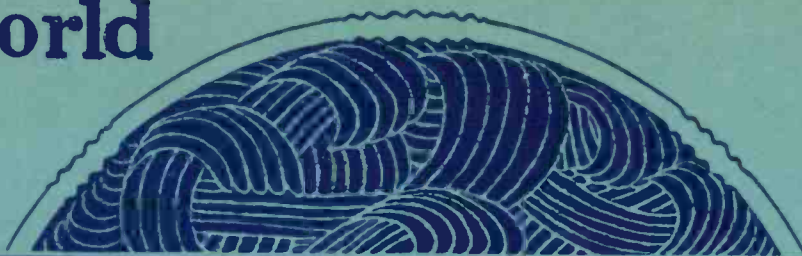


The **Wireless
World**

1/6 NET



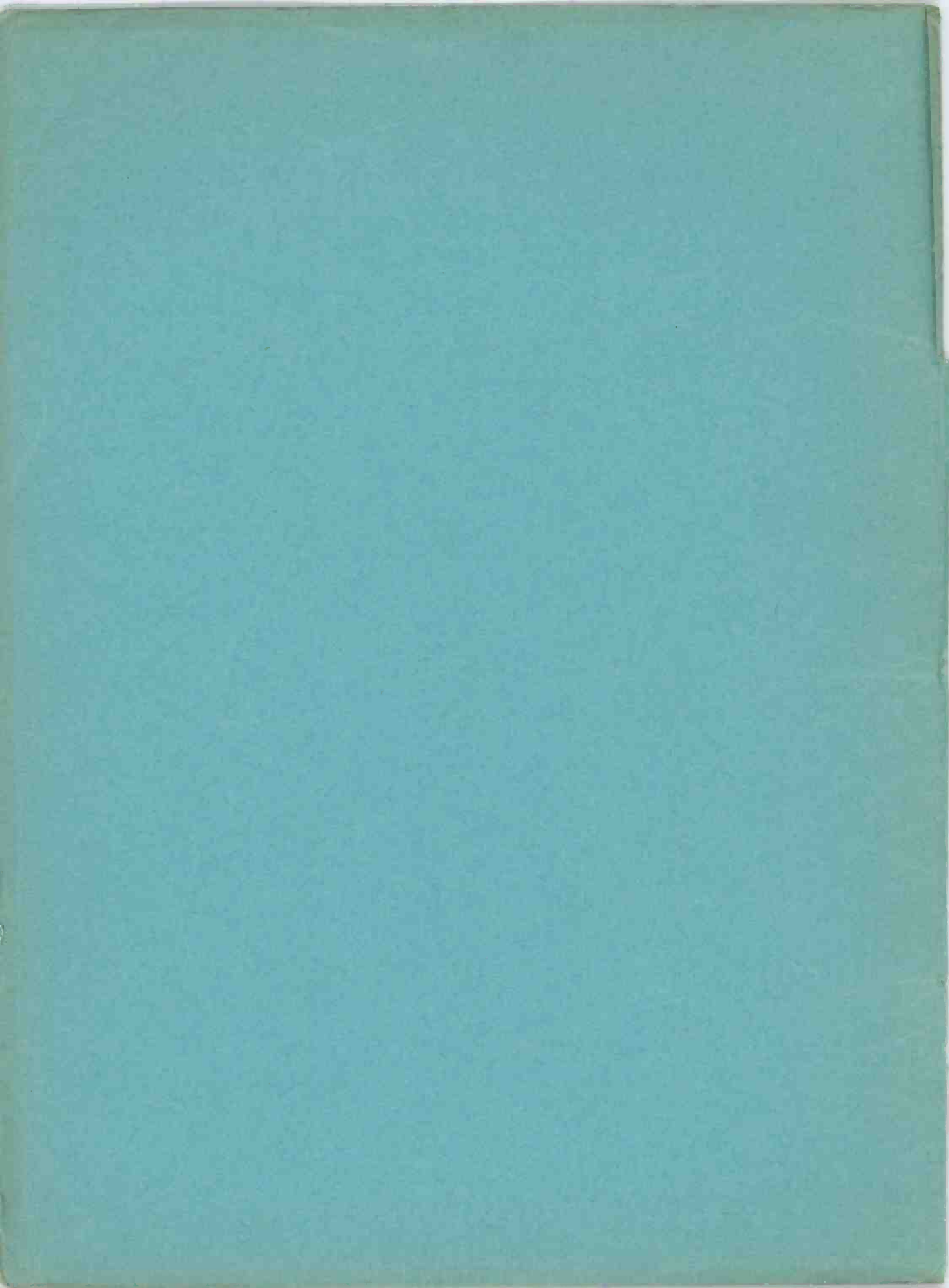
MONODIAL

**A.C.
SUPER**



DESIGNED
BY
W.T. COCKING

ILIFFE & SONS LTD. LONDON



COMPLETE CONSTRUCTIONAL
DETAILS
OF
"The Wireless World"
MONODIAL A.C. SUPER

An Ultra-selective Seven-
valve Superheterodyne
Receiver of Outstanding
Performance

