldering tags, washers, insulating fibre washers, rubber grommets, "Quickwyre", screws and nuts, everything for the full construction of the receiver.

PRICE OF COMPLETE KIT,

£6 - 10 - 0

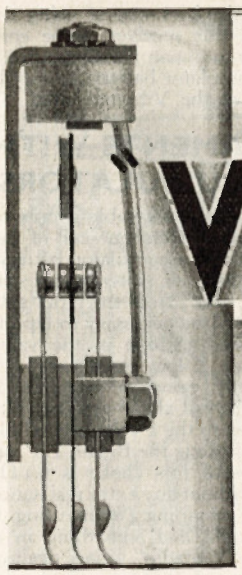
NOTES ON AERIALS.

IT should not be forgotten that an aerial has the properties of a tuned circuit. It possesses inductance, capacity and resistance, and is resonant at one particular frequency. On the long and medium wave bands, all domestic aerials are compromises, because it is out of the question to erect an aerial of sufficient length—say a quarter of a mile!—to resonate at wave-lengths of the order of several hundreds of metres.

On the short-wave bands, however, matters are different. When we are dealing with wave-lengths of the order of only a few metres, our aerials may quite well approach resonance even in their ordinary forms. If we are to have any control over this resonance, there must be sufficient inductance reserved in the form of the aerial input coil for the tuning condenser across it to have an appreciable effect. Hence, it is good practice, when engaging in short-wave reception, to use a comparatively short aerial. Such an aerial is quite sufficient for very sensitive modern sets to pick up good signals on the long and medium bands, and on the short-wave bands, the natural properties of the aerial tend to make up for the weakness of signals that may be encountered on these bands.

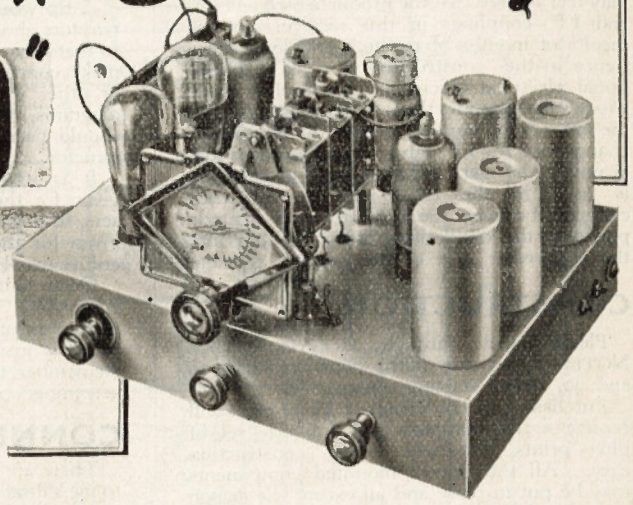
Since the aerial (external to the set) is short, it follows that it must be placed in the best possible position for the picking up of signals, in order to avoid loss of signal strength—and, what is just as important, to keep the signal-noise ratio high. Hence. although a huge pole or lattice mast are not necessary, the length of aerial wire (which includes the lead-in portion to the set) must be suspended well clear of all conductive materials. The "effective height" of an aerial is an electrical property that often has nothing to do with its distance from the ground level: an aerial may be forty feet from the ground, but if, at that height, it runs close to a wall or metal roof or gutter, it will possess no more height, electrically speaking than if it ran six feet from the ground. Indeed, quite often a more open space for an aerial can be found comparatively close to the ground. Again, it must not be forgotten that it is often the vertical portion of the aerial that has the maximum voltage induced in it by the radio frequency waves: the horizontal portion does little more than add inductance and capacity. Hence, as much of the aerial as possible should be suspended vertically. This explains why the lead-in portion, which is very often a large proportion of the vertical component of an aerial, is so important. Unfortunately, it usually has to run fairly close to conductive materials, particularly the electric light house wiring, which is apt to radiate interference.

Bearing these points in mind, the constructor should realise that the erection of his aerial is by no means the unskilled, haphazard business that the uninstructed sometimes think it is.



No H.T. Batteries

"VIBRADIO"



MAINS VOLUME AND QUALITY WITHOUT H.T. BATTERIES

PUSH-PULL OUTPUT
SENSITIVE SELECTIVE

TESTED CIRCUIT No. 25

THE IDEAL RECEIVER FOR MAINLESS DISTRICTS

THE RECEIVER to be described has the exceptional merit of dispensing with H.T. batteries. We say 'merit' advisedly, because there are quite a number of people who are never quite happy with dry-battery supplies. Their case is that they really only get the full voltage for which they have made arrangements when the battery is new, with consequent loss of power and tone.

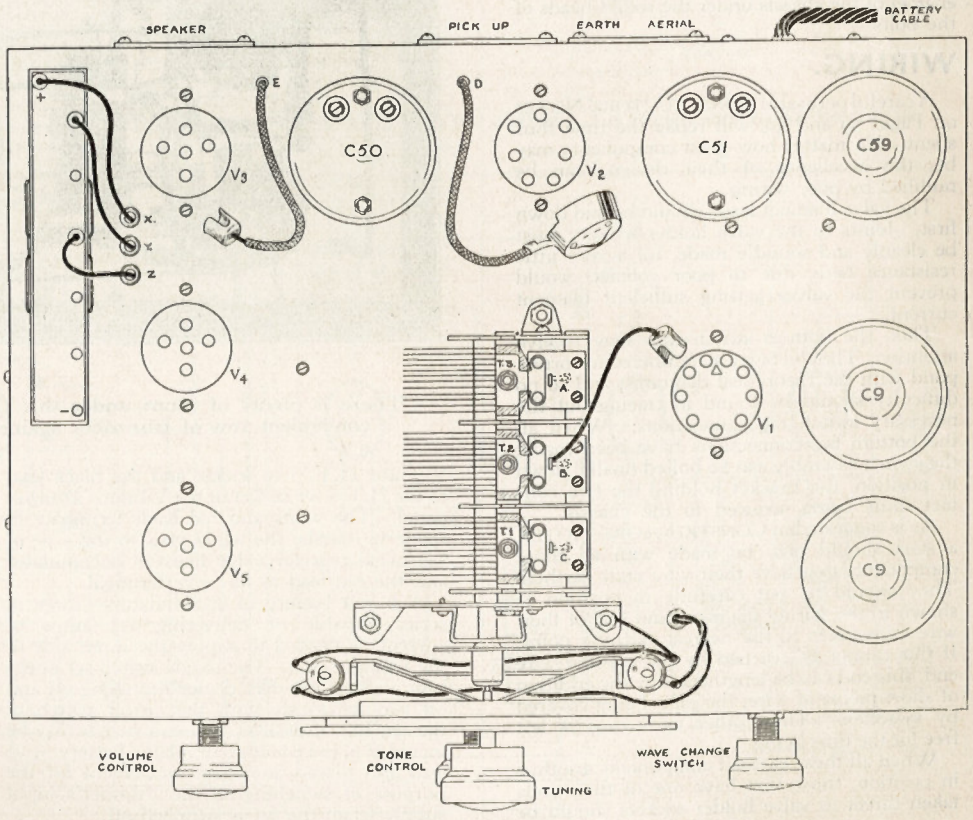
On the other hand, there always are, and always will be, positions where the dry H.T. battery is unchallenged.

In districts where a little extra, or a little more frequent, charging of an L.T. accumulator can be arranged, the Bulgin Vibrator H.T. Supply scheme will introduce practically all the merits of mains supply—constant and high voltage, ample current, and so forth—without the actual need for the connection to Company's Supply. In country districts where, for example, a windmill charger (by no means so infrequent as may at first be supposed) is used, the arrangement is not only ideal—it is the best possible from all points of view. To recapitulate, with the Bulgin H.T. Vibrator Eliminator, constant supplies of unchanging anode current at full voltage can be obtained with no more trouble than is involved in the periodic re-charging of the accumulators, rendering the battery set very well comparable in volume and quality to the ordinary mains set.

THE CIRCUIT.

The output stage is arranged for push-pull, and in the type intended for use with the Vibrator Unit, a pair of critical-anode-distance tetrodes are employed, the power (2½ watts) and quality of the output from these being much superior to that obtainable from battery pentodes. These tetrodes operate in normal push-pull, being biassed to the middles of the straight part of their curves, so that they pass a considerable amount of standing current—some 30 mA. This would be a prohibitive drain on any but superpower H.T. batteries, but it is well within the capabilities of the Vibrator, which is designed for an output of no less than 60 mA. at 150 volts. With such an anode supply, both quality and volume leave very little to be desired even by those who are used to listening to mains driven receivers.

Should it be desired to operate the receiver from the usual H.T. batteries, however, these tetrodes should be replaced by smaller tetrodes, Y220, and they should be biassed back to the bottom bends of their characteristic curves (between 9 and 12 volts negative) so that they work in Quiescent Push-Pull. The standing current will then be of the order of only 3 or 4 mA, which is perfectly normal for ordinary H.T. batteries. The volume and quality will not be quite so good as with the larger tetrodes, but it will still be quite up to the standard of powerful battery driven sets employing Q. P. P. output.



The remainder of the circuit follows normal superheterodyne principles; selectivity is ensured by a band-pass aerial input circuit. Although the special peculiarities of coils cannot be shown in theoretical diagrams, constructors may feel assured that the products used as H.F. and I.F. couplings in this receiver are the results of months of research and long experience in the construction of coils of exceptional electrical efficiency. A double diode triode valve provides the L.F. signal and A.V.C. the latter being applied to both the frequency-changer and the I.F. valve. It will be noted that a novel and very efficient form of coupling is used in the triode-pentode frequency changer, between the oscillator and pentode portions, the oscillations being injected into the suppressor grid of the pentode portion.

CONSTRUCTION.

Please read through CONSTRUCTORS' NOTES at the end of the book on Pages 39 and 40, before starting construction.

Purchasers of the complete kit of parts will receive a free complete and full size set of blue-prints that will render construction easy. All the chassis mounted components may be put in place and all except the switch assembly bolted home tightly, before wiring up.

The switch assembly consists of a driver-locator unit, to which is bolted one rotary contact unit: two other rotary contact units are supported one on each side of a bracket. The contact units may be slipped on to the square driver rod, but the assembly should not be finally bolted home until the bottom tags (shaded in the wiring diagram) have been connected to their appropriate coil tags. This will be explained later.

The soldering tags that are shown under some of the holding down screws and nuts should not be neglected. They form short and convenient earthing points for many of the smaller components. So that they make sound electrical contact with the steel of the chassis, it will be best to scrape away a little of the enamel of the chassis under the round heads of the bolts.

WIRING.

A careful perusal of CONSTRUCTORS' NOTES on Pages 39 and 40, will repay the time thus spent. No matter how good components may be, the excellence of their designs can be nullified by poor wiring.

The valve filament leads should be laid down first. Joints to the valve holder sockets must be cleanly and soundly made, for a very little resistance here, due to poor contact, would prevent the valves getting sufficient filament current.

Then the bottom switch tags may receive attention. The coil tags are numbered to correspond with the theoretical diagrams, and so no difficulty should be found in tracing out the necessary switch tag connections. When all the bottom tag connections have been made, the switch assembly can be bolted finally down in position, the bracket holding the two contact units being screwed to the chassis.

As is suggested in CONSTRUCTORS' NOTES, a start should now be made with all those components that have their wire ends earthed. They should be put carefully in position as shown in the wiring diagram, and one of their wire ends taken to the nearest earthing point. If this cannot be reached by the existing wire end, this end can be lengthened by the addition of short pieces of wire, the join being covered by systoflex. Their other ends can be left free for the time being.

When all these earthed components are thus in position, those that have one of their ends taken direct to valve holder sockets should be fixed. Again, if the wire ends are not long enough to reach from the component's correct position to the valve holder socket, additions may be made (soldered, of course) and the joints protected by insulation.

A tip worth following is to slip over all the resistors short pieces of 8 millimetre systoflex, so that their metal caps are covered and cannot make contact with each other or the chassis or other wiring. This is not shown in the diagrams, for the sake of clearness, but it should be done for safety's sake by the constructor.

It is important to adhere to the lay-out given for these resistors and tubular condensers. If departures are made from the positions given for them, instability and ganging difficulties may be encountered later on.

Quite half the wiring will now have been completed. There will remain the linking up of the rest of the circuit by various lengths of properly insulated wire of the right thickness. Remember to earth most carefully the metal screening on all flexible screened leads.

CONNECTING UP.

There are four leads connecting the receiver to the Vibrator H.T. Unit and the valve filament accumulator. The yellow and black leads should end in wander plugs: the yellow goes to the Vibrator H.T. +ve socket and the black lead to the H.T. – ve socket of the Vibrator's output panel. The white and red leads terminate in spade terminals: the white goes to the – ve of the usual receiver valve filament accumulator and the red lead to its +ve terminal.

A 6 volt battery of accumulators—three in series—capable of delivering 1.5 amps of current, is needed to supply the input side of the Vibrator unit. The toggle switch set in the case of the Unit may do for switching on and off simultaneously with the on-off switch of the set, but, if desired, an extra switch may be included in the 6 volt accumulator-battery +ve lead and placed anywhere convenient for the purpose of switching off the Vibrator's input supply when the set is switched off.

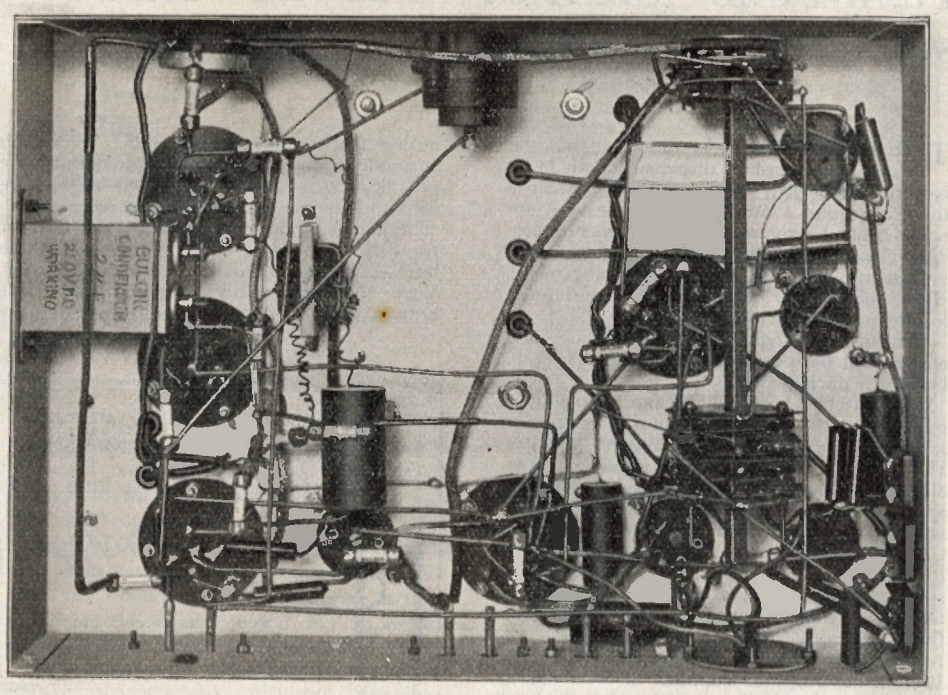
Although this is the best way of using the Vibrator Unit with this receiver, some constructors may desire to obtain filament current from the 6 volt accumulator battery, to supply the valves as well as the Vibrator input.

2 VOLT FILAMENTS WITH 6 VOLT ACCUMULATORS.

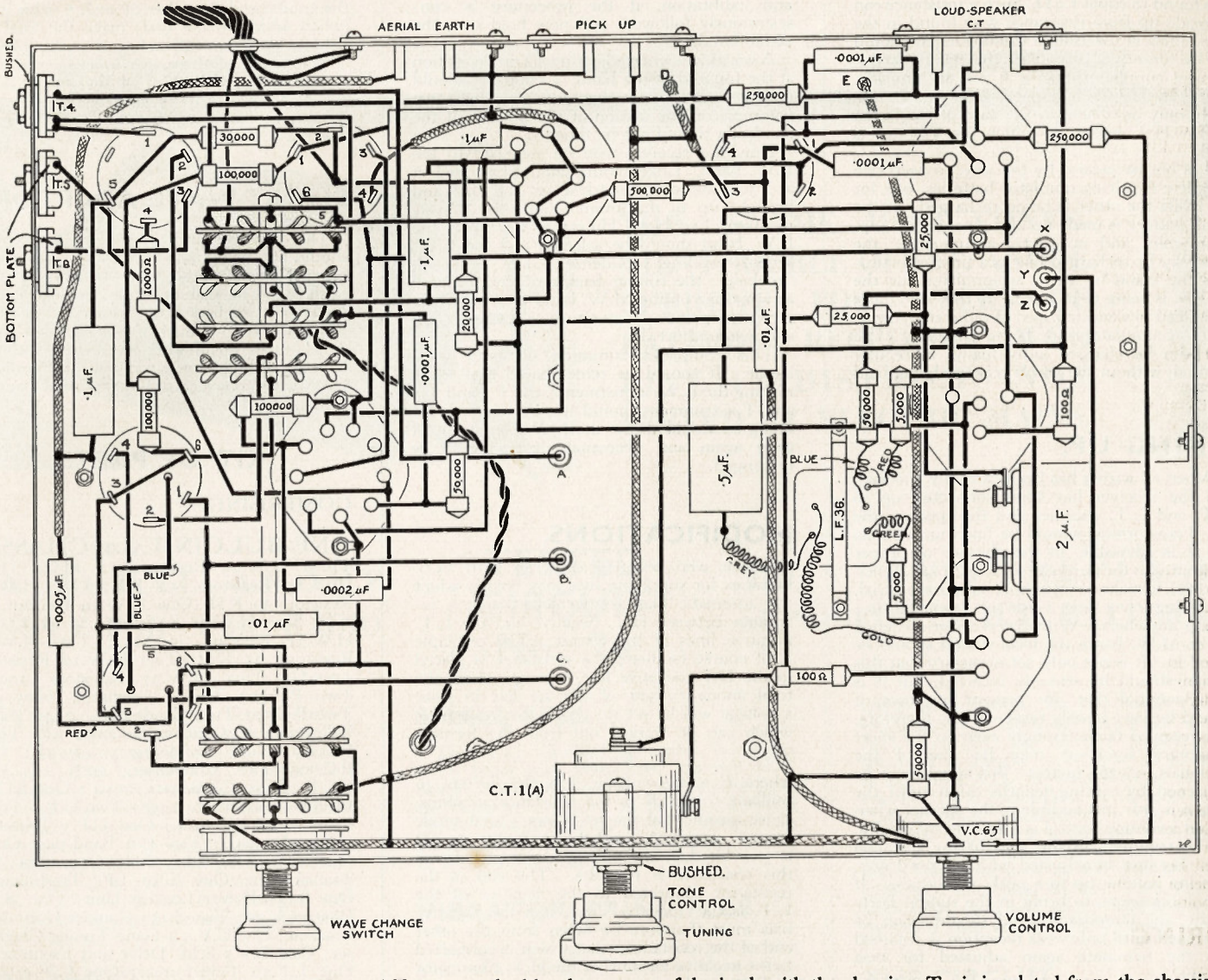
If this is done, it is not advisable simply to tap off the 2 volt supply from one cell of the 6 volt (3 cells in series) accumulator battery. This may cause hum or interference on account of the "kick back" from the input side of the Vibrator. It will be necessary to tap off the whole 6 volts and include in the valve filament supply leads a low resistance L.F. choke, that not only prevents interference reaching the filaments, but also drops the voltage from 6 volts down to the 2 volts needed for the valves. Such a choke is the Bulgin L.F.44. The D.C. resistance of this choke is 6.1 Ω: hence it is suitable without any extra resistance for filament voltage dropping (when using 6 volt batteries for L.T.) and smoothing in a receiver, such as the "Vibradio" we are dealing with, that takes .7 amp. L.T. current. Should it be used, however, with a receiver of which the total filament current is less than this, an extra resistance must be put in series with the choke L.F.44, in order to drop the voltage adequately when less current is passing. The formula for finding this extra resistance is