By W. T. COCKING

PUBLISHED FROM THE OFFICES OF
"THE WIRELESS WORLD"
ILIFFE & SONS LTD., DORSET HOUSE, TUDOR ST., LONDON, E.C.4
1933

PREFACE

SOME years ago *The Wireless World* was largely instrumental in reviving the popularity of the superheterodyne receiver. The superheterodyne principle has been known for some twelve or thirteen years—a very long time when measured in terms of wireless progress—but until comparatively recently it was generally considered that high quality of reproduction could not be obtained with the employment of a circuit of this nature. Realising that the early objections to this circuit principle had disappeared as a result of progress made in many directions, and that the time had come to renew acquaintance with the superheterodyne in the light of general progress, *The Wireless World* set an example by publishing articles and designs for up-to-date superheterodyne receivers. These had none of the disadvantages of the earlier types, and the designs quickly attained popularity because the quality of reproduction was found to be well up to the standard set by the more familiar straight set, whilst the added selectivity obtainable with this principle came at a time when mutual interference between European stations was becoming a problem and the difficulty of separating individual transmitters with comparatively unselective straight sets was a subject of constant comment.

The Wireless World Monodial A.C. Super, although designed more than a year ago, remains to-day an outstanding example of a modern ultra-selective quality receiver, and its performance continues unchallenged. It is still so far ahead of other designs that it has been found unnecessary to make any modifications in re-publishing in the present booklet the description of how to construct the receiver. This booklet has been prepared in response to a very general demand for the description of this set to be brought together in a convenient form, for hitherto it has only been available spread over two or three issues of *The Wireless World*. To our knowledge, many thousands of these receivers have been constructed, yet we have come across no instances of failure or disappointment with the performance due to any difficulties in construction. To those familiar with building receivers, who realise that sets are often built by entirely inexperienced constructors, this record is particularly satisfying. The receiver is a somewhat ambitious one, but so straightforward is the design, and so simplified the method of assembly, that no difficulties of construction need be anticipated.

As to performance, in view of the reputation which the receiver has gained, it seems unnecessary to say more than that if any better receiver has been designed to meet the requirements of quality, range and selectivity, then for some reason its existence is being kept a close secret.



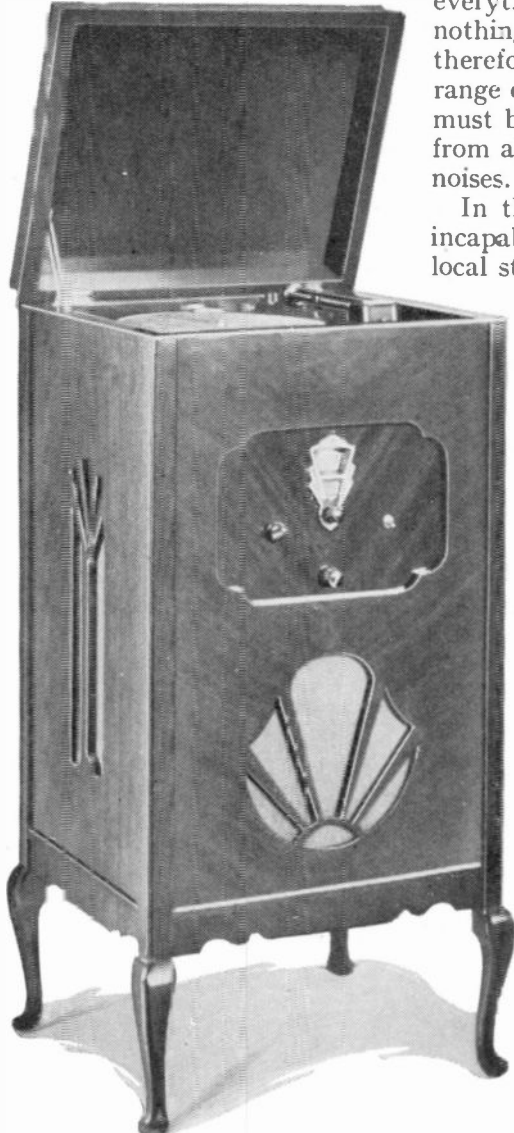
HOW TO BUILD THE MONODIAL A.C. SUPER

THERE can be little doubt that faithful reproduction is the primary requisite of a broadcast receiver. High quality alone, however, is insufficient for the complete enjoyment of broadcasting, for this can only be attained when the reproduction contains everything transmitted by the desired station and nothing from any other source. The ideal receiver, therefore, must be capable of reproducing the whole range of audible frequencies without distortion, and it must be sufficiently selective to eliminate interference from all sources, while the set itself must not introduce noises.

In the past, these exacting requirements have been incapable of fulfilment, except in the case of a purely local station receiver with which neither interference nor set noises are usually of any importance. Recent developments in radio, however, have resulted in the possibility of building a set which, so far as the more powerful of distant stations are concerned, may truthfully be said to approach very closely to the ideal. The complete attainment of all the attributes of the ideal receiver of any type is, of course, still impossible.

Theoretical accounts of modern circuit developments have appeared in *The Wireless World*,¹ and it may be said that a set built in accordance with these principles will give a very satisfying performance. Full reproduction of all audible frequencies up to a limit of about 5,000 cycles is possible, while retaining a degree of selectivity sufficient to eliminate interference when receiving the stronger of distant stations. The high quality and freedom from modulation interference are retained on the weakest stations, but the possibility of sideband heterodyning from adjacent stronger stations has not yet been overcome. Except when the receiver is being worked at a point approaching its maximum sensitivity, at which point even the weakest stations are normally receivable at good strength with any reasonably efficient aerial, noises introduced by the set itself are so low as to be inaudible.

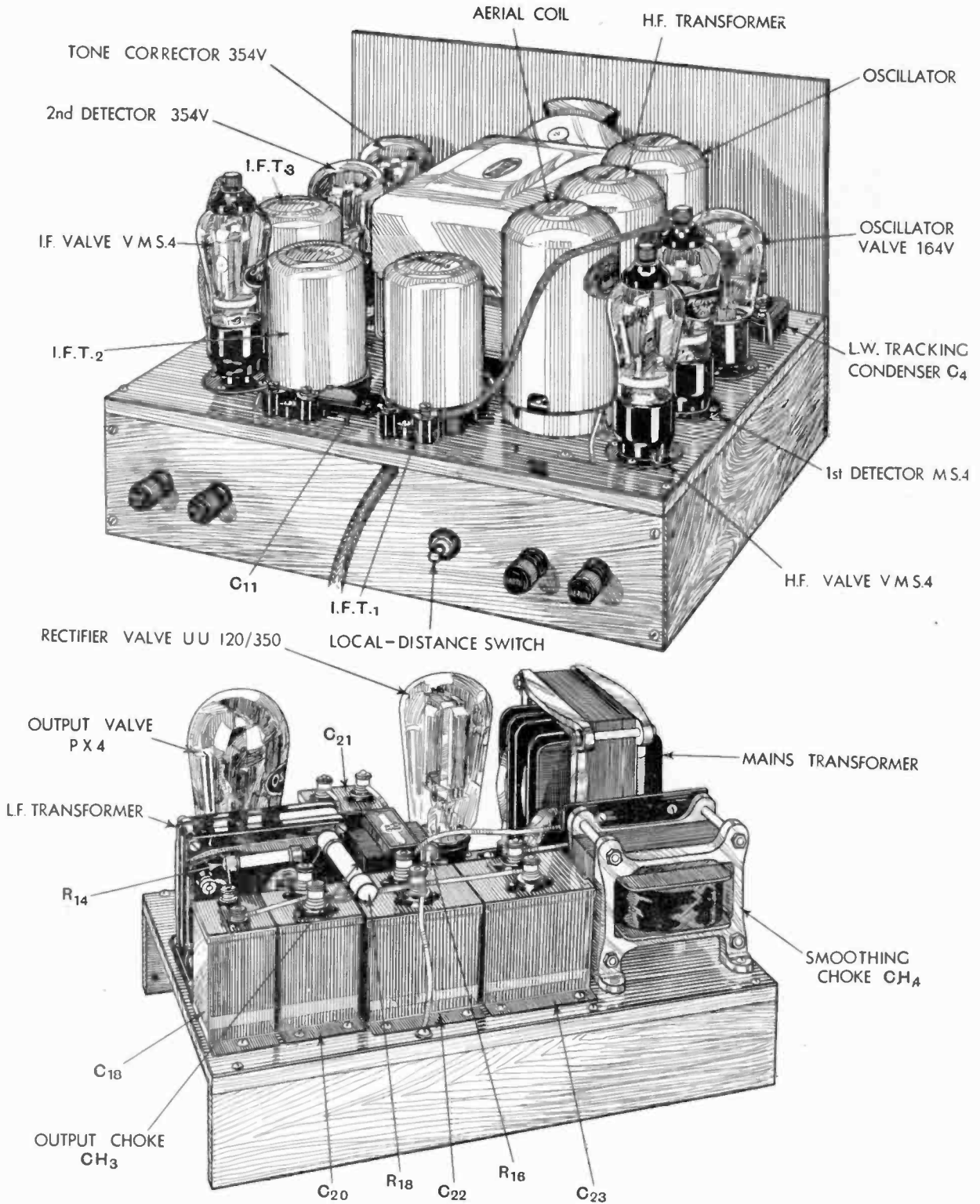
It is unnecessary to enter into a description of the circuit principles here, and so we shall