$$R = \frac{(6.1 \times \text{Current}) - 4}{\text{Current}}$$

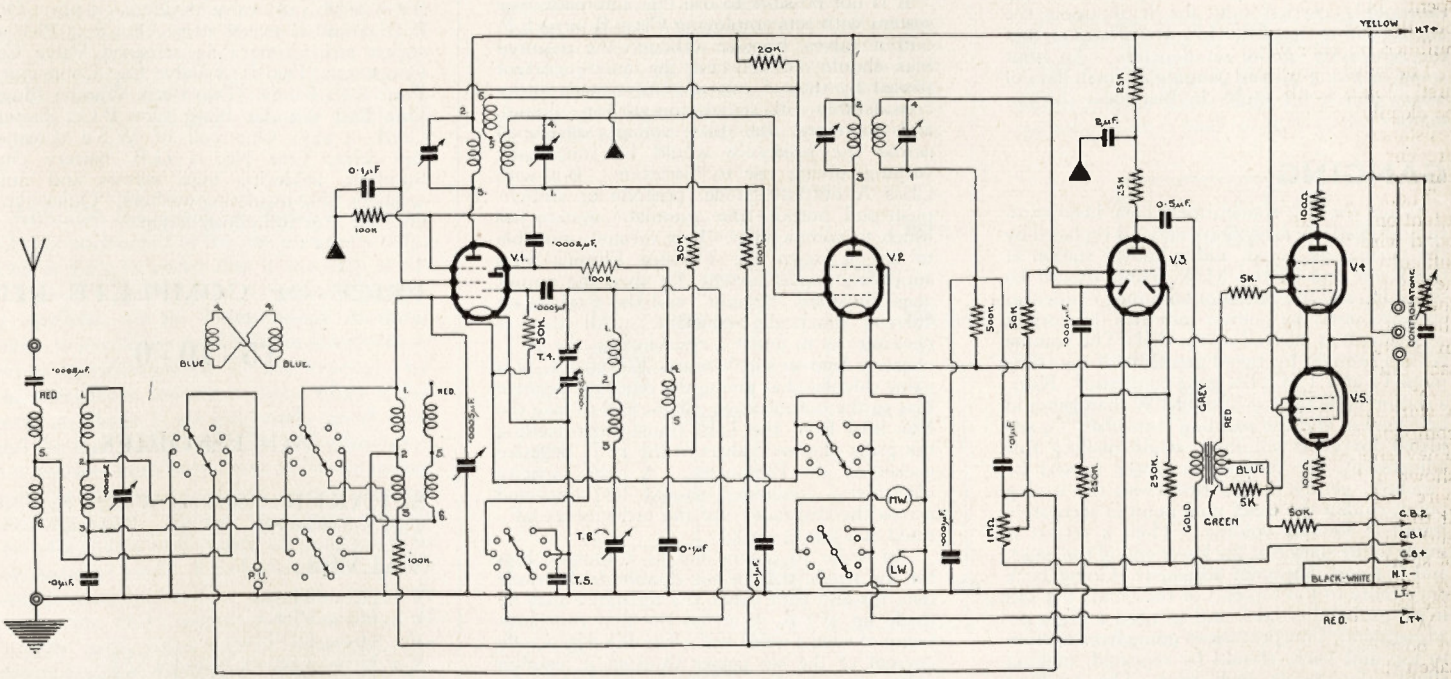
where R is the extra resistance (which must be capable of carrying the total filament current without overheating) and the current is the total current taken by the filaments of all the valves in the set. This current can be ascertained very easily by simply adding up the filament current ratings of the valves. Thus, a 4 valve set might have three H.F. valves taking .1 amp each, and one output valve taking .2 amp. This makes a total of .5 amp. Substituting .5 for the term "current" in the formula,



There is plenty of room under this chassis for all the components. Note the convenient row of trimmers against the side of the chassis on the right.



The earthed plates of the trimmers T.5 and T.6 are earthed by the contact of the bush with the chassis. T.4 is insulated from the chassis.



Note the novel method of coupling the oscillator to the signal circuit in the triode-pentode valve.

R is found to equal 1.9 Ω. Such a resistance can be made up from resistance wire found in the wire tables in the Bulgin Catalogue. It should not be forgotten, of course, that taking 2 volt filament supplies from the 6 volt accumulator battery in this way is not very economical. It is really only justifiable in the case of car radio, for the H.T. supply of which the Vibrator is used.

It is not necessary, by the way, to keep two complete 6 volt accumulator batteries, one for use while the other is being recharged. If the 6 volt battery is made up of 3 *separate* 60 amp. hour. cells, and one extra accumulator, the cells may be recharged one at a time, substituting the stand-by extra accumulator for the cell that is being re-charged. In this way, there is no need to wait, deprived of radio enjoyment, while accumulators are being charged. The cells can be charged individually, in regular rotation, without the whole receiver being held up.

LINING UP.

When all wiring has been carefully checked, and the receiver has been connected up to H.T. and L.T. supplies and the speaker, the I.F. Transformers should be lined up. To do this it is advisable, in the absence of proper apparatus for the purpose (see CONSTRUCTORS' NOTES), to make use of a short temporary aerial, consisting of a few yards of insulated flex strung anywhere. With the receiver switched to the M.W. band, the local station should be tuned in. It is not only *not* necessary that this station should be strongly received, but it is even essential that, for present purposes, it should be very *weakly* received. If, therefore, it is received fairly strongly even on the short temporary aerial—it may be one of the Nationals, on 261 metres—this aerial must be shortened by cutting lengths off it until the station is only just audible in the speaker when the set's volume control is turned to maximum.

The trimmers in the tops of the I.F. coil cans may now be adjusted with a screwdriver, to bring volume up to a peak of loudness. If doing this seems to bring in the station fairly loudly, the temporary aerial should again be shortened until only weak reception is obtained and the trimmers again adjusted for best volume.

This operation should be very carefully and thoroughly carried out, for it is upon the correct lining up of the I.F. transformers that the sensitivity of the set depends. An hour spent in lining up and ganging is worth days of weary search for faults in blameless components.

GANGING.

When the I.F. transformers have been carefully aligned, the temporary aerial is replaced by the permanent aerial, and a known station at the lower end of the M.W. band should be tuned in, and the oscillator trimming condenser adjusted until the pointer indicates the correct wavelength as marked on the dial. The volume is then brought up by adjustments of the trimmers T2 and T3 on the gang condenser. Next, a station up at the top of the M.W. band should be tuned in and the padding condenser T4 adjusted for good volume; while making this adjustment, the tuning condenser should be "rocked" gently to and fro across the tuning point, so that the exact final point is accurately found at loudest volume. Then a return is made to the station at the lower end of the band, and T2 and T3 again adjusted. Going back once more to the top end of the band, T.4 will in all probability be found to need a slight re-adjustment. This process, of going from bottom to top and back, should be repeated, making slight adjustments each time. The tracking and calibration, if the procedure is conscientiously followed, will now hold over the whole band.

A warning—when adjusting T4 on the station at the top end of the band, T2 and T3 should not be touched, and when adjusting these two trimmers on the station at the bottom of the band, T4 should not be touched.

Now the receiver may be switched to the L.W. band. Luxembourg should be tuned in at 1304 metres as marked on the dial and brought up to maximum volume by adjustments of T5. Next, Huizen at the top of the L.W. band should be selected and the L.W. series padding condenser T.6 adjusted, "rocking" the tuning backward and forward as was done on the M.W. band to get the best reception point. Next return to Luxembourg and again adjust T5 .

This completes trimming on both wave bands. It should be remembered that while making the L.W. adjustments, the T.2 and T.3 and T.4 trimmers should not be touched, for doing so would throw the M.W. band out of gang again and necessitate it having to be re-ganged.

MODIFICATIONS.

Those who wish to dispense with G.B. batteries for supplying bias may readily adopt the automatic bias arrangement, using a resistance between H.T. negative and the L.T. negative lines of the circuit. The principle is of course familiar; if a resistance is placed in the H.T. negative line, through which the total anode current of the set has to pass, a voltage will be set up across this resistance, which can be worked out from the formula

$$E = \frac{I \times R}{1000}$$

where E is the voltage, I is the current in milliamps, and R is the resistance in ohms. If we assume that the set passes a total anode current of 20 mA., and the resistance we use is 500 Ω, then the voltage developed across this resistance is 10 volts. The end of the resistance connected to the negative of the L.T. is the "positive" end, and the negative bias must therefore be taken from the other end of the resistance—that which is connected to the negative terminal of the H.T. Eliminator or Battery.

It is not possible to use this automatic bias system with sets employing Class-B or Q.P.P. output valves, because although the required bias should be constant the anode current passed by these forms of output stage varies considerably with signal strength (or volume), and therefore, the bias voltage developed across the resistance would be continually varying, giving rise to distortion. But with Class A output—triode, pentode or straight push-pull output—the automatic system has much to commend it. It is certainly possible to use it when the Vibrator Eliminator is supplying anode current, for then the output stage must be "straight" and the total anode current practically constant. All that is necessary is to insert a resistance in the H.T. negative lead to the Vibrator Eliminator, of a value calculated as giving the required negative bias to the output stage valves, and to take the bias lead from the L.F. transformer feeding the grids of these valves to the H.T. negative socket on the Eliminator. A large capacity electrolytic condenser should be connected across the resistance—of the order of 25 μF., rated at 25 volts peak.

In order to obtain similar automatic bias for the triode part of the double-diode-triode detector and L.F. valve, the resistance may be made up of two in series, the first resistance being of such a value that when the total anode current of the set passes through it, enough voltage is set up across it to provide bias for the triode, and the other of such a value as to (when added to the first) make the total resistance up to enough to bias the output stage. The junction of these two resistances is connected to the G.B. lead of the triode valve. Again, a large capacity electrolytic condenser should be used to by-pass each resistor, towards L.T. as usual.

SHORT WAVE ADAPTORS.

There is no reason why all-wave reception should not be obtained with the "Vibradio," receiver we have described. This can be quite easily done by making up a Short-wave converter unit, such as T.C.7, described in Radio Progress No. 1. Such a unit, of the "autodyne" types,—will work excellently with the Vibrator Eliminator supplying the ordinary receiver without recourse to abnormal arrangements.

KIT OF PARTS

COMPRISING:—

ONE BULGIN T.C.25 CHASSIS; Three H.W.25 Resistors, .1 MΩ; Three H.W.23 Resistors, 50 KΩ; One H.W.21 Resistor, 30 KΩ; One H.W.19 Resistor, 20 KΩ; Two H.W.28 Resistors, .25 MΩ; One H.W.31 Resistor, .5 MΩ; Two H.W.20 Resistors, 25 KΩ; Two H.W.10 Resistors, 5,000 Ω; Two H.W.37 Resistors, 100 Ω; Two P.C.305 Tub. Condensers, .0005 μF; Two P.C.101 Tub. Condensers, .01 μF; Two P.C.302 Tub. Condensers, .0002 μF; Three P.C.101 Tub. Condensers, .01 μF; One P.C.303 Tub. Condenser, .0003 μF; One P.C.P.5 Tub. Condenser, .5 μF; One S.C.20 Electro. Condenser, 2 μF; Two C.P.4 Trimmers, .0006 μF max.; One C.P.3 Trimmer, .0003 μF. max.; Two C.9 Band-pass Coils; One C.59 Oscillator Coil; One C.51 I.F. Transformer; One C.50 I.F. Transformer; One S.151 Driver Locator Unit; One S.154 Contact Unit; Two S.153 Contact Units with Brackets; One C.V.3 3-Gang Tuning Condenser; One C.V.5 S.M. Drive and Escutcheon; One L.F.36 Transformer; One C.T.1 Controlatone; Three V.H.49 valve holders, 7-pin; Two V.H. 48 valve holders, 5-pin; One P.51 A and E socket strip; One P.53 Pick-up socket strip; One P.65 screened Valve Cap Connector; Two P.68 Valve Cap Connectors; Four K.82 Knobs; Two Black Wander Plugs; One Red Wander Plug; One B.C.2 Battery Cord, 4-way; One coil of W.S.2 screened flex wire; One No. 2 G.B. battery clip; Sundries, soldering tags, screws and nuts, washers, fibre insulating washers, "Quickwyre" etc., etc., for full construction.

PRICE OF COMPLETE KIT,

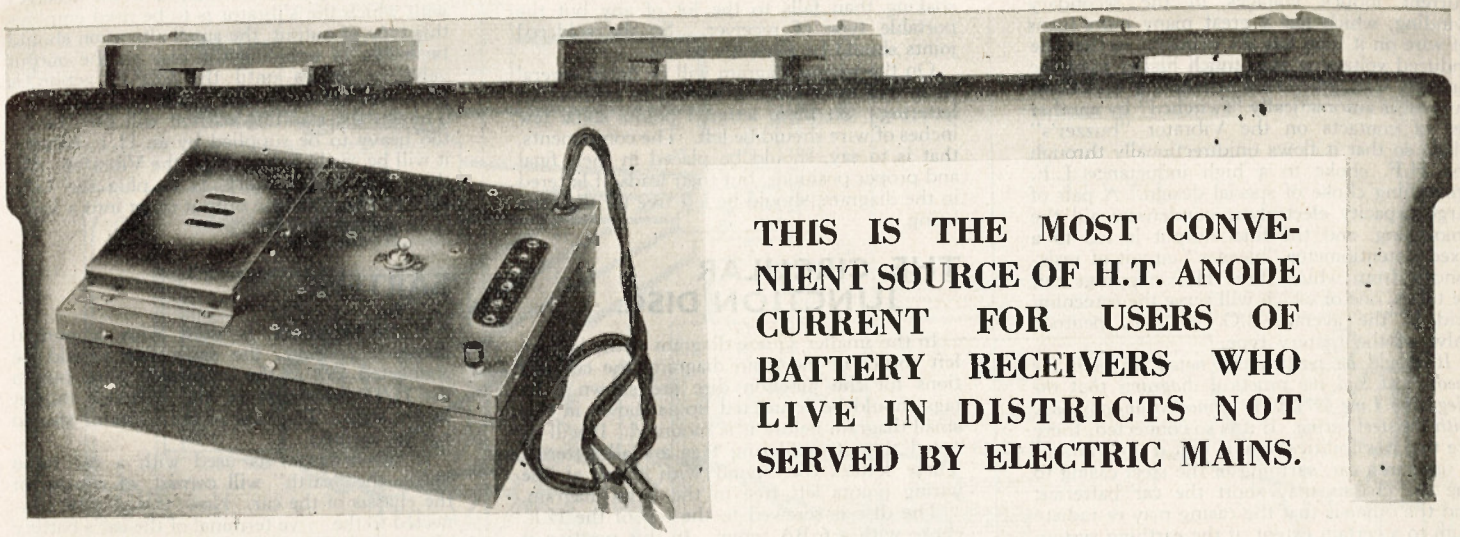
£5 - 10 - 0

ACCESSORIES.

SPEAKER: Stentorian W.B.38. S., P.M., with transformer.

VALVES:

V.1. Hivac TP230.
V.2. Hivac VP215.
V.3. Hivac DDT220.
V.4. Hivac Z220 or Y220 for Q.P.P.
V.5. Hivac Z220 or Y220 for Q.P.P.



THIS IS THE MOST CONVENIENT SOURCE OF H.T. ANODE CURRENT FOR USERS OF BATTERY RECEIVERS WHO LIVE IN DISTRICTS NOT SERVED BY ELECTRIC MAINS.

AN IDEAL ANODE SUPPLY FOR CAR RADIO

TESTED CIRCUIT No. 26

THIS UNIT REPLACES SUPER-POWER H.T. BATTERIES.

FOR many years, the High Tension Battery has been regarded as the only practicable way of obtaining anode supplies in battery receivers. The Bulgin H.T. Vibrator Unit now makes it possible to obtain ample anode current at high voltage by the conversion of low-tension accumulator power into high tension current. The advantages of such a scheme are numerous and fairly obvious. There is no falling off in quality and volume as long as the accumulators are kept charged, and there is not the urgent necessity to economise in H.T. current.

CAR RADIO.

For the anode supplies of car receivers, the H.T. Vibrator is ideal. It can be worked off the usual car batteries, which can also supply filament current. The moving parts are so few and simple that there is little to go wrong even under the severely vibrating conditions found in a car.

SMALL SIZE.

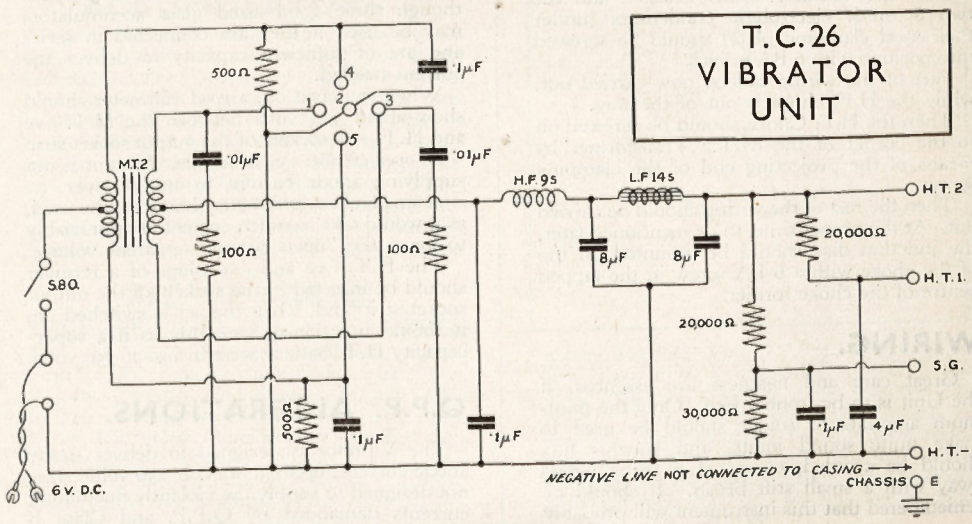
The H.T. Vibrator Eliminator, complete, is no larger than a standard 120 volt H.T. battery. No alterations in space requirements are therefore needed. In fact, the Vibrator can be regarded, as far as H.T. connections are concerned, very much as if it were a battery or a mains eliminator.

VIBRATOR PRINCIPLES.