The Monodial A.C. Super receiver lends itself particularly well to gramophone reproduction. It is here shown housed in a cabinet with electric gramophone motor and pick-up.

¹ Superheterodyne Improvements. *The Wireless World*, April 6, 1932.

HOW TO BUILD THE MONODIAL A.C. SUPER.



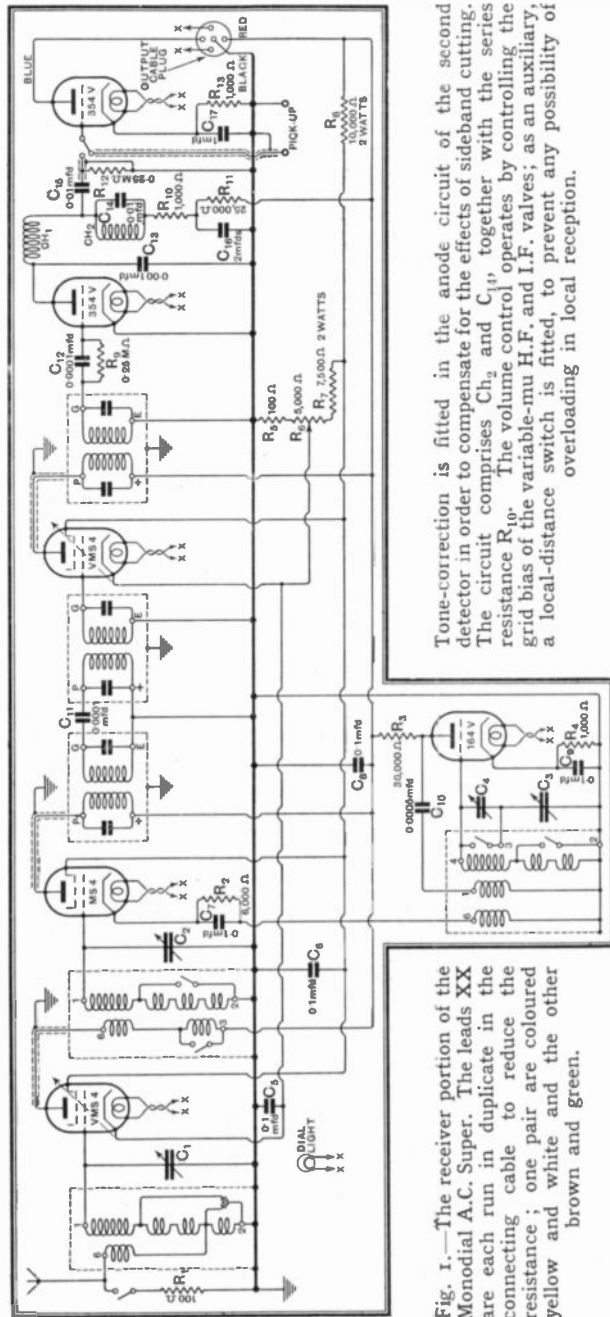
The receiver and eliminator units. The output stage is included in the mains chassis, so as to localise all high-voltage equipment.

proceed to the actual constructional details of a practical receiver, and consider only those precise details which, although not affecting the general principles, are by no means unimportant, and upon which the success or failure of a receiver so largely depends. The circuit diagram of what may be termed the receiver portion of the apparatus is shown in Fig. 1 and that of the power unit, which includes the mains equipment and the output stage, in Fig. 2, and it will be seen that the former unit contains six valves which are employed in an H.F. stage, first detector, oscillator, I.F. stage, second detector, and tone corrector stage.

THE PRE-SELECTOR

In order to keep second channel interference at a minimum, two tuned circuits are used to precede the first detector, and as an H.F. stage is employed, one takes the form of the aerial tuning circuit, while the other provides the H.F. intervalve coupling. The total selectivity of the signal frequency circuits, therefore, is rather greater than with the more customary band-pass filter, while their characteristics are such that a negligible amount of sideband cutting is introduced.

For maximum efficiency the so-called aperiodic aerial coupling is used, and the switching is so arranged that on both wavebands the aerial load is substantially constant, thus avoiding ganging errors. The circuit, whose inductance is matched to that of the intervalve coupling, is tuned by one section C_1 of the special 0.005 mfd. three gang condenser. In order to avoid cross-modulation and to provide a distortionless pre-detector volume control, the H.F. valve is of the V.M.S.4 variable-mu type, and is coupled to the first detector by means of an H.F. transformer. This circuit is tuned by the second section C_2 of the gang condenser, a section which is in every respect identical with C_1 .



Tone-correction is fitted in the anode circuit of the second detector in order to compensate for the effects of sideband cutting. The circuit comprises C_8 and C_{10} , together with the series resistance R_{10} . The volume control operates by controlling the grid bias of the variable-mu H.F. and I.F. valves; as an auxiliary, a local-distance switch is fitted, to prevent any possibility of overloading in local reception.

Fig. 1.—The receiver portion of the Monodial A.C. Super. The leads XX are each run in duplicate in the connecting cable to reduce the resistance; one pair are coloured yellow and white and the other brown and green.

The M.S.4 first detector is employed as an anode bend rectifier, and is self-biased in the usual way by a 6,000 ohms resistance R_2 , shunted by a 0.1 mfd. condenser C_7 , in its cathode lead. A valve with a comparatively low mutual conductance has been deliberately chosen for use at this point, since it has been found to introduce less background noise than more efficient types, and it has also a greater signal input handling capacity, a very important point.

A separate triode valve, with its grid circuit tuned, is used for the oscillator. It is biased by the 1,000 ohms resistance R_4 , shunted by the 0.1 mfd. condenser C_9 , in its cathode lead, and its H.T. supply is taken from the common 200 volts line through the 30,000 ohms resistance R_3 . The reaction coil is shunt fed from the anode circuit through the 0.0005 mfd. condenser C_{10} , and the coupling between the first detector and oscillator circuits is provided by means of a coupling coil connected in series with the first detector cathode lead.

The medium waveband tuned oscillator winding has an inductance considerably less than that of the two pre-selector circuits, and it is tuned by the third section C_3 of the three-gang condenser. This section of the condenser has plates specially shaped so that the correct frequency displacement of 110 kc. between the oscillator and pre-selector circuits is accurately maintained over the whole of the medium waveband, without the necessity for using special tracking condensers. This correct ganging, however, is not maintained automatically on the long waveband, and it is necessary to introduce a series padding condenser C_4 , which is adjustable over a capacity range in the neighbourhood of 0.001 mfd., and which is short-circuited on the medium waveband by a switch built into the coil base. Ganging adjustments are thus reduced to a minimum, and it is readily possible to obtain the accurate alignment of circuits which is so essential for the avoidance of second channel interference.

The primary circuit of a four-stage filter, tuned to the intermediate frequency of 110 kc., is included in the anode circuit of the first detector. This filter consists of two pairs of mutually coupled coils, themselves coupled together by the 0.0001 mfd. condenser C_{11} between the high potential ends of the coils. Following this filter is the I.F. stage, which consists simply of a single V.M.S.4 variable- μ valve coupled to the second detector by means of the usual type of two-stage filter.

THE VOLTAGE SUPPLY CIRCUITS

Since the valves do not all operate upon the same signal frequency, it has been found possible largely to dispense with de-coupling without any fear of introducing unwanted feed-back effects. The anode voltages of the two variable- μ valves and the first detector are all taken directly from the common 200 volts line, with a single 0.1 mfd. condenser C_8 shunted to earth. The screen grids are similarly fed from the same tapping on a voltage divider shunted across the H.T. supply, and with another 0.1 mfd. condenser C_6 shunted to earth. This voltage divider is made up of R_8 and R_7 , which have values of 10,000 ohms and 7,500 ohms respectively, and are of the 2-watts type, in series with the 5,000 ohms volume-control potentiometer R_6 , and the 100 ohms resistance R_5 . The cathodes of the two variable- μ valves are joined together and taken to the slider of the volume control, while a 0.1 mfd. condenser C_5 is shunted to earth.