The principle upon which the low-tension D.C. of accumulators is converted into high voltage anode supplies is basically that of an ordinary buzzer or electrical bell. Only the extraordinarily high accuracy of adjustment possible with modern manufacturing methods and long research for suitable materials have made a reliable "buzzer", however, available for the exacting requirements of an H.T. unit. It is sufficient here to say that, by an automatic vibratory mechanism, the low-tension D.C. of accumulators is converted into about 4 volts A.C. This A.C. can be then stepped up by means of a suitable transformer to as much as 250 volts A.C. It must then be rectified into D.C., and this is done by contacts on het "buzzer" itself, automatically. The resultant D.C. has ripples in it which can be smoothed out by choke-and-condenser filters on very much the same lines as the ordinary mains eliminator smoothing circuit. Thus finally a remarkably pure and steady supply of H.T. current is made available for the anode circuits.

THE CIRCUIT.

In working form, the above described principles are applied to a number of specially designed components, of which the step-up transformer is the beginning. Through its primary flows the 6 volt D.C. accumulator current, which is made to vary by the Vibrator



Although the casing or chassis is of steel, it is not connected to the circuit in any way. This is done in order that if the only available earth is not too good it may be separately earthed, to an independent earthing point, to avoid any possibility of interference being communicated to the receiver by radiation from the input side. Only if the earth available is an extremely good one, and the lead to it from the set and eliminator is a few feet long only, may both the casing and the set be connected to a common earthing point. Sooner than have the set and eliminator and casing all connected to one inferior earth, it is better to leave the casing unearthed and to connect the earth line to the H.T. negative socket only. If another earth point can be arranged, the casing may be connected with it.

"buzzer" unit. These variations in primary current induce voltages in the secondary winding, which has a great many more turns of wire on it than has the primary, so that the induced voltage is very much higher than the primary voltage. This alternating secondary current is automatically "switched" by another set of contacts on the Vibrator "buzzer's" blade so that it flows unidirectionally through the H.F. choke to a high inductance L.F. smoothing choke of special design. A pair of large capacity electrolytic condensers aid the smoothing, and the final output is fed to a fixed potentiometer "bleeder" circuit of resistances, from which three H.T. tappings can be taken, one of which will serve the screening grid of the average S.G. or H.F. pentode valve of the battery type.

It should be particularly noted, in both the theoretical and the practical diagrams that the Negative Line is NOT connected in any way with the steel casing. If it is so connected, there are two possibilities: one is that if the vibrator is used in a car, earthing of the steel casing to the car chassis may short the car batteries, and the other is that the casing may re-radiate hum to a certain extent, if the earthing system of a receiver is not too good.

CONSTRUCTION.

All the chassis mounted components can be screwed into position before wiring is commenced. The lay-out has been so arranged that the top of the casing carries everything, so that the box part will not be required during construction.

The mounting of the H.F. choke requires mention. The centre of this H.F. choke is tapped, and the choke is mounted by being screwed on to the end of the longest of the 6 BA screws clamping the laminations of the transformer M.T.2.

THE CIRCULAR JUNCTION PLATE.

Attached to the top of this H.F. choke by means of a 6 BA screw is the round junction disc with 11 soldering tags riveted in it. This should be left until last, and the rest of the wiring done, when it can be mounted and connected up.

ASSEMBLY PROCEDURE.

The procedure when mounting the chassis components on the steel top should be more or less as follows:

First, the M.T.2 Transformer, the L.F.14S Choke, the Vibrator socket bracket, and the two 8 mFd. electrolytic condensers (under their steel clamping plate) should be screwed into position with 6 BA screws.

Part of the wiring can be now carried out, while the H.F. choke is out of the way.

Then the H.F. Choke should be screwed on to the corner of the M.T.2 Transformer by means of the projecting end of the clamping screw.

Then the rest of the wiring should be carried out. At the proper time, to be mentioned later, the junction disc should be mounted on top of the choke with a 6 BA screw in the tapped centre of the choke former.

WIRING.

Great care and neatness are essential, if the Unit is to be trouble free. Only the minimum amounts of solder should be used to make quite sound joints, and surplus flux should be avoided, excess of it being wiped away with a small stiff brush. It should be remembered that this instrument will probably come in for rather rougher handling and shaking than falls to the lot of any but the portable type of receiver. So the soldered joints should be perfectly sound.

On the wiring diagram will be noted several leads that are shown as ending in arrows and lettering. At these lettered points some few inches of wire should be left. The components, that is to say, should be placed in their final and proper positions, but their leads, if lettered in the diagram, should be left free for the time being.

THE CIRCULAR JUNCTION DISC.

In the smaller square diagram at the bottom left corner of the main diagram, the connections for the junction disc are shown. Its tags should be connected up as shown in this small diagram before it is mounted. It will be noted that its soldering tags are all lettered. These letters correspond with those at the wiring points left free in the large diagram.

The disc is screwed to the top of the H.F. choke with a 6 BA screw. In this position it can have connected up to its tags the free ends of the components in the large diagram.

VIBRATOR UNIT CONNECTIONS.

At the bottom of the right hand corner of the larger diagram will be seen the plan of the pins of the Vibrator Unit itself. Great care must be taken over the wiring up of these pins, for incorrect connections here might destroy either the Unit or the transformer.

The Vibrator Unit is very loosely mounted. This is done purposely so that no vibration shall be communicated mechanically to the casing. Under the can, too, there is a layer of sponge rubber. These precautions will make the Unit practically noiseless in operation. And by "noiseless" we mean that when it is working, it will be audible only if the ear is held within a couple of feet of the casing. This is about as quiet as any apparatus of this nature could be made without abnormal and very expensive arrangements.

TESTING.

When the construction is finished and the wiring has been thoroughly checked over, the top or chassis may be fitted over the box part.

The apparatus requires an input of 6 volts. from a battery of accumulators capable of delivering between 1.5 and 2 amps of current. A 6 volt car type battery is ideal for this purpose though three good sized glass accumulators may be used if they are connected in series and are of sufficient capacity to deliver the current needed.

When switched on, a *good* voltmeter should show about 180 volts between the H.T.+ve and H.T. – ve sockets of the output socket strip —*on open circuit*: i.e., when the Vibrator is not supplying anode current to any receiver.

A small, cheap voltmeter should not be used, as it would take so much current as appreciably to lower the "open circuit" apparent voltage.

The H.T.+ve and – ve plugs of a receiver should be inserted in the sockets of the output socket strip and, when the set is switched on, it should function as smoothly as if a super-capacity H.T. battery were in use at 150 volts.

Q.P.P. ALTERATIONS.

The Vibrator is designed to deliver *steady* anode current, up to 50 mA. at 150 volts. It is not designed to supply the violently fluctuating currents demanded by Q.P.P. and Class B output arrangements. Hence, if the receiver with which the Vibrator is to be used employs this type of output, the small alteration should be made, of reducing the bias on the output valve or valves until the Q.P.P. action is converted into "straight" push-pull operation. Though the standing current will then be far too heavy to be supplied by an H.T. battery, it will be easily delivered by the Vibrator. All, then, that is necessary, is to plug the G.B. battery plugs for the output stage into a lower G.B. voltage socket.

EARTHS.

If the Vibrator is used with a normal domestic receiver, the earth line should be connected, not to the set's earth plug, but to the H.T.—ve socket of the Vibrator output socket strip. The case of the Vibrator should not be earthed.

If the Vibrator is used with a car radio ouftit, the "earth" will consist, of course, of the chassis of the car. Now, this *may* be connected to the +ve terminal of the car's battery of accumulators which, if of the six volt type, will probably be used to supply the Vibrator. In such a case, "earthing" the Vibrator H.T. —ve socket or the receiving unit's "earthing" terminal by a connection directly to the car's chassis will short circuit the car battery.

To avoid such a disaster, the "earthing" connection is made to the case of the Vibrator only, and the receiving unit's H.T. —ve line is not to be "earthed." If the receiving unit is of the type that has a special earthing terminal *with a condenser in series*, it will be in order to connect this earth terminal with the car chassis, but not otherwise.

Of course, if the car battery has its —ve terminal "earthed" to the car chassis, then the H.T. —ve line may also be connected to the car chassis without ill effects.

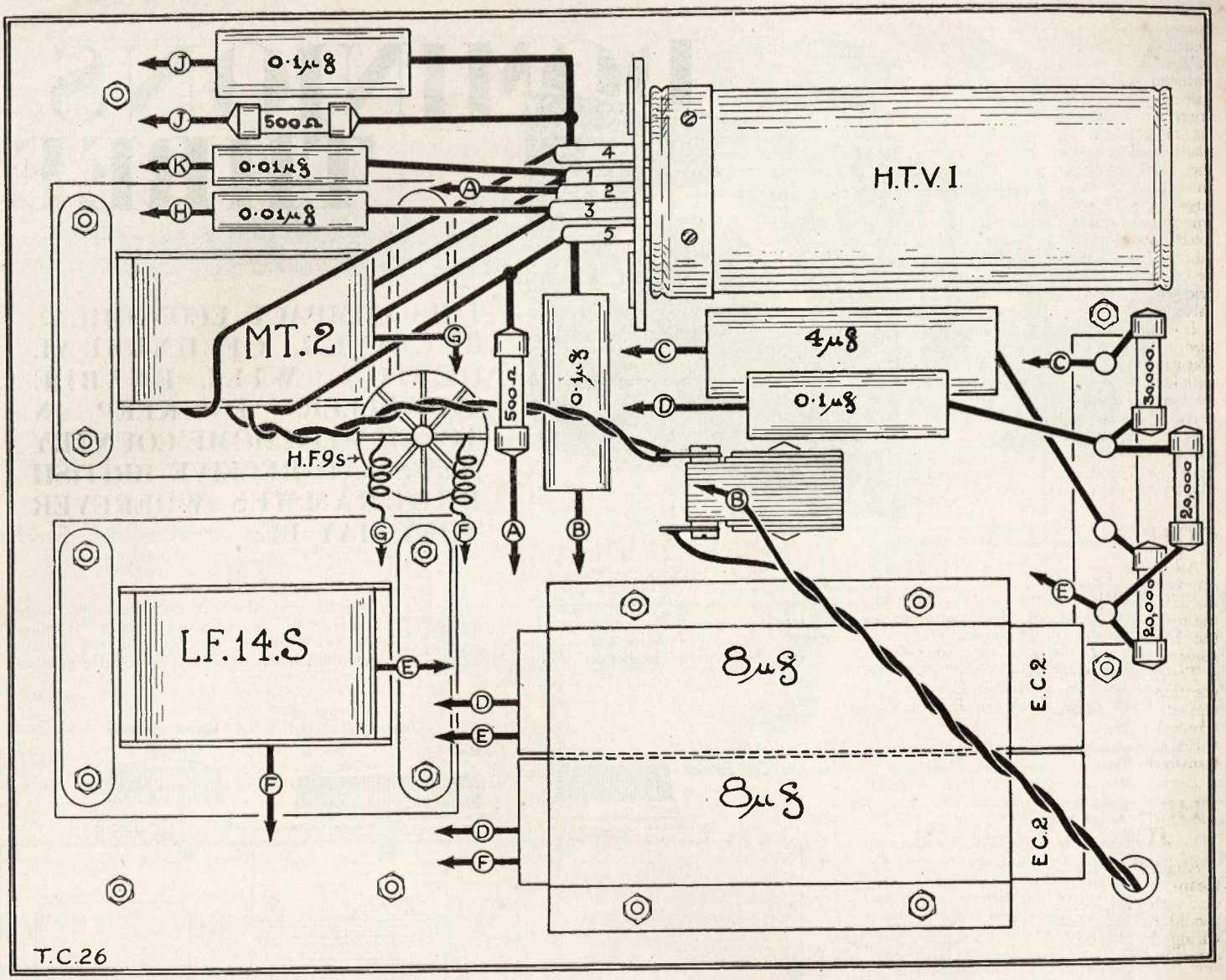
FILAMENT SUPPLIES FROM 6 VOLTS.

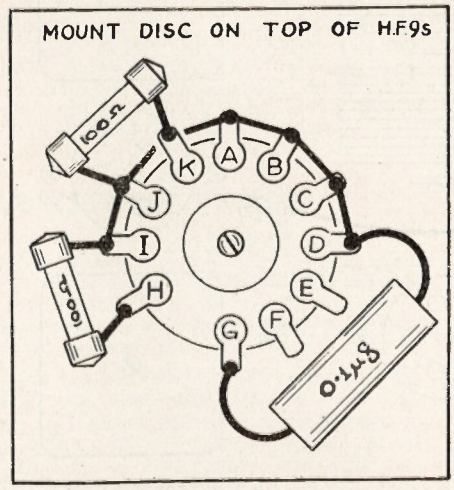
Should it be desired to supply the 2 volt filament of receivers from the 6 volts Vibrator input battery, it will be necessary to avoid "kick back" causing perhaps hum and interference, and also to drop the filament voltage from 6 down to 2 volts. This may be done by means of the Bulgin L.F. 44 low-resistance choke. One filament lead is taken to the 6 volt accumulator —ve terminal, and the other lead is taken to one side of the L.F.44 choke. the other side of the choke is connected to the 6 volt +ve terminal.

Now, this L.F.44 choke has a D.C. resistance of 6.1. Hence, it can be used alone to drop the filament voltage from 6 to 2 volts if the receiver valve filament current totals .7 amp. Should the receiver take less filament current, with consequent less voltage drop, an extra resistance must be placed in series with the choke. The value of this resistance may be ascertained from the formula

$$R = \frac{(6.1 \times \text{current}) - 4}{\text{current}}$$

where R is the extra resistance required, and the Current means the total L.T. current taken by the valves. This current can be very easily estimated by adding together the current ratings of all the valves used. Thus, supposing that a receiver were used having 4 valves, of which the first took .1 amp, the second .1 amp and the third also .1 amp, while the output valve took .2 amp, the total current would be .5 amp. Substituting .5 for the term "current" in the formula gives us $R = 1.9\,\Omega$. Such a resistance is easily made with a length of 24 S.W.G. oxydised nickel-chrome resistance



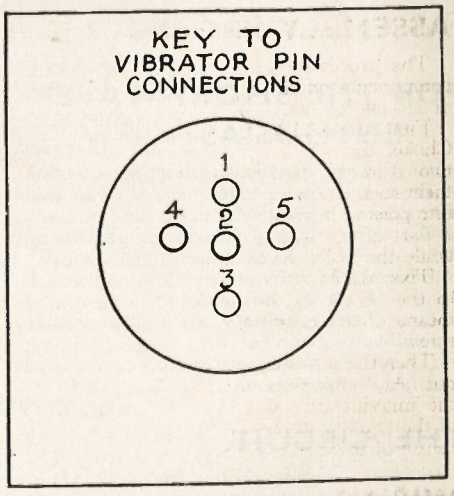


wire 38 inches long. It should be wound, with carefully spaced turns, round a piece of ebonite or bakelite sheet or tube. The resistance required with any receiver can be found from this formula, and the wire required to make up the resistance found by reference to the Bulgin Catalogue.

The choke is not needed when, in a properly designed commercial car receiver, the valve filaments are of the 6 volt *indirectly heated* type. The 6 volt filament supply may then be taken direct to the 6 volt accumulator terminals, and no interference will be experienced.

CHARGING THE ACCUMULATORS.

The 6 volt accumulator battery may consist either of a block of 3 car type cells, or it may be made up from 3 glass or celluloid accumulators connected in series. If the latter form is adopted, it will not be necessary to have a whole battery of 3 cells kept ready for use during the re-charging process. All that is necessary is to have *one* such accumulator. The 3 glass or celluloid cells can be re-charged one at a time, in rotation, and, while a cell is being charged, its place may be taken by the spare one.

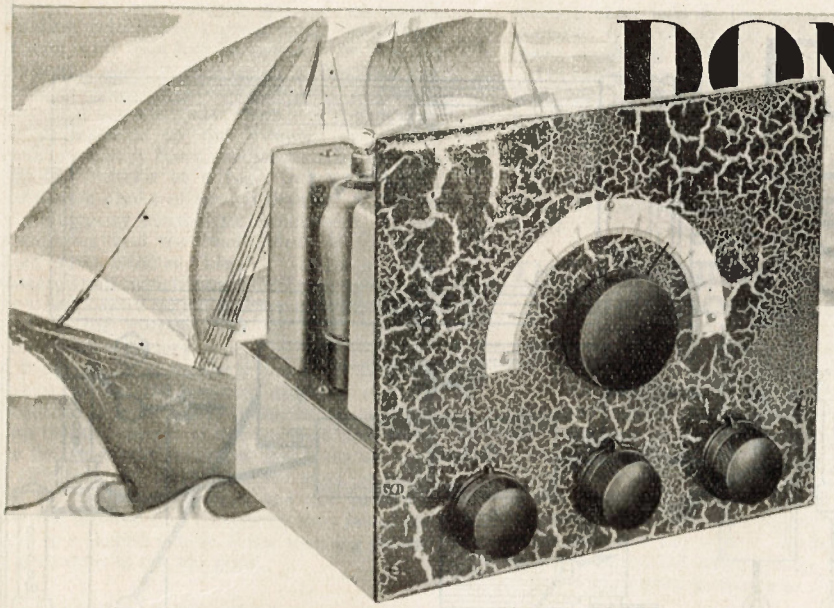


KIT OF PARTS

ONE BULGIN T.C.26 CASING;

One H.T.V.1 Electronic Vibrator Unit; Four P.C.P.1 Tubular Condensers, .1 μF.; Two P.C.101 Tubular Condensers, .01 μF.; One E.C.16 Electrolytic Condenser, 4 μF.; Two E.C.2 Electrolytic Condensers, 8 μF.; One L.F.14.S. L.F. Choke; One M.T.2 Vibrator H.T. Transformer; One H.F.9.S H.F. Choke; One S.80.T.Toggle Switch; Two H.W.19 Resistors, 20,000Ω; One H.W.21 Resistor, 30,000Ω; Two H.W.37 Resistors, 100Ω; Two H.W.2 Resistors, 500Ω; One Vibrator Unit Holder; One Bracket for Unit Holder; all brackets, clamping strips, transformer shrouds, terminal discs, socket strip, moulded (black) terminal, screws, nuts, washers, fibre washers, soldering tags, etc., etc. for full construction.

PRICE OF COMPLETE KIT, £3 - 3 - 0



DOMINIONS THREE

THIS COMPACT ECONOMICAL RECEIVER, OF UNUSUAL DESIGN, WILL ENABLE TRAVELLERS TO KEEP IN TOUCH WITH HOME COUNTRY NEWS AND RECEIVE BRITISH PROGRAMMES WHEREVER THEY MAY BE.

IT IS SURPRISING how few people in this country are aware of the conditions of reception in other parts of the Empire. As a race, we are particularly unobservant of our distant neighbours and fellow men. It is also true to say that, as a Mother Country, we ought to know more about our Empire than we do.

Reception conditions in India, for example, are vastly different from those which we in the British Isles encounter. In one particular —long-wave reception—one man's meat is undoubtedly another's poison.

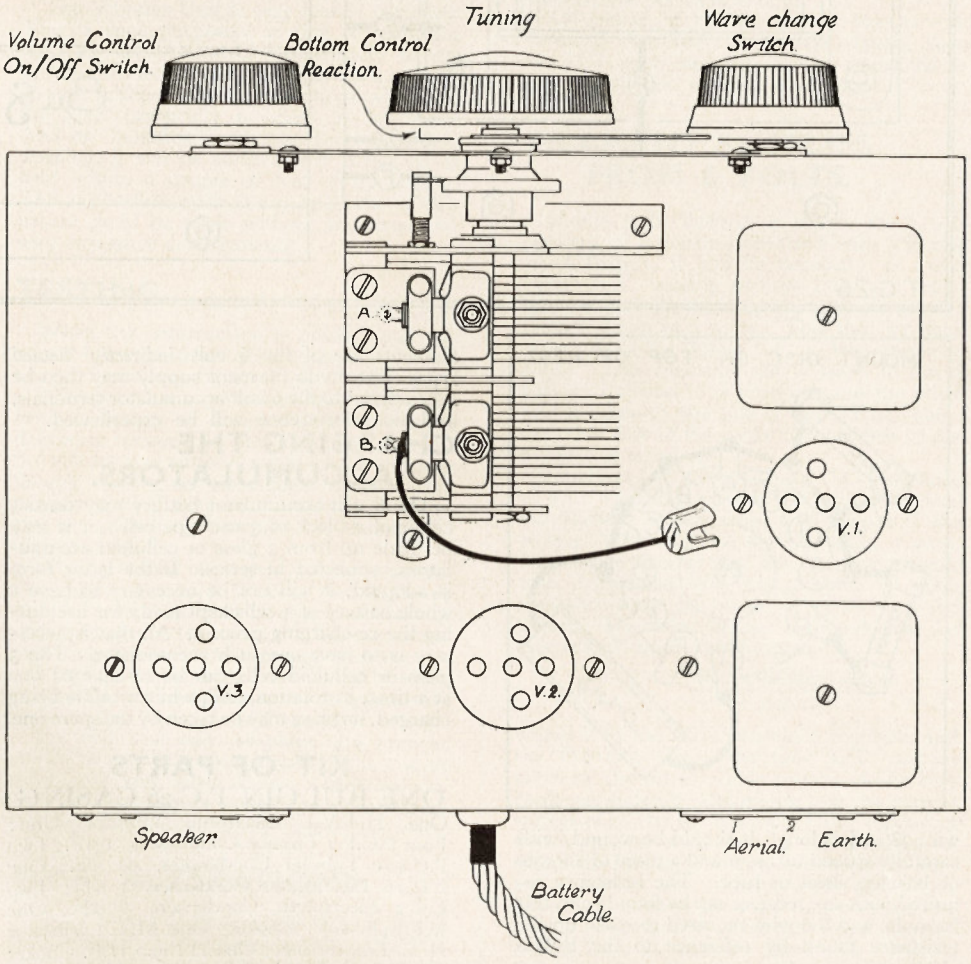
The Receiver to be described was designed chiefly for the Indian market, and to meet the particular needs of conditions in that continent. It uses English valves for battery power, and covers the medium-wave band and two short-wave-bands, and ignores the long-wave band. This receiver, we hope, will prove of especial value to English folk who live abroad, for by its use the Empire short-wave transmissions should be receivable in the tropics.

FOR THE SHORT-WAVE ENTHUSIAST.

The receiver should also attract the attention of those keen radio experimenters who find their greatest interest to lie in the idiosyncrasies of the short waves. Success in multi-band short-wave receivers is attained, as most S.W. enthusiasts know, by efficient coil and switch design. These are specialities of the House of Bulgin. Extreme accuracy in manufacture make it possible to obtain excellent ganging even on the high frequencies without complicated trimmer compensation.

THE CIRCUIT.

Interest naturally centres about the H.F. stages, but mention must be made of the system of automatic grid bias, dispensing with the need for bias batteries. A wire-wound resistor of the 10 watt type provided with bands for tapping off any required value is included in the H.T.–ve lead and across this the total anode current passed by the set develops a voltage depending on the type of valves used, especially in the output stage. The middle tapping band of this resistor picks off part of the voltage as bias for the output valve. To prevent spurious oscillation, this is led to the secondary of the L.F. 33 intervalve transformer through a 50,000Ω resistor. It follows that it is highly desirable, if not actually essential, to adhere to the types of valve specified.



BIAS FOR THE V. MU. PENTODE.

Across the 1000 Ω bias resistor is connected a 50,000 Ω potentiometer, and the slider of this taps off negative voltage to control the Variable-μ H.F. Pentode in the H.F. amplifying stage, thus forming the best kind of volume control. Automatic Bias in battery driven sets—its action was fully explained in past numbers of the Bulgin Bulletin—has many advantages besides the obvious one of dispensing with G.B. batteries. Since the bias voltage developed across the 1000 Ω resistor is dependent on the anode current passed, it will automatically become lower as the H.T. Battery runs down, and thus relieve the listener of the necessity of changing G.B. battery plugs. When a new H.T. battery is installed, there is no need to remember to put the G.B. plugs up again to prevent excessive current drain and improve quality—the bias will automatically adjust itself to the correct value.

The bias resistor is by-passed by a 50 μF. low voltage electrolytic condenser, which makes a good output in the bass possible.

HIGH EFFICIENCY 3-RANGE COILS.

The aerial and grid coils are of the newest types, precision wound for accurate ganging on all the three bands covered. The S.W. range covers 12 to 35 metres and 30 to 80 metres and on the M.W. band 170 to 500 metres. Separate windings are used in each of the coils for the primary of the aerial input transformer and for reaction in the tuned anoded coupling.

Bias is applied to the H.F. pentode through a 10,000 Ω decoupling resistor. The detector consists of a triode with condenser and grid leak rectification, the grid leak value being rather high, of the order of 3 M Ω, for efficiency on the short-wave bands. This valve parallel-feeds the L.F. coupling transformer.

ROTARY SWITCHES.

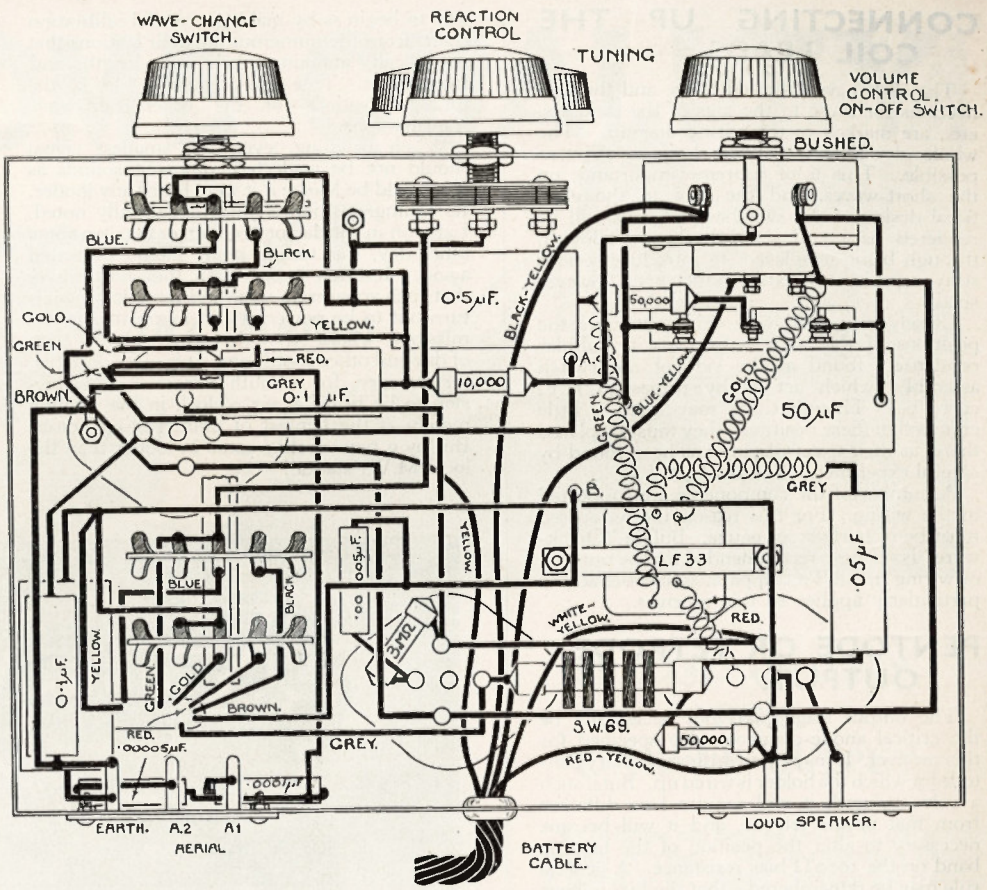
The benefits of good coil design would be lost if stray capacity in the wiring were allowed to become excessive. This important factor has been kept down to a minimum by the use of Bulgin Rotary Wave Change switches. These, mounted closely under the coils, make the extremely short leads, which are essential, quite possible. The V. Mu volume control and on-off switch are ganged together.

CONSTRUCTION.

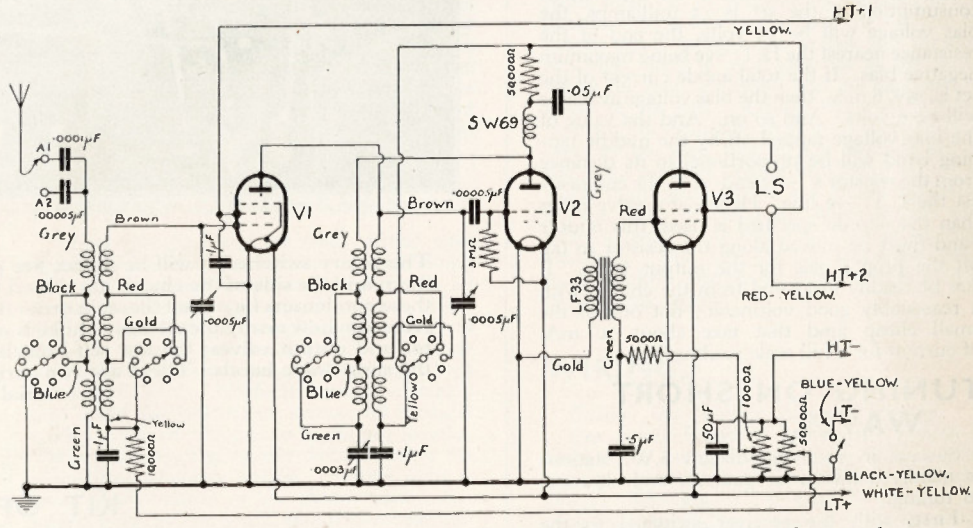
It is of extreme importance in this receiver that the positions of the components as given in the wiring diagram should be strictly followed in the chassis. Just why this is so will be understood after a perusal of CONSTRUCTORS' NOTES, on Page 39.

This is preeminently a short wave receiver, and for this reason, slight changes in the positions of components and the arrangement of the wiring may have serious effects on its performance. This matter cannot be too strongly emphasised.

All the chassis-mounted components may be put in position before wiring up is commenced, with the exception of the switches. The chassis is ready drilled, and no difficulty should be found over this part of construction. Purchasers of the complete kit of parts, too, will find the free full sized set of blue prints to asisst them.



It is most important that the leads to the switch tags from the coils be kept as short as possible. Otherwise, instability is liable to occur.



This circuit is simple enough, yet in practice it has been proved to be of unusual efficiency.

Note that the valve holders should be screwed to the underside of the chassis, and that some of the chassis mounting components have soldering tags under their screws. These soldering tags play an important part in the wiring up and should not be left out. They are for earthing purposes and, to make quite sure that they make good contact with the chassis, a little of the enamel should be scraped away from under the round heads of the screws that secure them, on the chassis itself, so that metallic contact is made with the steel.

WIRING.

Untidy or careless wiring will ruin the performance of this receiver, even though all the components may be in perfect condition.

A start may be made with the rotary wave-change switches. Those tags that are nearest the undersurface of the chassis, shown shaded in the wiring diagram, should be connected up before the switches are put into position, and short lengths of wire left attached for connection subsequently to other components. When this has been done, the switch assembly may be bolted home in the chassis.

CONNECTING UP THE COIL LEADS.

The ciols have coloured leads, and the connections for these to the tags of the switches, etc., are marked in the wiring diagram. The whole idea is to have these leads as short as possible. This is of supreme importance on the short-waves, and the care in the electrical design of the switches and coils will be rendered useless if these leads are allowed, through being misplaced, to introduce serious stray capacity, or extra inductance, however small.

Closely connected with this matter are the positions of the fairly large capacity tubular condensers found at the side of the switch assembly, which act as by-passes to H.F. currents. Though these may seem a little cramped in these positions, they must be placed there, as their exact placing has been found by careful experiment to be the best.

A number of the components are supported in the wiring. For this reason the wire used must be of fairly stout gauge. Bulgin "Quickwyre" is strongly recommended for the purpose of wiring up all T.C. apparatus and the advice particularly applies to this receiver.

PENTODE OR TETRODE OUTPUT.

The output stage need not necessarily be the critical anode-distance valve specified for this receiver. It may be an ordinary battery pentode for which the holder is wired up. But if such a valve is used, it will require bias different from that of the tetrode, and it will become necessary to alter the position of the tapping band on the 1000 Ω bias resistance. A general rule may be remembered—that the bias voltage across this resistance will be equal in volts to the number of milliamps of anode current passed by the set. Thus, if the total anode consumption of the set is 15 milliamps, the bias voltage will be 15 volts, the end of the resistance nearest the H.T. –ve being maximum negative bias. If the total anode current of the set is, say, 6 mA., then the bias voltage available will be 6 volts. And so on. And the value of the bias voltage tapped off by the middle tapping band will be proportional to its distance from the resistor's +ve end—*i.e.*, the end nearest the L.T. –ve line. Hence, if a valve other than the tetrode specified is used, this middle band must be moved along the resistor to tap off the proper bias for the output valve. It can be readily measured from the chassis with a reasonably good voltmeter—not one of the small cheap kind that take about 30 mA. of current for a full scale reading!

TUNING ON SHORT WAVES.

Success in receiving distant S.W. stations is mainly a matter of patience and slowness in tuning.

First, with the receiver switched to the S.W.1 band, a station at about 20 metres should be tuned in. It should be brought up to maximum strength by adjustment of either or both of the tuning condenser trimmers. This adjustment is a permanent one, and the least possible capacity in the trimmers should be used.

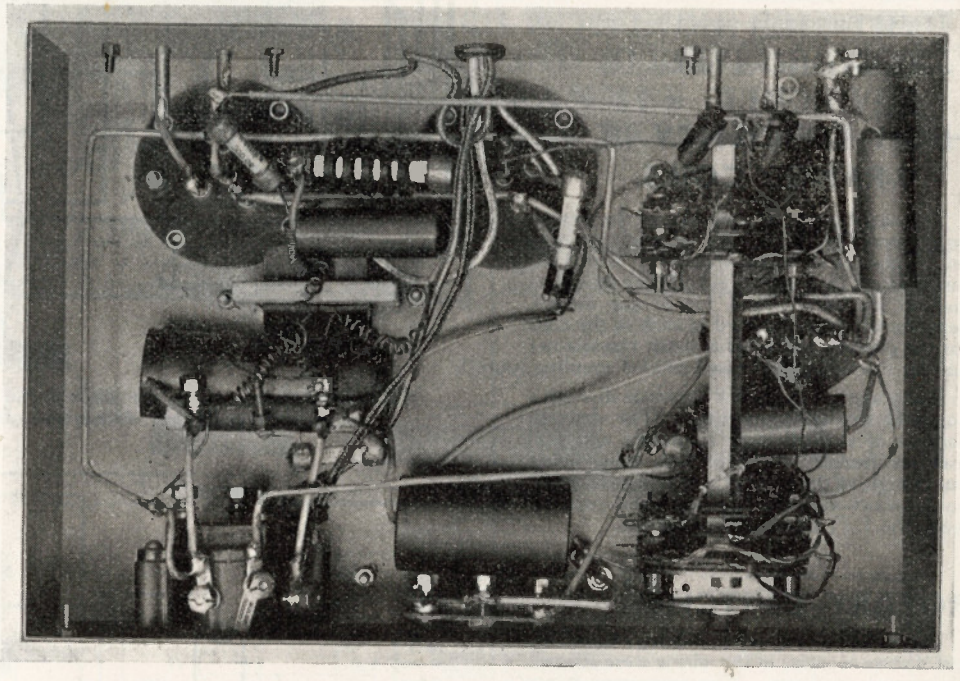
That is the only trimming needed. The strong "landmarks" of the short-wave band will soon be heard—Italian and German stations probably, and *perhaps* the Empire transmissions. But these are not the most interesting to the S.W. enthusiast. He will want to reach out and log America; and beyond!

That can be done easily, after practice, on this receiver. But at first it is not as easy as receiving Rome and Zeesen. Perhaps the best way to begin is by making a careful calibration chart from the numerous amateur stations that periodically announce their wave-lengths and frequencies. This will give some idea of the tuning positions of the other short-wave transmissions.

When listening, even the smallest signal should not be neglected, unless it sounds as if it would be Morse if it were heard any louder. Its tuning position should be carefully noted. Later on in the day or evening, or even on some other day, this tuning point should be tested again. It often happens on the short waves that such apparently weak and worthless signals turn out to be powerful and interesting transmissions, whose strength varies with the time of day and other conditions. It is quite possible, for instance, for a South American transmission to be heard at six o'clock in the evening merely as the faintest of uninteresting noises. But by 9 p.m., it may come in louder than the local M.W. station!

USING REACTION.

The main value of judicious reaction will come out in short-wave working. It should be pushed to the very threshold of oscillation but not beyond, and, when running over the dial to search for stations, (this should be done very slowly, of course) should be delicately re-adjusted so that is is kept right on the edge of oscillation. Some authorities advocate searching for stations with the set actually oscillating, so that stations announce themselves by squeals, which can be resolved into clarity by reducing reaction. But this we do not advocate, as it may seriously interfere with other short-wave listeners. The best way is to get used to keeping the reaction on the verge of oscillation, and never to neglect to investigate the possibilities of even a very weak station.



The rotary switches, it will be noted, are placed close over the coil tags, and between them and the side of the chassis are placed large tubular condensers. It is necessary that these condensers be placed there, in order that the leads may be kept in their right places. Note also how neatly the all-wave choke is suspended by its wire ends between the detector and output valves; the low self-capacity of this choke makes it highly efficient on the short wave bands. There are two aerial sockets, of which the use depends on the aerial used.

KIT OF PARTS.

COMPRISING:—

ONE BULGIN T.C.27 CHASSIS; One C.V.2 Tuning Condenser; One Special Dial and Drive; One S.150 Driver Locator Unit; One S.154 Contact Unit; One S.153 Contact Unit; One N.24 Diff. Condenser; One V.M.36 Compact Vol. Control with Switch; One P.61 Socket Strip; One P.54 Socket Strip; One L.F.34 Transformer; Two H.W.15 Resistors, 10K; One H.W.23 Resistor, 50K; One A.R.1K Resistor; Two P.C.P.1. Tub. Cond'rs., .1 μF.; One P.C. 301 Tub. Cond'r., .0001 μF.; Two P.C.P.5 Tub. Cond'r., .5 μF.; One H.W.35 Resistor, 3MΩ; One B.C.3 Battery Cable; One E.C.5 Tub. Elec. Cond'r; One Aerial Coil, C.6; One H.F. Trans., C.7; Four knobs; sundries, washers, tags, screws, nuts, grommets, "Quickwyre", etc., for full construction.

PRICE OF COMPLETE KIT:

£3 - 10 - 0

ACCESSORIES.