The bias impressed on both the variable- μ valves, therefore, is the same, and varies from a maximum of some 60 volts to a minimum, provided by the voltage drop along R_5 , of 2.5 volts. A complete control of volume is thus obtained by means of a single potentiometer, for the amplification of both the H.F. and the I.F. stages is controlled simultaneously. It has been found, however, that distortion may sometimes occur

when receiving a strong local station at low volume, and for local reception some means of reducing the aerial input is often desirable. A "Local-Distance" switch is fitted, therefore, whereby a resistance R_1 of 100 ohms may be connected at will between the aerial and earth terminals.

TONE CORRECTION

A 354v. type valve is used as a power grid second detector, and the grid leak and condenser, R_9 and C_{12} , are given the normal values of 0.25 meg. and 0.0001 mfd. respectively. The usual I.F. filter is fitted to the anode circuit, and consists of a high inductance choke Ch_1 and a 0.001 mfd. condenser C_{13} , but the intervalve coupling is of an unusual type, since its purpose is to provide a degree of tone correction for the side-band cutting of the tuned circuits. In place of the usual resistance, therefore, a network of capacity, inductance, and resistance is employed.

This network consists of the parallel resonant circuit, Ch_2 and C_{14} , in series with the

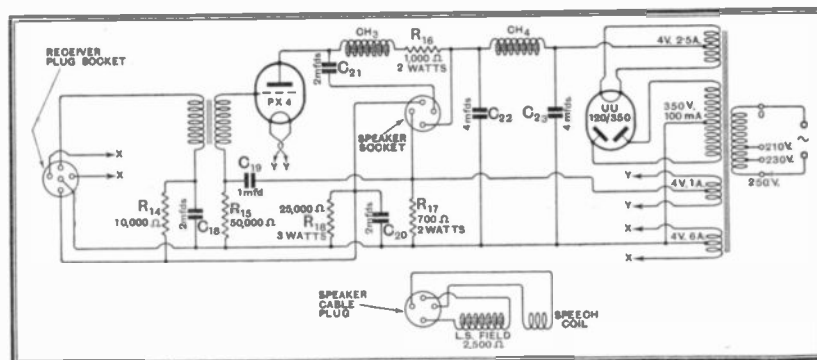


Fig. 2.—The power unit, including the output stage, which is built as a separate unit.

1,000 ohms resistance R_{10} . At low frequencies the coupling is provided only by the circuit resistance, which consists of R_{10} in series with the choke resistance of 250 ohms, giving an effective value of 1,250 ohms. For quite high audible frequencies, the circuit impedance does not greatly depart from this value, and so the stage amplification remains fairly constant at a low value. When a certain frequency is passed, however, the impedance, and hence the amplification, rises rapidly until the resonance frequency of some 5,000 cycles is reached, and the amplification is nearly equal to the amplification factor of the valve.

The choke Ch_2 has a value of 90,000 μH . and it is a McMichael Binocular Junior; it is important that in this case the specified component be employed, for the compensation obtained is dependent not only upon the inductance, but also upon the choke resistance. The shunt condenser C_{14} has a capacity of 0.01 mfd., and so gives a resonance frequency of about 5,000 cycles. The intervalve coupling is completed by the usual 0.01 mfd. grid condenser C_{15} and a 0.25 meg. grid leak R_{12} , while the detector anode circuit is fed from the 200 volts line through the 25,000 ohms de-coupling resistance R_{11} with a 2 mfd. condenser C_{16} shunted to earth. The radio-gramophone switch is connected to give a single-pole change-over action, and is joined directly in the grid circuit of the 354v. tone corrector or first L.F. valve, which is biased by a 1,000 ohms resistance R_{13} , shunted by a 1 mfd. condenser C_{17} in its cathode lead.

The coupling between this valve and the P.X.4 output stage is by means of a 3.5-1

ratio transformer, which is fitted in the power unit, and the tone-corrector anode circuit is de-coupled by the 10,000 ohms resistance R_{14} and the 2 mfd. condenser C_{18} . The output valve, which delivers some 2,500 milliwatts to the speaker, is biased by the 700 ohms (2 watts) resistance R_{17} , connected between negative H.T. and the centre tap of its filament-heating winding on the mains transformer, and its grid circuit is de-coupled by a 50,000 ohms resistance R_{15} and a 1 mfd. condenser C_{10} . A choke-feed output circuit is employed with a 20H. choke Ch_3 in series with a 1,000 ohms 2 watts resistance R_{16} , whose purpose it is to prevent excessive anode voltage being applied to the output valve. The loud speaker or output-transformer primary is, of course, fed through the 2 mfd. condenser C_{21} in the conventional manner.