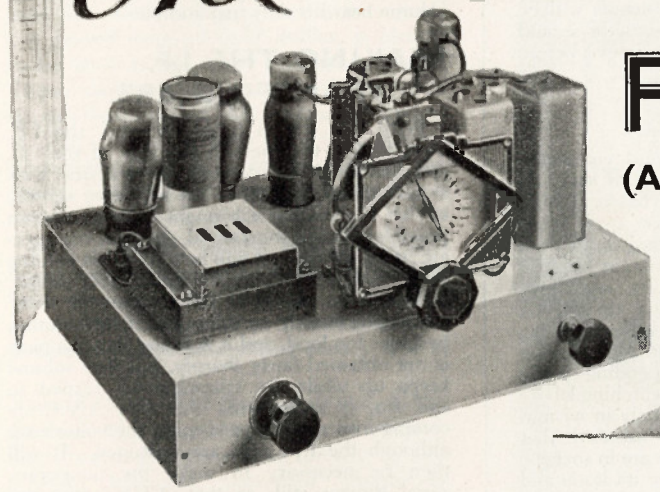
SPEAKER: WB 38 J or Rola, F612 P.M.

VALVES:

V.1. Hivac VP215.
V.2. Hivac H210.
V.3. Hivac Y220.

The HOME QUALITY FIVE

(A.C. MAINS)



NEWEST DESIGN OF COILS FOR EASY BUILDING

THE need undoubtedly becomes apparent, in these modern days of comparatively small houses, for a type of receiver which, while it will not fill a hall with sound, will give excellent quality to listeners in an average sized room. Quality is more important than volume in this case.

Of course, the term "volume" in this connection is used comparatively. When one remembers that the majority of listeners find a speech output of over 1 watt very uncomfortably loud, and that even on orchestral passages they very seldom require a mean output of more, there seems to be no sense in designing a popular 'domestic' receiver with more than a few watts output.

The receiver we are now describing is designed to deliver up to 3½ watts of *excellent* quality. This leaves ample power in hand for those who like to hear musical items with realistic volume while the clear quality of reproduction is preserved.

THE CIRCUIT.

With these points in mind, consideration of this receiver starts with the tetrode output valve. This is one of the new "critical anode distance" types, which are as sensitive as pentodes but free from the slight drawbacks in the quality that can be put out by pentodes. Those who have gramophones are strongly advised to make a start at electrical reproduction of records (if they have hitherto neglected the pickup terminals of sets) with this receiver, using a good pick-up.

Scrutiny of the theoretical circuit will suggest that the I.F. stages follow normal practice. Delayed A.V.C. is applied to both the Frequency Changer and the I.F. pentode, giving good control. Special note should be taken, however, of the Oscillator Coil. This is one of the newest Bulgin products and of exceptional efficiency. It will be observed that separate windings are used for M.W. and L.W. bands Each has its own padding condenser, and these are situated inside the top of the can of the oscillator coil, thus obviating external trimmers

TESTED CIRCUIT No. 28

with their long leads and fittings in the chassis lay-out. A high L.C. ratio is secured by the use of separate windings and the usual complicated trimming adjustments are cut out. Stability is also much improved. The highly selective aerial input transformer is extremely simple and so accurately manufactured that trimmers other than those on the two gang tuning condenser are unnecessary. With so high an intermediate frequency, combined with the efficiency of the aerial transformer, no trouble will be experienced from second-channel and I.F. break-through, if lining up and ganging of R.F. circuits is properly carried out.

LAYOUT OF CHASSIS.

Those who purchase the ready drilled steel chassis for this receiver will find the positioning of the components very easy, as they can all be mounted before any wiring is done. *Care must be taken to follow the lay-out given.* A good deal of trouble has been taken to arrange components in such a way that wiring is kept remarkably short. By the free use of soldering tags under the component screws, all earthing leads have been reduced to minimum lengths. These soldering tags should be included in the mountings wherever shown. *Scrape away a little of the enamel of the chassis under each soldering tag,* so that sound electrical connection to the steel is made when the nut is turned home tightly.

SWITCH MOUNTING.

The wave-change switching is a notable point about this receiver. Three mains type toggle switches are used, ganged by means of a 5/32nd inch rod passed through their dollies and secured by grub-screws. These switches are extremely reliable, have a perfect snap action and, being mounted close over the holes for the coil leads, add unusually little stray coupling or capacity to the H.F. circuits. It is best to start by passing through their dollies the 5/32nd inch rod, slightly loosening the grub screws (do not take them right out).

SPECIAL QUALITY FROM TETRODE OUTPUT

The switches can then be bolted to the special bracket provided. Next this assembly bracket is bolted to the chassis, opposite the bushing hole, the rod being passed through the hole but still loose in the dollies. Then the rod is slipped back through the dollies so that the panel bush can be screwed in the front of the chassis. With this in position, the rod can be moved again through the dollies and through the bush until it protrudes out at the front, where the reducing sleeve and the knob can be fitted to its end. Lastly, the rod is fixed *tightly* in the dollies by their grub screws. Take care, by the way, that all the switches are in the same position—either all ON or all OFF, when their grub screws are finally tightened on the rod. Turning the knob should now effect a clean, fairly stiff snap over of all three switches. The bracket has purposely been made slightly flexible so that there is a little play for easy action.

WIRING.

Follow the wiring diagram exactly.

Use either Bulgin "Quickwyre" (which is best) or 18 s.w.g. tinned copper wire covered with 2 millimetre systoflex. The reason why Bulgin "Quickwyre" is best is because its push-back insulating covering is always automatically cut exactly to the right length when the wire itself is cut. When using tinned copper wire and systoflex, often the systoflex is cut rather too short (or alternatively, too long, when it must be shortened, with inevitable waste), with the result that parts of the wiring are left bare and are prolific sources of danger and trouble. With "Quickwyre", just the right amount of it is cut from the coil to follow the path indicated on the wiring diagram: to make soldered connections to its ends the covering is simply pushed back a quarter of an inch, baring the tinned wire inside for soldering: when the joint has been made, the pushed back covering can be again slipped right up to the soldered point, leaving practically nothing uninsulated.

KEEP TO THE LAYOUT!

It is extremely important to make a really neat job of the wiring. The wire specified is stiff enough to support the resistances and small condensers away from the chassis without resort to bakelite panels and the like. If thinner wire is used, it will be false economy, for disastrous short-circuits are likely to ensue due to resistances carrying high tension current sagging and touching the chassis or other parts of the wiring or component terminals. Arrange the resistances and small tubular condensers in the positions indicated on the wiring diagram: they are placed in these positions for very good reasons—shortness of wiring and avoidance of instability. They are not given positions on the diagram haphazardly. To depart from the lay-out given for these small components is very risky, and constructors are seriously advised to adhere to it in their own interests. By doing so, they will save themselves endless trouble and a good deal, perhaps, of expense in having to send the receiver to us for putting in good order at a *minimum* of 12/6 a time!

A SIMPLE PRECAUTION.

Although the resistances are shown in the drawings and photos as bare, a very wise—and trivially cheap—precaution is to cover them in an inch or so of 8 millimetre systoflex. Then, if they happen to touch, no harm is done. We show them bare in our drawings for the sake of clearness.

FREE BLUE PRINTS.

The wiring of this receiver is unusually plain and easy to follow. Constructors who have ordered the complete kit will be given a set of full sized blue prints *free* with the kit. Much the safest and quickest way of wiring consists of soldering leads one at a time, crossing them off on the diagram or blue-print immediately they are finally in position. The valve cathode heater wiring, which is twisted together to avoid hum, should be put in first. Then the earthed resistors and condensers should be placed in position and their earthed ends soldered to the nearest or most convenient chassis soldering tags. Next, the resistances and tubular condensers, one of the ends of which are connected directly to valve-pin sockets in the valve holders, should be put in. Then the three switches should be wired up to the coils—be careful about the colours of the leads. That will leave the rest of the wiring very easy to do.

Notes, by the way, on wiring will be found in "CONSTRUCTORS' NOTES", on Pages 39 and 40. Other very useful details will be found here, too, and every constructor should make a point of referring to these pages before he starts building his set.

FIRST TESTS.

When everything is wired and connected up—*do not* at once plug in the mains lead and switch on. That is asking for trouble. Check over the wiring. And check it over again. And then get somebody else, if possible, with a little knowledge of electric circuits, to check it independently. This is delaying, we know. But it is cheaper than blowing up valves, burning out coils and causing other damage. It is also quicker and neater than switching on and finding no results and spending many hours altering the wiring and searching laboriously for faults that may exist only in wiring.

However, when completely satisfied that everything is in order—all valves are in sockets, speaker is *correctly* connected by its leads and flat-pin plug to the right sockets, etc.—the mains may be connected and the set switched on. The pilot lamps should light up at once. After some 30 seconds, the heaters of all the valves should be seen glowing redly. There may be a faint rushing sound from the speaker, showing that the set is lively.

If a pair of old headphones is handy, its leads can be pushed into the pick-up sockets at the back of the chassis. Tapping the diaphragms should (with the volume control turned to maximum) cause a knocking sound in the speaker. A wet finger touched to one or other of the pick-up sockets should also cause a sound in the speaker—perhaps a hum. This will show that the L.F. side of the set is O.K.

LINING UP.

We may now proceed with the lining up and ganging of the receiver. For this purpose, a short length of insulated wire is used as a temporary aerial. It need be only two or three yards in length and may be strung up anywhere. The earth should be plugged in and then, using the short temporary aerial the set should be switched to Medium Waves and the local station tuned in. This should be received as weakly as possible, the temporary aerial being shortened by having pieces cut off it until the volume heard is only just audible.

PEAKING THE I.F. TRANSFORMERS.

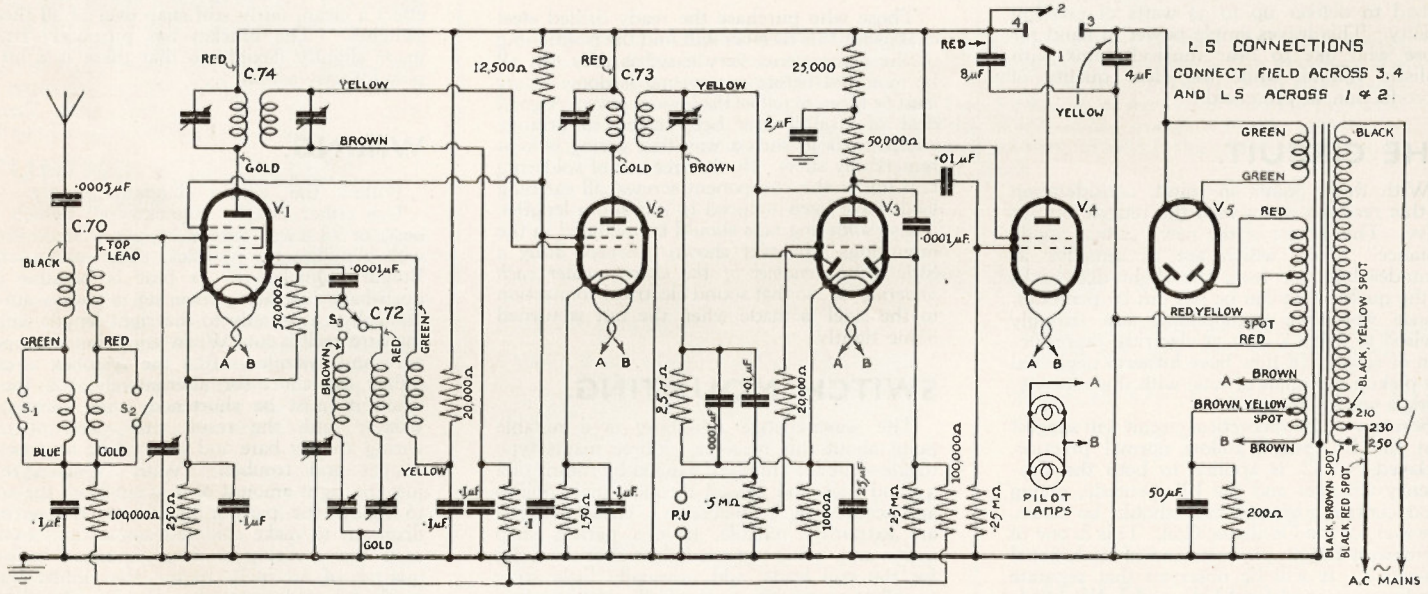
With this station being received, the I.F. Transformer trimmers in the tops of the I.F. coil cans should be adjusted, one at a time, with a screwdriver applied to the adjusting screws, so that the volume is brought to its maximum possible with this short aerial. As these trimmers are being adjusted, it will be found that volume comes to a peak. This peak can be easily passed so some care should be taken to set the trimmer finally exactly on the peak. If the volume, becomes too loud, and it is found that the peak is not obtained fairly sharply, but that volume keeps up while the trimmers are turned to and fro, it means that the set's A.V.C. is coming into action and keeping the volume up although the I.F. coils are mistuned. It will then be necessary to make the temporary aerial shorter still, so that A.V.C. does not operate and the I.F. coils can be sharply peaked.

This operation of lining up the I.F. Transformers should be done very carefully and thoroughly, as it is in these I.F. stages that most of the gain is obtained, which controls the ability of the set to receive weak and distant transmissions.

Many a perfectly good receiver fails to deliver its full volume and best quality through the lining and ganging not having been properly carried out. This is a waste of good components. An hour spent on careful lining up is worth days of weary search for defects in sound components.

GANGING THE H.F. CIRCUITS.

When the I.F. Transformers have been thus lined up, the temporary aerial can be removed and the permanent, full size aerial

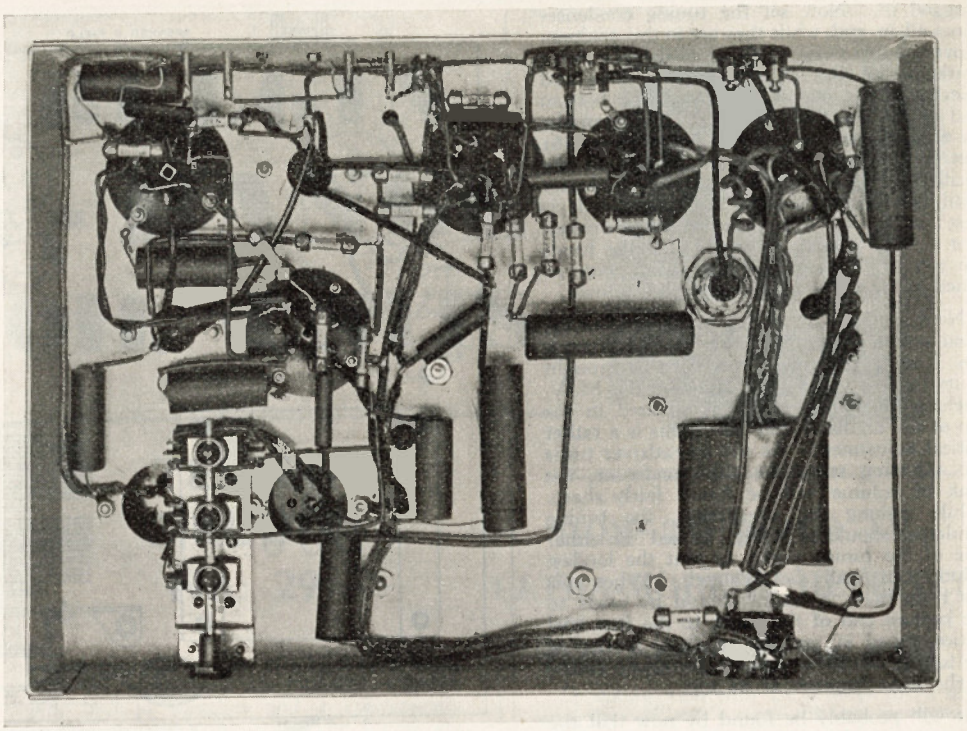


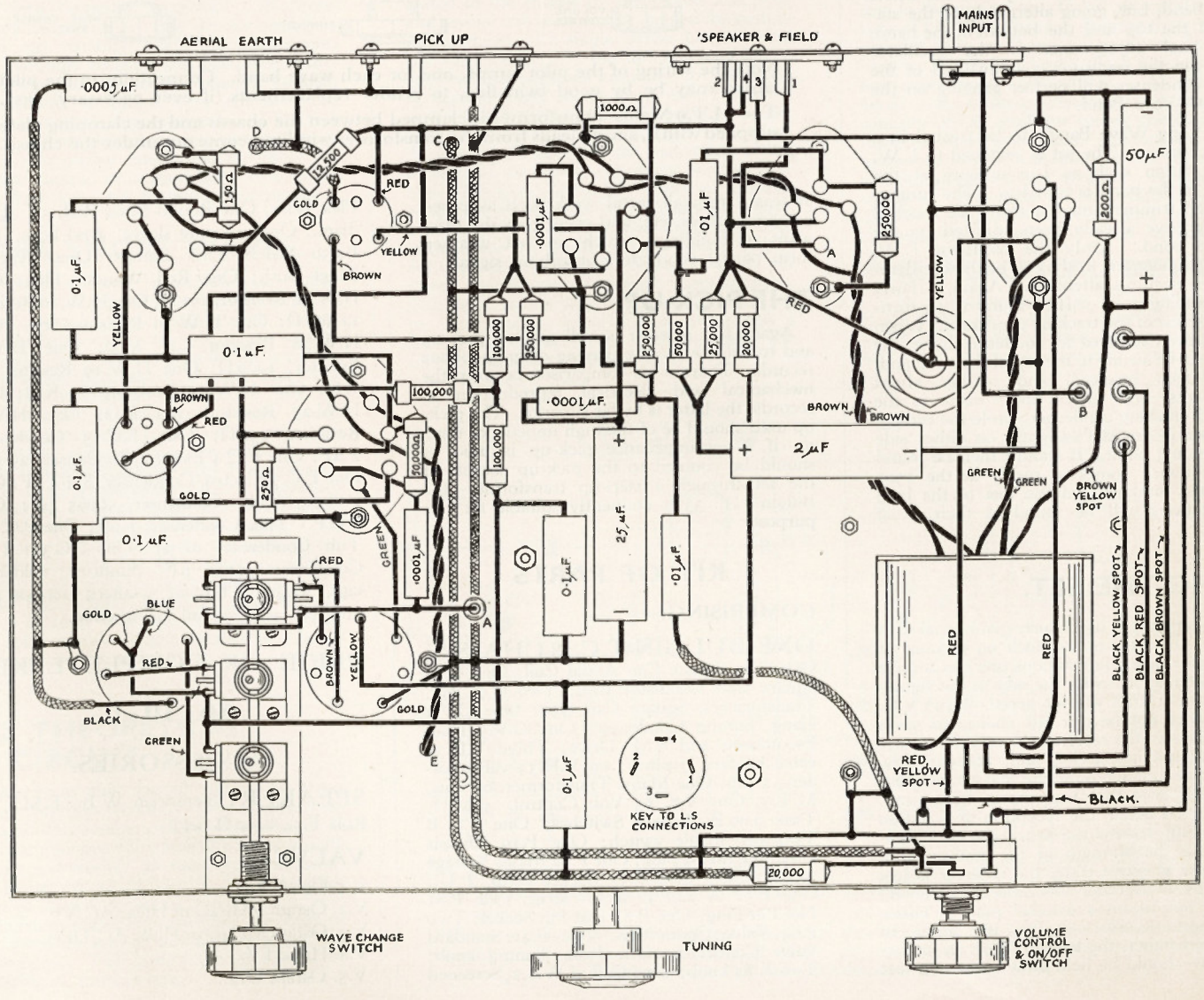
Two points to take care of are; (1) The speaker socket connections and (2) the polarity of the 25 and 50 μF. by-pass condensers. Their positive ends are connected to cathodes and their negative ends to chassis.