THE POWER UNIT

A U.U. 120/350 valve rectifier is used, and delivers some 360 volts at 100 mA. across the 4 mfd. condenser C_{23} . The whole current is smoothed by the 10H. choke Ch_4 of 120 ohms D.C. resistance in conjunction with another 4 mfd. condenser C_{22} , and the supply for the output valve is then tapped off. The remainder of the current, some 50 mA., flows through the 2,500 ohm field winding of the moving-coil loud speaker, where it is still further smoothed in conjunction with the 2 mfd. condenser C_{20} . In order to provide sufficient current for adequate field excitation under all conditions, a 25,000 ohms 3 watts resistance R_{18} is connected across this condenser, where it also tends to stabilise the anode voltage of the early valves.

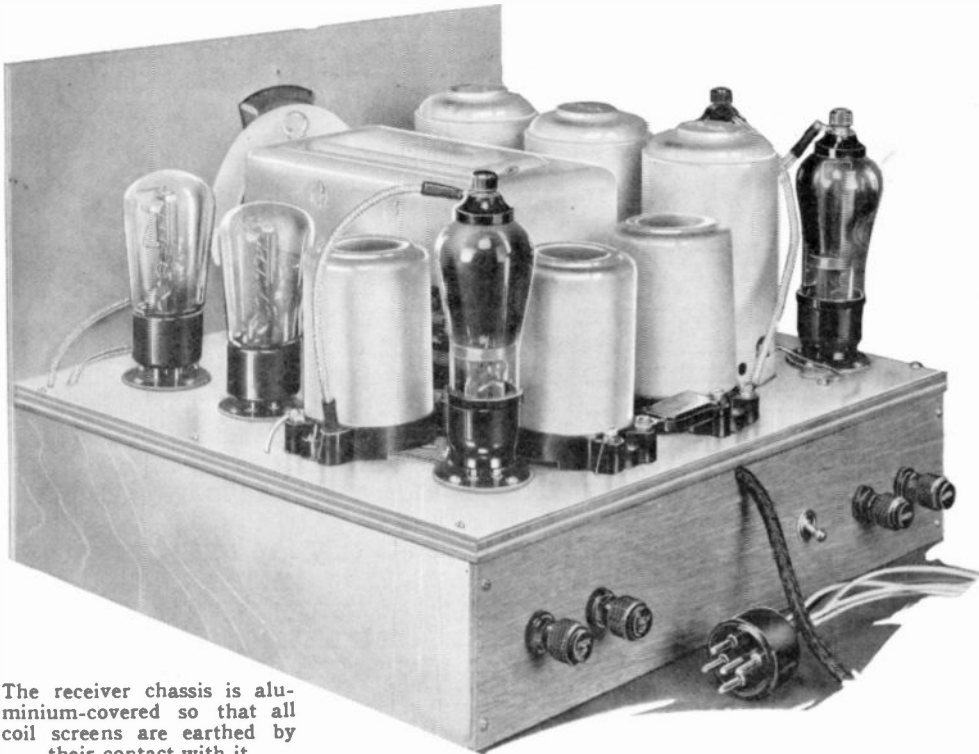
The mains transformer carries secondaries giving voltages of 350-0-350 volts at 100 mA. or H.T., 4 volts at 2.5 amps. for the rectifier filament, 4 volts at 1 amp. for the output-valve filament, and 4 volts at 6 amps. for the six early valves and the light illuminating the dial.

Now it is well known that modulation hum is usually due to high-frequency currents in the mains being transferred to the receiver circuits through the capacity between primary and secondary windings. It is the usual practice to eliminate this undesirable effect by connecting condensers between the mains and earth, so that the H.F. currents are by-passed to earth and do not enter the circuits of the receiver proper. While this scheme is very effective, it has been found that in cases where the earth lead is very long, there is a tendency for background noise to be increased. Since every possible precaution against background noise has been taken in this receiver, an alternative method of eliminating modulation hum has been thought advisable. The primary of the mains transformer is electrostatically screened from the secondaries by means of earthed copper strips interposed between the windings, and it has been found that this method is as effective as the older scheme.