This photograph shows the neatness of lay-out and the shortness of the leads to components that is a feature of this chassis. The mounting of the three toggle switches used for wave-changing, with the $\frac{3}{32}$nd" rod passed through their dollies, is clearly to be seen in the lower left hand corner. These switches are situated closely over the coil bases, so that H.F. leads are extremely short. There is room for a tone control (Controlatone, C.T.1.) in the front of the chassis under the tuning condenser, if such a refinement is desired.

Note especially in the wiring diagram below how the speaker socket is wired. The field winding of the speaker is connected across flat pins 3 and 4, and the speaker transformer primary across pins 1 and 2.

Special Note: The dual range coil, C.70, used in this receiver, has been slightly modified to suit the characteristics of this circuit. Mention, therefore, should be made, if the coil is ordered separately, that it is intended for use in this receiver, T.C.28, and is not the standard *type.*





plugged in. Now set the tuning condenser vanes all-in, and, while they are in this position, move the dial pointer exactly to the 550 metre mark on the dial. Run over the tuning and select a known station down near the bottom end of the band—Lille P.T.T., for example, on 247.5 metres, or even the Nationals on 261 metres. Then adjust the trimmer on the oscillator section of the tuning condenser until the loudest volume is obtained. It is best that this trial station should be the weakest that can be audibly received, so if the locals are too strong, some foriegn station may be tuned in, provided its wave-length is known.

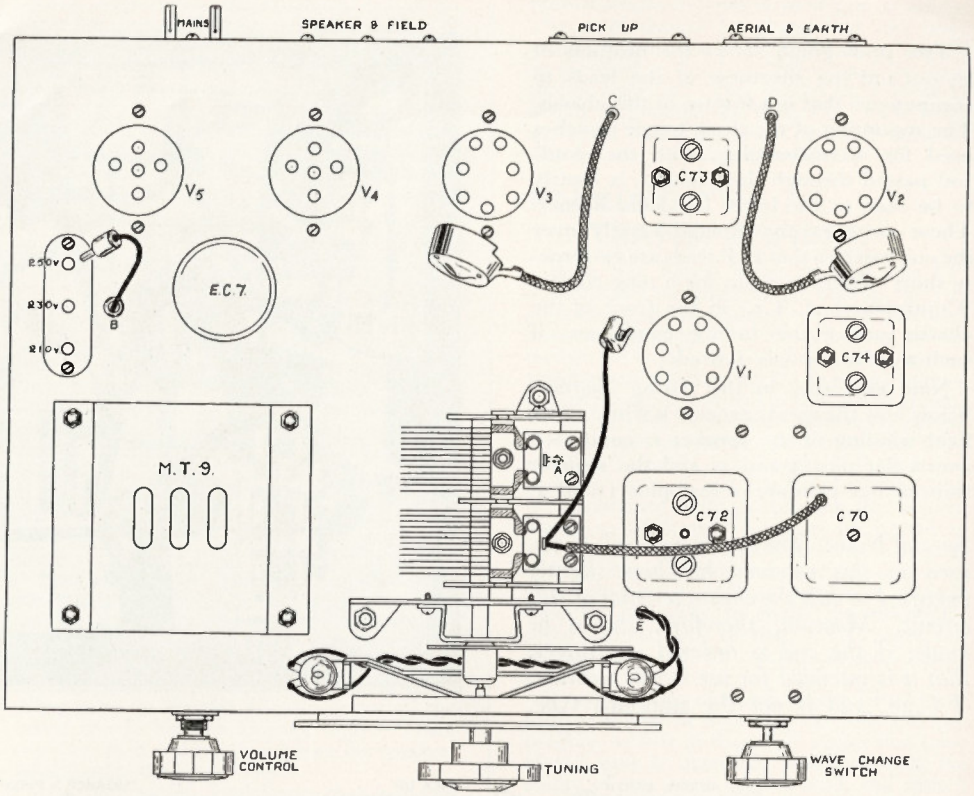
Next, tune up to the top end of the M.W. band and receive some station such as Brussels No. 1, on 483 metres. This must be brought to its loudest volume by adjusting the M.W. tracking condenser, which is situated in the top of the oscillator coil can. This is a rather critical adjustment. As the screwdriver turns the adjusting screw for this condenser, the peak of volume will be found fairly sharp. While making the adjustment, the tuning condenser should be gently "rocked" on either side of the tuning point, so that the loudest volume can finally be obtained. When this has been done, a return should be made to the bottom end of the band, to the first trial station tuned in, and the oscillator section of the tuning condenser again trimmed by means of the little trimmer at its top.

It will probably be found by now that the receiver tunes fairly accurately over the whole M.W. band, but, going alternately to the stations at the top and the bottom of the band, slight final adjustments of the oscillator tracker (in the oscillator coil can) and of the tuning condenser will perfect ganging on the Medium Wave Band.

The Long Wave Band can be treated in a similar manner. The set is switched to L.W. and a station such as Luxembourg at the bottom of the band is tuned in. The tuning, condenser trimmers must not now be touched for they have already been adjusted on the medium band. Only the oscillator L.W. tracking condenser, in the top of the oscillator coil can, requires attention. Again, a fairly sharp peaking point will be found when turning the screw of the tracking condenser. When this has been adjusted for loudest volume, the tuning can be swung to the top of the band and, say, Huizen received, and further slight adjustments—only slight ones—made to the oscillator tracking condenser, while the tuning, condenser is "rocked" slightly on either side of the tuning point. It should then be found that Droitwich comes in nicely at the 1500 metre dial marking and the rest of the long wave stations will be found at their usual settings.

USING THE SET.

It is a pity not to use a fairly good aerial with this set. This is not so much on account of the number of foreign stations one can receive with a good aerial, as for the sake of the signal-noise ratio. With a poor aerial, the A.V.C. system does not have a fair chance to come into operation: the receiver has to work always at its highest sensitivity, and, consequently, it will pick up not only the station but also any interference that happens to be around. With a good aerial, the reception of a station automatically lessens the sensitivity to correspond with the strength of the station, and, in the less sensitive state, the receiver is less affected by interference. Of course, by a "good" aerial is not meant a colossal pole or lattice mast: more necessary is that the aerial—of which, remember, the lead-in forms an important part—should be held away, some ten feet at least, from all metal work such as pipes, guttering, roofs, etc, and even from the brick walls of buildings, which, in wet weather, form partial conductors absorbing signal.



Note the wiring of the pilot lamps, one for each wave band. Connections to the pilot lamps may be by good twin flex, to render replacements (if ever necessary) easy.

The M.T.9 Mains Transformer is clamped between the chassis and the clamping plate supplied with it, and all leads from the transformer windings come out under the chassis.

THE PICK-UP.

Again, this receiver is well worth a pick-up and turn-table for the playing of gramophone records. There is no comparison between the mechanical and electrical reproduction of records: the latter is by far superior. The pick-up used should be of the high impedance type, or, if a low-impedance pick-up is used, it should be coupled to the pick-up sockets of the set through a step-up transformer—the Bulgin L.F. 33 is eminently suitable for this purpose.

KIT OF PARTS

COMPRISING:—

ONE BULGIN T.C.28 CHASSIS; One C.70 Square Can Aerial Coil; One C.72 Square Can Oscillator Coil; Two C.73 I.F. Transformers, Square Can type; One C.V.2 Gang Tuning Condenser; One C.V.5 Dial, Escutcheon and S.M. Drive; Three V.H.35 valve holders, 7-pin; Two V.H.34 valve-holders, 5-pin; One Mains Transformer, 60 watt, M.T.9; One V.S. 63 Vol: Control, .5 MΩ; Two S.80.B Toggle Switches; One S.81.B Two-way toggle switch; One P.19 Chassis mounting mains plug; One P.62 Mains Voltage socket strip; One P.53 Socket Strip, P.U.; One P.51 A and E socket strip; One P.81 Flat Pin Plug; One P.84 Flat Pin Socket; Two P.64 Valve Connectors; One P.41 Standard Valve Connector; One K.64 Tuning knob; Two K.82 knob; One Coil of W.S.2 Screened Flex Wire; One Round Brass Rod, 5½" $\frac{5}{32}$nds diam.; One reducing sleeve, $\frac{5}{32}$nd bore; Two B.650 M.E.S. Pilot Lamps; One Type A Panel Bush; One Red Wander Plug; One H.W.38 Resistor, 150 Ω; One H.W.16 Resistor 12,500 Ω; One H.W.39 Resistor, 200; One H.W.28 Resistor, .25 MΩ; One H.W.3 Resistor, 1000 Ω; One H.W.19 Resistor, 20 KΩ; One H.W.23 Resistor, 50 KΩ; One H.W.25 Resistor, 100 KΩ; One H.W.1 Resistor, 250 Ω; One E.C.15 Condenser, 2 μF; One E.C.4 Electro. Condenser, 25 μF; One E.C.7 Electro. Condenser, 8 + 4 μF; One P.C.305 Tub. Condenser, .0005 μF; One P.C.P.1 Tub. Condenser, 1 μF; One P.C.101 Tub. Condenser, .01 μF; One P.C.301 Tub. Condenser, .0001 μF; Sundries, soldering tags, washers, tubular washers, screws and nuts, etc., etc., for full construction.

PRICE OF COMPLETE KIT,

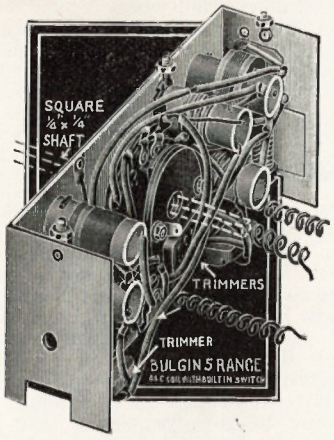
£6 - 10 - 0

ACCESSORIES.

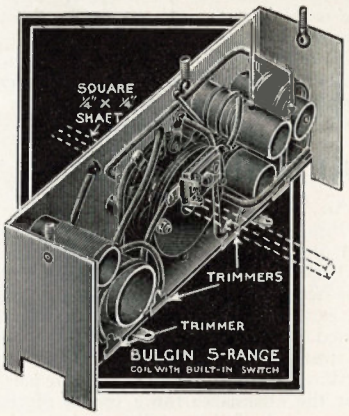
SPEAKER: Stentorian W.B., E.M.2, or Rola F.5., 2000 Ω field.

VALVES:

V.1. Osram X41.
V.2. Osram VMP4G or Hivac AC/VP.
V.3. Osram MH4D or Hivac AC/DDT.
V.4. Hivac FY.
V.5. Osram U12.



BULGIN 5-RANGE COIL UNITS



5 to 2,100 METRES IN FIVE BANDS

TESTED CIRCUIT No. 29

HOW TO BUILD AN ULTRA-MODERN RECEIVER

THE design of the H.F. stages of radio receivers has become both more complicated and more interesting, during the last few years, owing to the advent of the short-wave bands into domestic reception. To constructors in particular, this development has opened up exciting fields of experiment. Given a soundly designed and well made multi-band coil unit as a basis, it is possible for keen experimenters to evolve very effective and individual designs for receivers. With this in mind, we are describing two new coil units here, one for signal tuning and the other for oscillator tuning in conjunction, that cover ranges from 5 - 2,100 metres in five bands.

ULTRA SHORT WAVES.

Transmission and reception on ultra-high frequencies offer almost the only straightforward method of securing, at the present time, any considerable advance in the quality of reproduction. This is because the width of the sidebands permissible is such that very high audio-frequency modulation can be carried out at the transmitting end, which results in extremely good quality reception if a receiver and amplifier are used that are capable of dealing faithfully with these unusually high audio-frequencies. Such a possibility is bound to interest those who know what real "quality" in reproduction means. To these connoisseurs, we make no apology for recommending the use, in conjunction with a receiving unit based on the 5 range coil units, of the high-fidelity amplifier described in pages 8 to 12 of this journal, this instrument being fully capable of doing justice to a range of frequencies from 40 to 12,000 cycles per second.

THE THEORETICAL CIRCUIT.

Apart from this special feature of these 5-range coil units, however, their efficiency on the usual short-wave and broadcast bands is such that they provide a basis for an unusually compact and modern all-wave type of receiver. The theoretical circuit we give is in the nature of one of several variations possible, and, provided certain important principles are kept in mind, a certain amount of elasticity in lay-out is permissible. This gives scope for originality by intelligent constructors.

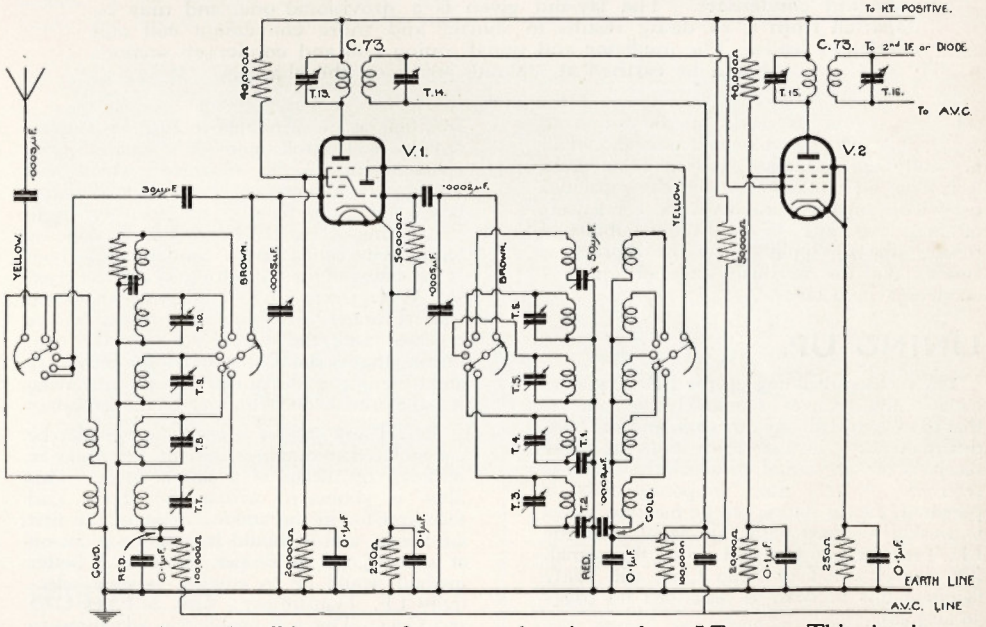
Each coil unit consists of a rigid steel frame upon which the coils are mounted, together with built-in switches and a conveniently situated strip of trimmers. The frames are bolted to the chassis by three bolts and nuts, and several coil units can be ganged for switching by means of a single Driver-Locator Unit and square shaft. On medium and long waves, optimum transformer coupling to the aerial is employed, and on the short wave bands the signal is fed direct to the frequency-changer (or H.F. valve) grid via a 30 $\mu\mu$F. condenser. A point to be noted is the restriction of the capacity of the tuning condenser on the ultra-high frequency band by means of a series condenser in the U.S.W. coil circuit. Also, a wider band-width is obtained on these high frequencies by shunting the circuit with a non-inductive resistance. Although we do not show pre-frequency-changer amplification, there is no reason why such a stage should not be incorporated, using a H.F. valve and a further 5-range aerial coil unit ganged by the common square switching shaft.

THE OSCILLATOR COIL.

In conjunction with the 5-range aerial coil unit, the oscillator 5-range coil unit generates a 465 kc/s intermediate frequency, for amplification in the normal way by valves and the C.73 type of I.F. Transformer. Despite the 5-ranges covered, this oscillator coil requires the connection of only four leads, which may appeal to less experienced constructors. As with the aerial coil, a series condenser restricts the capacity of the oscillator tuning condenser on the ultra-short-wave band. Though the trimmers may appear numerous in the theoretical circuit, in practice they need only slight adjustments to compensate for stray capacities with different practical lay-outs, and are very conveniently situated for such adjustments.

THE PRACTICAL DESIGN.

The lay-out we suggest in our wiring diagram is not a hard and fast one. Many variations are permissible, provided that certain principles, as we said before, are borne in mind. One of

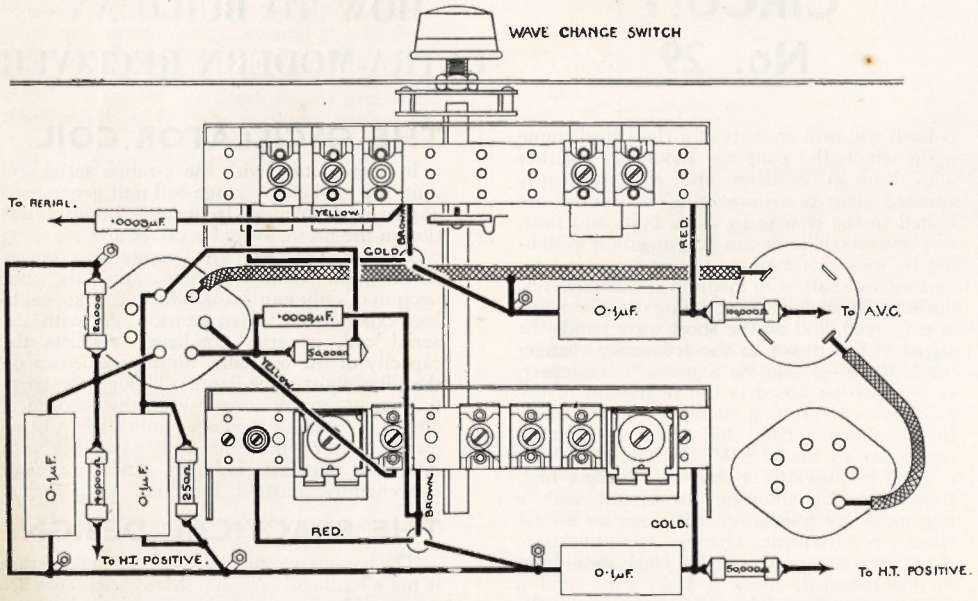


Here are shown the all-important frequency-changing and one I.F. stage. This circuit should precede some usual form of diode detection and A.V.C. arrangement, with subsequent L.F. amplification of a normal kind.

these lies in the necessity of making all connections as short as possible. We have shown the aerial coil placed towards the front of the chassis, in our diagram, and the oscillator coil unit some 2" or 3" to the rear, with the frequency-changer valve holder between them. Both coil units are switched by the square driver rod passed through them.

EARTHING POINTS.

An item of paramount importance is the earthing of the coils and tuning condensers. Reliance should not be placed solely on contact to the steel of the chassis, for this purpose; it is necessary, as we show in our diagram, for the earthing tags of the tuning condensers to be joined to the earthing leads of the coils unit by insulated wires, which are taken to common earthing points on the chassisl Note particularly that the chassis earthing points of the aerial tuning and of the oscillator sections are not the same. Each section is given a separate soldering tag of its own, for connection to the chassis. The by-pass condensers should all be really non-inductive, and in some cases it is even advisable to parallel the capacities used with smaller mica dialectric condensers of about .0003 μμF, to avoid the possibility of trouble due to "pulling" on the short-wave bands, due to residual—although small—condenser inductance.



Note especially the soldering tags under screws for the purpose of earthing the coils and condensers. The lay-out given is a provisional one, and may be departed from if so doing results in shorter and more convenient coil and condenser leads. The oscillator and signal tuning coil and condenser sections should be earthed at separate points on the chassis.

LINING UP.

The method of lining up the I.F. Transformers in this receiver is precisely the same as that employed with any other set, and has been described fully in the descriptions of other receivers in this journal, to which the reader is referred. A very short temporary aerial is prepared, a local station on the medium waves is weakly received with this aerial, and the I.F. Transformers trimmed up on this signal. (Of course, a V.T.17 Neon Liner will vastly facilitate this process, as described on pages 39 and 40).

With a receiver of this extremely modern nature, it is worth while to employ a little more care and trouble than is usual over the lining-up of the I.F. Transformers. The benefit will be expecially noticeable in the form of increased gain on the short-wave bands and in the high quality of reproduction. A very practical and simple refinement to this end is to place a loading resistance across the primaries and secondaries of the I.F. Transformers when trimming them up. Such a resistance may be of 20,000 Ω value. The method of using it is as follows.

First, the resistance should be temporarily connected—by short leads ending in crocodile clips, for example—across the secondary of the first I.F. Transformer. Then the lining up signal, preferably from a V.T.17 I.F. Liner, should be fed into the grid of the frequency-changer, and the *primary* of the I.F. Transformer trimmed up for maximum signals. (The Neon Output Measuring Unit, V.T.19, will be useful in this instance). Next, the 20,000Ω resistance should be transferred from the secondary to the primary of the I.F. Transformer, and the *secondary* trimmed up. The shunting of the windings in turn by this resistance will enable more of a square-topped characteristic to be obtained, which will improve reproduction. It may be advisable, when lining-up, to stop the oscillator from functioning. This can be very easily done by temporarily connecting a condenser of about .1 μF. between the oscillator grid and the chassis. When the first I.F. Transformer has been thus accurately lined-up, the process can be repeated with the second I.F. Transformer, putting the resistance first across the secondary and trimming up the primary, then transferring it to the primary and trimming up the secondary

Should any serious heterodyne whistles be encountered on tuning in stations, these may be removed by means of a simple filter. This filter is connected across the diode load resistance or in the anode circuit of the first a.f.-triode, and it should have a sharp cut-off at about 5,000 cycles per second. A better method would be to employ variable selectivity I.F. Transformers, such as types C.62 and C.63. This will enable the selectivity to be adjusted, so that when listening to the strong local stations, the band-width passed may be broadened and the full range of audio frequencies passed for handling by the high-fidelity amplifier, while when reaching out for distant transmissions, the band-width may be narrowed to cut our interference from the overlapping of adjacent stations. It should be mentioned that most sets work quite well with a slightly incorrect I.F. frequency, but whistles then become prevalent. *Verb Sap!*

GANGING.

If the C.V.14 5-range dial is employed, ganging will be rendered fairly easy. The medium and long-wave bands are ganged on exactly the same lines as are adopted for several other receivers described in this journal, and the reader will do well to peruse such details in other pages. But before ganging the M.W. and L.W. bands, the 5-range coil units should be switched to the ultra-short-wave band and the receiver tuned until the Alexandra Palace signals are heard—remembering that these transmissions take place only at certain times of the day. Adjustment of trimmer T.7 will bring this signal to its correct tuning point on the dial, and then volume can be brought up by adjustment of T.12. Next, the receiver is switched to S.W.2., and a station of known wave-length tuned in (see other all-wave ganging instructions in this journal); T.6 and T.10 will, when adjusted, bring the signal to its right calibration mark and loudest volume. The same procedure is adopted for S.W.3. On the M.W. band, T.4 and T.8. are adjusted and on L.W., T.3 and T.2.

The Instruction leaflets for these coils will be found of great assistance. There are several points in design that lend themselves to interesting experiment. For instance, in the A.V.C. system, a quick time constant should be adopted, to cope with the rapid fading often found on the S.W. bands. This can be arranged by providing a coupling resistance of .1 MΩ and a by-pass condenser of .05 to .1 μF. *really* non-inductive) for feeding A.V.C. voltages to the grid of the frequency-changer through the grid coil. Other values of smaller resistances and capacities may be tried and the results noted.

The Five Range Coils themselves, and all other components required to make up a complete receiving unit, with I.F. Transformers, resistances, non-inductive condensers, valve holders, tuning condensers, etc., etc., will be found in the Bulgin Catalogue. The valve used for frequency changing should be a triode-hexode, the Osram X41, for instance.

The C.V. 14 Dial will be found entirely suitable for use with this receiver. It is calibrated for the five ranges, and these calibrations will be found of assistance when lining up and ganging the receiver. This dial is complete with escutcheon, slow-motion drive and pilot lamp holders. As there are four such pilot lamps on this dial, it will be possible to arrange a neat and useful switching system that will indicate which band of wave-lengths is being received. A perusal of the circuit of T.C.21, in this magazine, will suggest how this switching may be carried out.

A further refinement would be the use of the V.T.50 Visual Tuning Meter. This should be included in the anode feed circuit of the first I.F. valve, and it should be shunted by a *non-inductive* .1 μF tubular condenser, otherwise instability is likely to occur.

The Bulgin Technical Staff will always be glad to check over any 5-range coil circuits (theoretical) that readers may submit to them, and to advise upon various matters in connection with them. Send 1½d. stamp for return postage. Requests should *not* be made, however, for complete circuit diagrams of entire receivers; this is another matter entirely, and such design has been purposely left for the present to the originality of, and the desire for experiment on the part of, construction enthusiasts.

MIDGET PARTS SENSITIVE MICROPHONE STANDARD BATTERIES

TESTED CIRCUIT No. 30

ENTIRELY SELF-CONTAINED POCKET SIZE ONE-VALVE AMPLIFIER

THE uses to which a small self-contained amplifier may be put are more numerous than might at first be thought. There are, of course, its possibilities as the foundation for a sensitive hearing aid. But besides that obvious use, it comes in handy wherever a little extra audibility is needed. For instance, difficulties in hearing at the telephone may be overcome by holding the telephone receiver against the amplifier's microphone, when barely audible speech will be converted into loud speech.

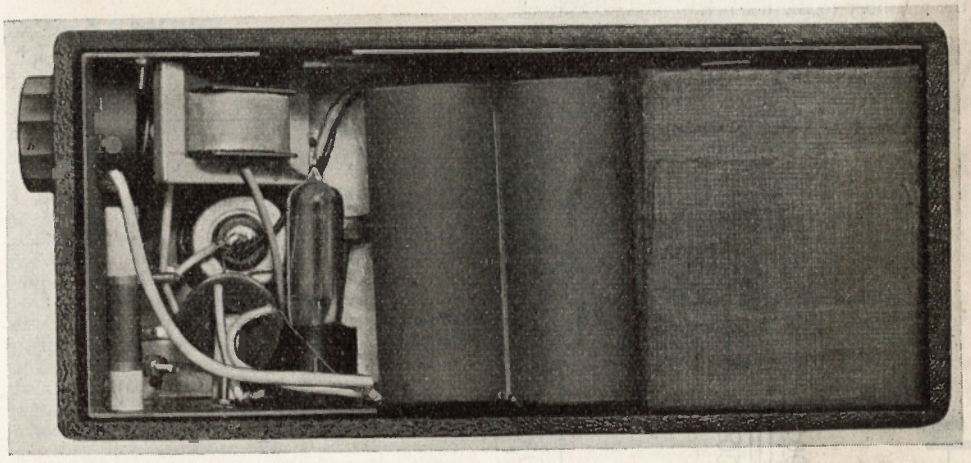
The amplifier to be described consists of a very sensitive carbon microphone set in the side of a small leatherette covered case that contains a complete one-valve amplifier and dry batteries.

THE CIRCUIT.

Beginning with the output, we find a specially made transformer of extremely high efficiency packed into a very small space, used to match the valve to the ear-piece impedance. This is necessary because the ear-piece is naturally of very small dimensions and can fit into the ear in a practically invisible manner. The windings on the ear-piece bobbin therefore have to be of comparatively low impedance for the sake of reliability. The valve itself is of fairly high impedance with a steep slope, so that an electrical gain of 23 decibels is obtained by its use. Since it is of the 2 volt filament type, and is supplied by a 3 volt dry battery of standard size, resistance has to be included in the filament circuit to limit the current passed. This is done by one fixed limiting resistance and also by a variable resistance that acts as a volume control. The volume, however, is much more controlled by the limitation of current passing through the microphone circuit than by filament current control, so that extremely little distortion is caused. At full volume the full voltage of the L.T. battery is applied across the microphone circuit, giving high sensitivity. The microphone transformer is a Bulgin L.F.49, which has a nickel alloy core of high permeability giving high inductance for a comparatively few turns of wire, so that a good step up is secured with ample impedance in the secondary to feed the grid of the XD Hivac Midget Valve.

CONSTRUCTION.

Though the components used are very few compared with the number normally used in an amplifier, the space is rather limited. Hence, care must be exercised in fitting the components and connecting them up. A start should be made by fitting the microphone, which is held in sponge rubber secured under small cleats. Then the ear piece lead socket strip should be bolted to the end of the chassis, and the volume control nutted home into its bush hole with the contact tags upwards—i.e., away from the chassis. The two transformers are then bolted to the sides at angles so that they clear the volume control and the sockets of the earpiece socket strip, and, finally, the midget valve holder secured with bolts to the side of the chassis. There will remain now only the fixed filament resistance which is held suspended in the wiring.



WIRING UP.

Neat and careful soldering is strongly advisable, of course, in the limited space. The flexible leads from the transformers are long enough to reach without additional lengths of wire to their appropriate points in the circuit. their insulation is sufficient, if they are handled carefully, to avoid short-circuits without further covering, but if desired, systoflex may be slipped over them for neat appearance. The wire used to connect the fixed resistance should be of fairly stout guage—say 18 s.w.g.—to support this component firmly.

Connection to the H.T. and L.T. supplies is made by means of contact plates on the fibre sheet. This sheet, therefore, should have its leads connected, but be fixed permanently in place after the chassis has been fitted into the case.

TESTING OUT.

When construction is finished, the chassis should be fitted closely into the case. It will be a fairly tight fit, to prevent vibration. The contact sheet should be slipped down between the chassis and the side of the case. Now the batteries may be put in. The L.T. battery, of two large dry cells, goes next to the valve. Care should be taken to insert these two batteries the right way round.

The volume control also switches the

apparatus on and off. With this control turned to maximum, the leads of the ear-piece may be plugged into the sockets of the strip and the ear-piece fitted to the ear.

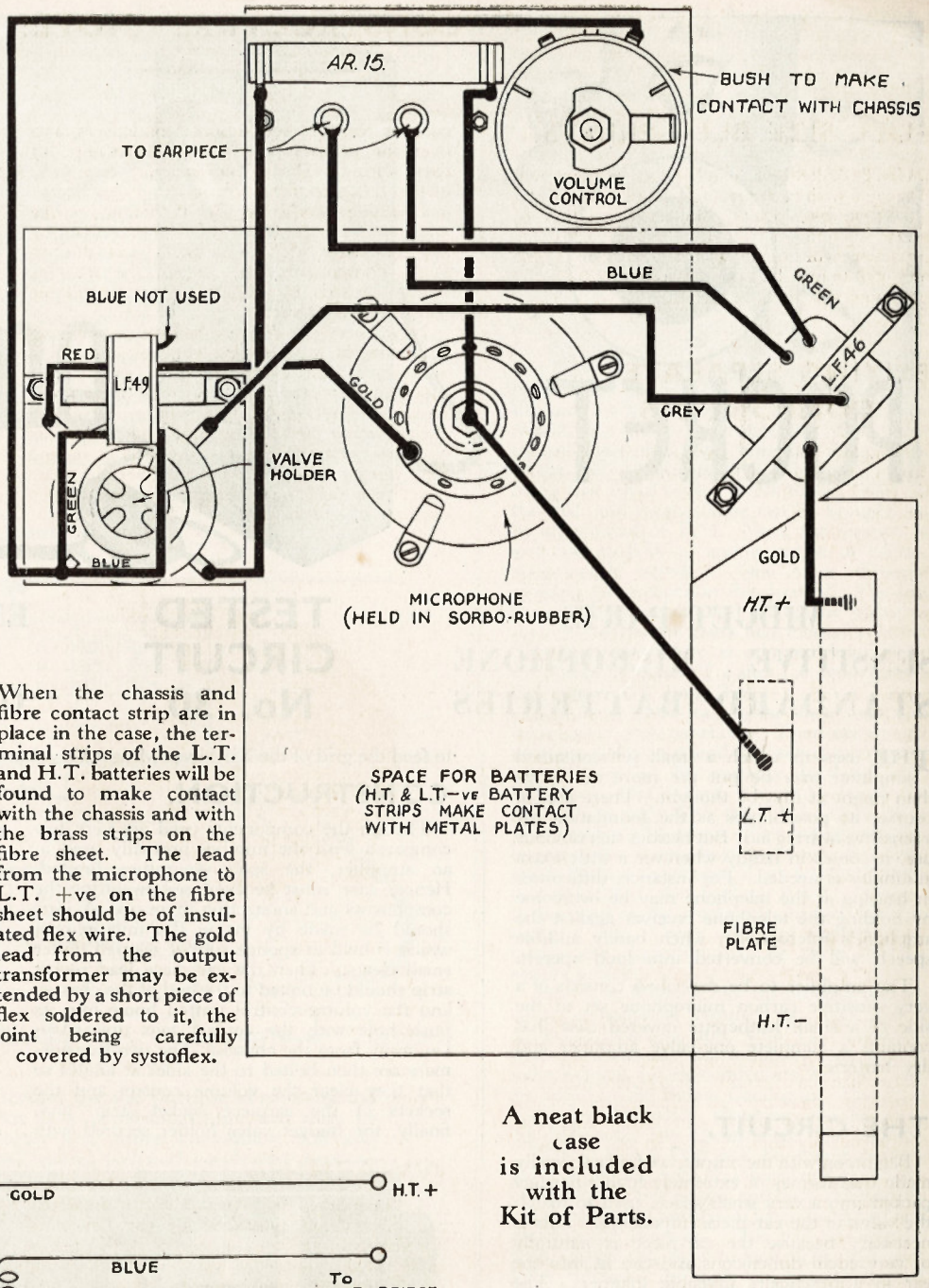
Speech should be heard clearly and loudly in the ear-piece when uttered within 3 or 4 feet of the microphone. The microphone is fairly directional, so that as far as possible it should be turned to face the speaker.

USE AND MAINTENANCE.

There is a good deal of misunderstanding about pocket sound amplifiers that employ a valve. They are the most efficient types, but also, the art of hearing with them *must be learnt*. The ear takes a little time to get accustomed to the peculiar timbre of the tiny ear-piece and automatically to interpret the sounds actually heard into familiar ones. This is a psychological effect that soon takes place, owing to the adaptability of the human hearing system. In brief, it takes a little practice to hear clearly with these sensitive instruments. Once it has been accomplished, however, the user finds his range of hearing is enormously increased.

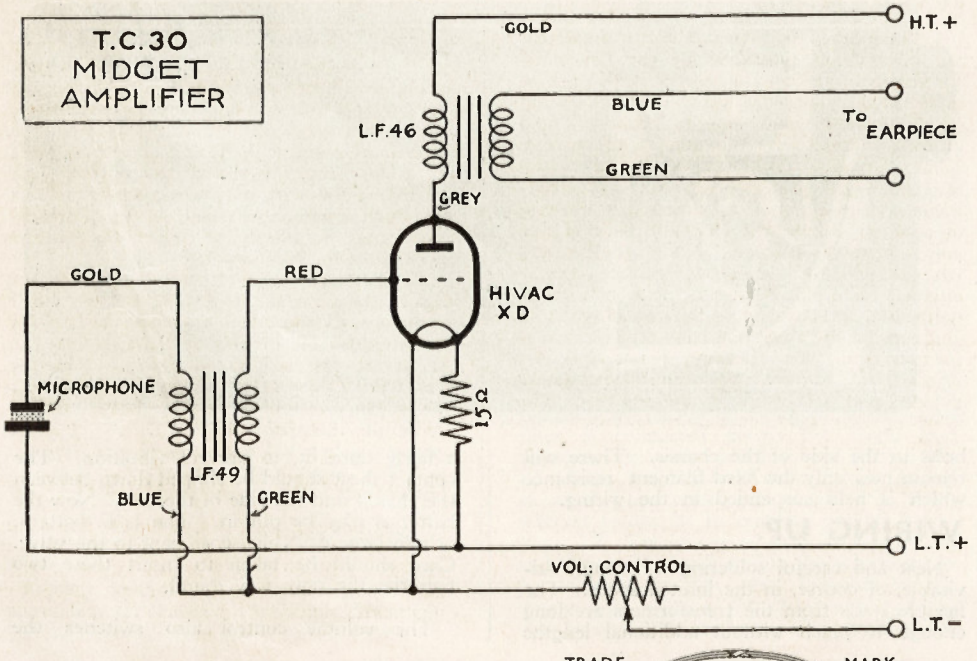
The maintenance of the little amplifier in good order is extremely simple. There is really nothing to go wrong of itself and it is sufficiently robust to stand a certain amount of shaking—provided the wiring is carefully done. All that is necessary is to renew the dry batteries when they run down. The H.T. battery will give about 300 hours use before it needs replacement. At the rate of 4 hours a day, this means 2½ months of use. The L.T. battery is of the very familiar two-cell type that can be bought for a few pence, and will never need renewal at more than 10 day intervals, unless the amplifier is used considerably.

One of the handiest uses to which this small amplifier may be put is that of enabling speech to be heard at some distance from its source. For instance, there is the problem of the person who wishes to take part in some discussion involving a number of people, in committees and the like gatherings, but cannot be seated sufficiently close to the speakers for clear audibility to be attained. This trouble may be overcome simply by placing the amplifier, which is neat and unobtrusive, on a table or similar support within the zone of normal audibility, and extending the ear-piece leads, up to several yards if necessary, to reach the listener. As the ear-piece winding is of low impedance, such long leads will cause no appreciable loss or distortion. The leads may be run under carpets or across ceilings, from the amplifier to the listener.



When the chassis and fibre contact strip are in place in the case, the terminal strips of the L.T. and H.T. batteries will be found to make contact with the chassis and with the brass strips on the fibre sheet. The lead from the microphone to L.T. +ve on the fibre sheet should be of insulated flex wire. The gold lead from the output transformer may be extended by a short piece of flex soldered to it, the joint being carefully covered by systoflex.

A neat black case is included with the Kit of Parts.



KIT OF PARTS.

COMPRISING:—

ONE BULGIN CHASSIS, SPECIAL TYPE; One L.F. 49 Midget Microphone Transformer; One L.F.46 Midget Output Transformer; One Special Volume Control; One Siemens Microphone; One A.R.10 Resistor, 15 Ω ; One V.H.30 Midget Valve Holder; One T.10 socket strip; Drydex 325 battery; L.T. 3V. battery; special ear-piece; Sundries, soldering tags, fibre contact sheet, washers, screws, nuts, etc., for full construction.

Price £4-15-0

ACCESSORIES.

Hivac Midget Valve, Type XD.

CONSTRUCTORS' NOTES

FULL SIZE BLUE-PRINTS.

PURCHASERS of *complete* kits of parts will receive with each kit a full set of blue-prints. On these blue-prints, the exact position of every component in a TESTED CIRCUIT apparatus will be shown in actual size. These blue-prints may be bought separately from the kits, however, for 2/6 per set.

BUYING SEPARATE COMPONENTS.

Complete Kits only are supplied. If individual components are required, they should be purchased through the usual channels—retail shops—or, in cases of difficulty in obtaining components, orders may be sent direct to us. All such orders should give the List Number or Numbers of the components required, obtained from our Catalogue, price 3d.

This means that those constructors who already have certain components by them, which they wish to incorporate in T.C. apparatus, should *not* order "T.C. — Kit *less* this that and the other part," but should make a list of the parts they *do* require, giving each part its correct List Number as found in the Catalogue. This procedure is necessary, in order to keep down to a minimum the costs of Kits to constructors. The extra overhead and checking work involved in "kit-splitting" makes it impossible to handle such orders economically.

UNSPECIFIED COMPONENTS.

The parts used in TESTED CIRCUIT apparatus have been found by stringent tests to operate at maximum efficiency for that particular type of circuit. If TESTED CIRCUIT apparatus, therefore, is built entirely of the parts we specify and in close accordance with the wiring lay-outs we give in our diagrams, constructors may feel assured that the apparatus will work with the same efficiency that our own laboratory models display.

But if unspecified parts are used, it is, frankly, largely a matter of luck and the technical knowledge of the constructor, whether efficient operation is obtained. There is a great deal more in the design and construction of components than appears on the surface. Hidden, and apparently trivial differences in quality and methods of construction, may have very divergent results in practice. This factor operates irrespective of the price paid for the "goodness" of components. Our designs are based on electrical characteristics, not price. Hence, we cannot be held responsible for unsatisfactory performance of TESTED CIRCUIT apparatus that incorporates components other than those specified for that apparatus.

LAY OUT OF COMPONENTS.

We have been forced to the reluctant conclusion that an appreciable proportion of constructors do not take nearly enough care over the positioning of small components such as resistors and tubular condensers, and over the neatness and correct "dressing" of their wiring. *During the last year over 91% of the T.C. apparatus sent to us for "servicing" had nothing more wrong with it than bad wiring and muddled lay-out.* Of the remaining approximately 9%, only .82% was due to faulty components, the rest of the troubles being caused by defective or unsuitable (unspecified) valves.

Now, every one of those cases of poor wiring and careless lay-out cost the constructors a *minimum* of 12/6 each! In many cases, it cost them much more. The work was of no satisfaction to anybody, for we make no profit on the servicing of TESTED CIRCUIT apparatus and the constructors were annoyed at having their wiring criticised. All this trouble could have been easily and cheaply avoided by the exercise of a little care and patience.

In its new form, this modulated oscillator covers a range of frequencies from 15-36 metres, 30-85 metres, in addition to the normal range of 90-1,500 kc/s, using fundamentals of the oscillator. Will operate from either A.C. or D.C. mains of 200-250 V. List No. V.T.23

Price, complete with calibration chart and case—£10/10/-

A WARNING.

Components and wires in radio apparatus are given their positions, by the designers, for very good reasons. It is impossible to show on the wiring diagrams, but there exists around each component and wire an invisible "field of force" created by the passage of current. Under certain conditions, these fields act upon each other and give rise to certain phenomena. An example of this is found in the case of reaction, where the magnetic field of one coil is made to link with that of another coil (the grid coil, for instance) to produce reaction effects. Here, the linkage of fields of force is deliberate. It is *wanted*, in the case of reaction. But outside the screening cans of coils, transformers, etc., such linkage is not only *not* wanted, but, in most cases, it must be carefully avoided and prevented. Designers give components their positions only after taking into careful consideration how the invisible fields of force may act upon each other. Departure from the designers' given component positions may have disastrous results upon the operation of the receiver, due to unwanted and uncalculated interaction and the introduction of "stray" capacity.

Adhere closely therefore, to the lay-out given in the wiring diagrams.

"DRESSING" OF WIRES.

By providing a special clip or terminal board for each resistor and tubular condenser, the designers of TESTED CIRCUITS could make construction very nearly fool-proof. This, however, would add considerably to the cost, and, as the majority of radio constructors are not fools, it is unfair to penalise that majority, put it to unnecessary expense, for the sake of a careless minority. Hence, most of these small components are held suspended in the wiring, by the stiffness of the wire. That, however, does not do away with the necessity for correct positioning of these components. However long, or however short, the wire ends and leads of components are, as given in the wiring diagrams, the components *must* be approximately in their positions on the chassis as shown in the diagrams.

METHODICAL PROCEDURE PAYS.

The best way of ensuring the correct positioning of components and dressing of the wire connections is to divide the components into two classes—(1) those that have one of their wire ends directly earthed and (2) those that have one of their wire ends connected directly to the sockets of valve holders. These ends should be soldered in place first, leaving the other ends of the components free. If an existing wire end is not quite long enough to reach from the component (when in its right position) to the correct earthing point of socket, an addition can be made by soldering a short piece of wire on to the end and covering the joint with systoflex.

SWITCH WIRING.

Bulgin Rotary Switches have been most carefully designed, not only for mechanical efficiency—strength and precision of contact—but also for electrical efficiency. This latter is bound up with the matter of shortness of leads to coils for switching purposes.

It is plainly senseless to nullify all the care in design by clumsiness in making short connections. On the short-wave bands, even an extra inch of wire lead may make a considerable difference to gain, besides introducing ganging troubles and, perhaps, instability.

It is not good enough simply to cut off a very rough guess at the length of wire required for a short connection and take up any slack by letting the wire curl about anywhere. A few such connections may set up sufficient interaction hopelessly to upset the correct working of the H.F. stages.

To facilitate the soldering of wires to the tags of the switches nearest the under surface of the chassis, the switch assemblies are usually left quite loosely in position, so that they can be moved for easy access by the soldering iron's bit. When the connections have been made, the assemblies can be bolted tightly home into their final positions.

GANGING. LINING UP.

Fairly detailed instructions for the lining up of individual receivers are given for each TESTED CIRCUIT. But few constructors should rest content with following these instructions blindly. They should endeavour

to understand something of *why* they go through the various lining and ganging operations.

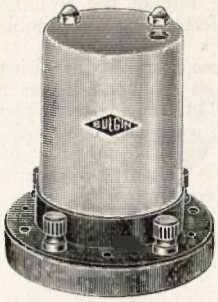
The need will soon become apparent, to the intelligent constructor, for simple apparatus of some kind that will provide proper signals for lining up purposes. This is especially the case if a good deal of lining up has to be done in a workshop, as is usually the case in service business.

As specialists in service requirements, Bulgin have a number of such useful instruments, ranging from a 10 guinea all-mains modulated test oscillator, using "universal" valves, which may be bought either complete and calibrated, or as a kit of parts, to a 15/- Neon oscillator. Brief descriptions of these instruments will explain this ganging and lining up business more clearly than pages of theoretical discussion.

The Modulated Test Oscillator is capable of delivering, when connected to either A.C. or D.C. mains over 200 volts, signals at any required frequency on 6 bands; 20-8.6 megacycles (15-35 metres), 10-3.5 megacycles (30-85 metres), the two usual broadcast bands of Medium and Long Waves, the band in between them that contains the popular 465 kc./s. used in most modern I.F. stages, and the band of frequencies over 150 Kc./s in which are found the older I.F.s in the region of 110 Kc./s. The signal can be attentuated without appreciable frequency shift, and is modulated by means of a neon oscillator at audio frequency. Such an instrument, of course, meets every need in the practical service workshop that has to deal with superhet receivers of all makes. It is contained in a handy black cloth-covered carrying case. List No. V.T.23.

Next to be considered are the Neon I.F. and R.F. Liners.

There are two I.F. Liners, one that delivers a 465 Kc./s signal (V.T.17) and another delivering a 110 Kc./s signal (V.T.20). Both of these consist of a small coil and neon lamp assembled in a neat can and moulded base with terminals for connection to input and output. Their use is simplicity itself. The input terminals are connected to any source of 200 volt D.C. As the current consumption is about 1/5th of a milliamp, the drain is neglible even for H.T. batteries, if D.C. mains are not available, and they can even be used with the rectified anode supply of an A.C. set that is being lined up. The output terminals are connected between the



465 Kc/s
I. F.
LINER
List No. V.T.17.
Price 15/-

grid of the frequency changer and the chassis. The I.F. Transformer trimmers are then adjusted for the loudest audio note heard in the receiver. Accuracy is extremely high, as the frequency is fixed at the factory. The price of each of these Liners is 15/-.

Then there is a similar neon oscillator that provides signals, for radio frequency ganging of the H.F. stages of superhet receivers, at 200, 250, 375, 500 and 1000 metres. This range is ample for the accurate setting of R.F. trimmers and the calibration of dials. This is V.T.21, at 15/-.

Practice in the use of these instruments combined with the study of superhet principles will soon provide the amateur with the experience and knowledge of a professional.

The importance of lining up and ganging cannot be overestimated. Upon the accuracy of these adjustments depends the ability of a receiver to do something more than receive only the local stations and rather badly at that. It is of no use to blame the components until one is perfectly satisfied that the trimming makes their efficient performance possible.

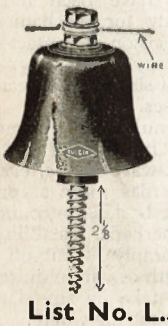
FURTHER INFORMATION. SERVICE.

Every constructor should have by him the Bulgin Service Manual and the Catalogue, the former costing 1/- and the latter 3d., post free.

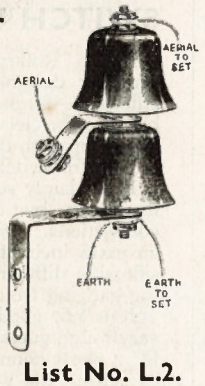
Should it be found impossible to make a receiver work satisfactorily after every care has been taken with the wiring and lining up and all operating conditions are checked over, it may be sent to us for examination and report. With it should be sent a detailed account of the troubles manifested. A *minimum* charge of 12/6 is made for this service, exclusive of return carriage. Receivers must be sent carriage paid and securely packed, the valves being included in the same package but carefully wrapped, and in the maker's cartons. Loud speakers and cabinets should *not* be sent.

The Bulgin Technical Service Dept. is prepared at all times to give advice and information concerning the use of Bulgin components and to suggest remedies in the event of trouble being encountered. But in all cases, the fullest possible information concerning the conditions under which the components have to operate and exhaustive details about their behaviour under such conditions (H.T. voltages, anode currents, etc., etc.) should be sent with queries. This will usually render it possible to give such replies as will result in the complete rectification of the difficulties met with.

A GOOD AERIAL



List No. L.5.
Price 1/9 each

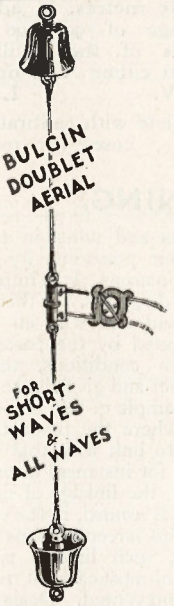


List No. L.2.
Price 4/- each

List No. L.3.
Price 1/9 each

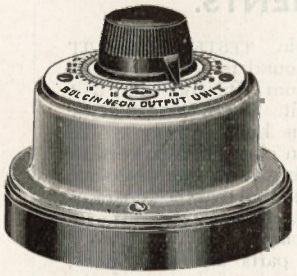
is half the battle in short-wave reception. It *must* be well placed, well insulated and not too long. The Notes on Aerials on Page 20 lay down the first principles of aerial design. These fittings enable these principles to be put into practice with the minimum of expense and trouble. The Doublet Aerial is of especial interest, since it can be used effectively even with sets of which the aerial input coils do not incorporate a doublet winding, and the transposed lead-in eliminates a very common course of local interference.

GET THE BULGIN 120 PAGE CATALOGUE!



List No. L.10.
Per Kit, 12/-

Supplied as a kit of parts, this Doublet Aerial Outfit includes 10 down-lead transposition blocks, 120 ft. of wire, moulded cowl insulators, junction insulator block, and full instructions for complete erection.



V.T.19
NEON
OUTPUT
MEASURING
UNIT

The ear is not a good judge of sound intensity, because it cannot appreciate any change less than 1 decibel, which may represent a considerable change in electrical conditions. The visual method of comparing output strength is far better. The little unit shown above needs no external source of power: it is simply connected across the speaker speech terminals of a receiver, and the signal causes the neon lamp to glow. If the signal is the steady tuning note of a broadcast station, or the audio note of a neon or modulated test oscillator, the circuits can be readily trimmed to maximum efficiency, since the length of the glow varies with the strength of output, thus plainly indicating the peaks. The price is 20/-.

SMALL ACCESSORIES.

For the man who makes a hobby of construction, there are scores of little parts to be found in the Bulgin Catalogue—panel bushes, shaft couplings, insulating washers, small screws and nuts, brackets, and the like—the use of which makes all the difference between a "botched" makeshift and a neat, professional finish.

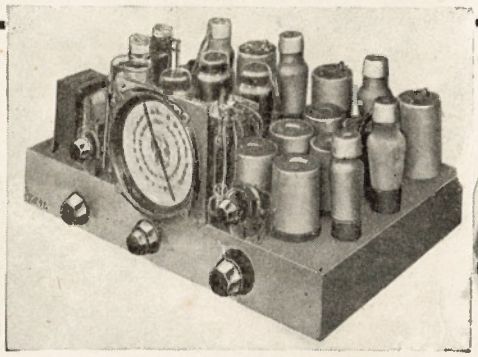
GET THE BULGIN 120 PAGE CATALOGUE!

MORE "TESTED CIRCUIT" KITS

Four Valve A.C. Mains "Straight" Receiver.

A simple medium and long-wave receiver, for A.C. mains. Excellent quality from tetrode output: 3 watts. Ideal for domestic use.

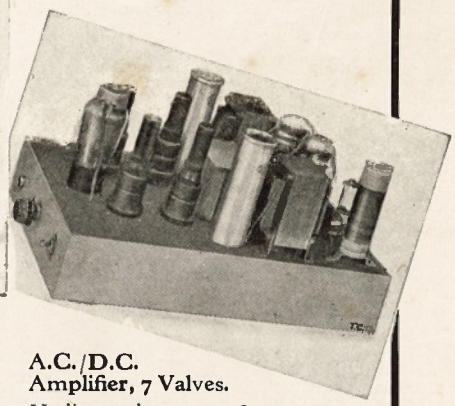
List No. T.C.16 **£6 - 5 - 0**



Ten Valve A.C./D.C. Superhet.

H.F. valve precedes the frequency-changer. Two I.F. stages. Special noise suppression and full A.V.C. Visual Tuning by dimming dial lights. Push-pull O.P. Universal mains operation.

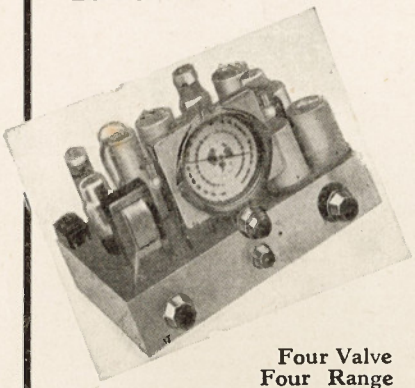
List No. T.C.11 **£12 - 0 - 0**



A.C./D.C. Amplifier, 7 Valves.

Undistorted output 8-10 watts. Parallel push-pull. Suitable for gramophone records or band relay. Super quality. All mains, 200-250v.

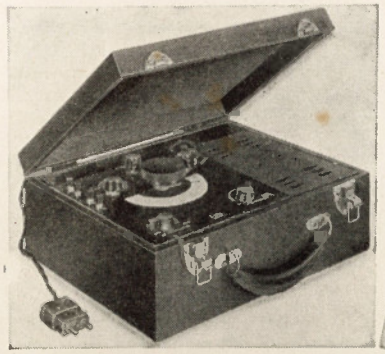
List No. T.C.13 **£5 - 0 - 0**



Four Valve Four Range A.C./D.C. Superhet.

Double-diode H.F. pentode, heptode frequency changer and tetrode output stage. From 12 to 2000 metres in four bands. All mains.

List No. T.C.17. **£7 - 0 - 0**



All-Wave A.C./D.C. Test Oscillator.

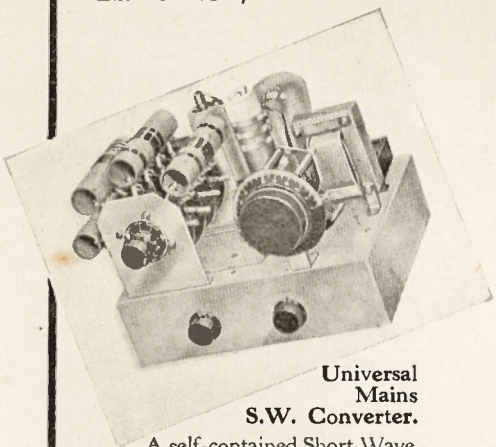
A modulated oscillator covering 90-1,500 kc/s. Self-contained. All mains, 200 to 250 volts, A.C. or D.C. Ostar-Ganz valves used.

List No. T.C. 15 **£5 - 0 - 0**

Battery 3-Valve Four Range Receiver.

A "straight" set giving first class all-wave reception. Very low battery consumption. Pentode output. Excellent quality.

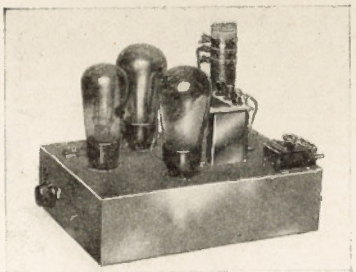
List No. T.C.19 **£5 - 0 - 0**



Universal Mains S.W. Converter.

A self-contained Short Wave Converter for use with any set having at least one H.F. stage. Covers from 10 to 170 metres in 4 bands. All mains 200-250 v., A.C. or D.C.

List No. T.C.3 **£4 - 0 - 0**



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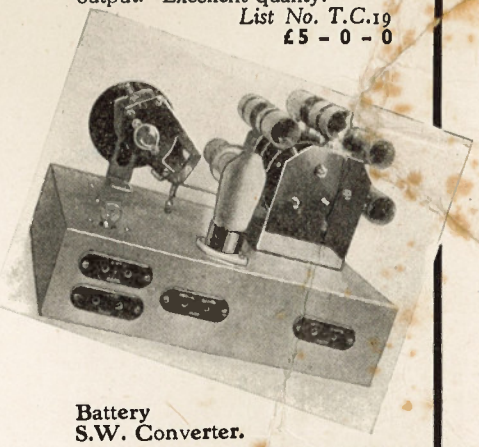

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Any battery set with an H.F. amplifying stage can receive Short Waves with this efficient 4 band converter. 10 to 170 metres.

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