CONSTRUCTIONAL DETAILS

It will be observed that the set is built in two separate units—the receiver and power chassis. For this there are several reasons, of which the most important is that the constructional work is simplified owing to the reduction in size and weight of each individual unit. Where the superheterodyne is to be fitted to a cabinet of the radio-gramophone type, moreover, the two-unit construction lends itself to an economy of space, since the receiver can be placed on one shelf, with the power unit and loud speaker on the other. A further point is that the mains equipment and output stage are available for use with other receivers if desired, and any modifications to the output stage which might be necessary for abnormally large volume are more readily carried out.

The first six valves are all mounted on the receiver chassis, which is built of aluminium-covered ply-wood mounted on 3 in. battens. This special wood is known as Venesta, and may be obtained with the large holes already cut. If undrilled material be obtained, however, these large holes, which have a diameter of one inch and are for the valve holders, can be readily cut with an ordinary brace and bit, since the aluminium covering is only thin. The first step in the construction is to mount the base on the battens, and then the valve holders, taking care that none of the valve legs come into contact with the metal covering of the wood. The components above the baseboard should next be mounted, with the exception of the gang condenser, and it may be



The receiver chassis is aluminium-covered so that all coil screens are earthed by their contact with it.

remarked, in passing, that the aluminium covering to the base is easily pierced with a pricker.

The under-base components are then screwed in position, and the wiring begun. With the exception of the three leads which run to the gang condenser, all the coil connections should be made first. No. 22-gauge tinned-copper wire is used and run in small-diameter sleeving, and in most cases, the leads are taken directly from point to point by the shortest path. Few soldered joints are necessary, and the metallised resistances are supported entirely by their connecting leads to other components; care should be taken, however, to see that the leads to these resistances do not come into contact with the metal cases of fixed condensers.

For the heating wiring, a separate pair of twisted leads must be run to each valve holder and the dial light, in order to avoid an excessive voltage drop; at one end the seven leads are twisted together and inserted into the junction block for connection to the

inter-unit cable. Screened leads are used for the anode connections to the three screened-grid valves, and for two of the connections to the radio-gramophone switch. The type of screening recommended is that in which a piece of large-diameter sleeving is provided with a braided-metal covering. The material should be cut to the correct length, and the metal covering pushed back at each end so that about one-eighth of an inch of the sleeving projects. A few turns of tinned copper wire should then be wrapped round each end and soldered in position, to prevent any possibility of the covering coming into contact with the internal wire. The screening should, of course, be earthed by joining one end to a convenient earth point on the chassis.

Having completed the wiring, three leads should be attached to the three terminals of the gang condenser, and this component secured to the chassis. The contact of the condenser with the metal-covered baseboard provides a sufficient earth connection, but care should be taken to see that the holding-down screws are well tightened up. The three connections to the coils can now be completed, and the dial and front panel placed in position.

THE INTER-UNIT CABLE

The receiver should now be complete with the exception of the inter-unit cable, which is terminated at one end by a five-pin plug and at the other by the junction block. The pins on the plug are arranged in the same way as on a valve base, and, in fact, it fits into an ordinary valve holder; it is convenient, therefore, to refer to them individually by the familiar valve-pin names. In connecting up the cable great care should be taken to avoid errors and short-circuits, and it will be a help in this respect if the colour code shown on the drawing be adhered to. The black and red wires should be used for joining the negative and positive H.T. lines to the cathode and anode pins respectively of the plug, while the blue wire must connect between the anode of the tone-corrector valve and the grid pin.

Since a seven-wire cable is used, and there are only five connections, four wires will remain. Of these, the white and the yellow wires are connected together at each end, and the two wires are then treated as a single lead and used for the connection between one side of the receiver heater wiring and one heater pin in the plug. Similarly, the green and brown wires are joined together at each end, and provide the other lead between the heater wiring and the other heater pin. Two wires in parallel are used for the heater connections in order to avoid an excessive voltage drop along the cable, and for the same reason it is important to note that a longer cable than that specified should not be employed. It is permissible to use a 5-wire cable if this be of a type having two extra-heavy leads for the heater connections; cables of this type are now obtainable.

The power unit is built upon a chassis of aluminium-covered ply-wood, and carries two valve holders for the output and rectifier valves. Two further valve holders are mounted on the rear supporting batten, for the receiver and loud speaker plugs, and this vertical mounting is adopted in order to prevent confusion with the valve holders proper. Since the L.F. transformer is fitted with reversible feet, it can be mounted on its side in the correct position without difficulty, but care should be taken to see that both this component and the mains transformer are fixed in exactly the relative positions shown in the drawings, or trouble from hum may be found.

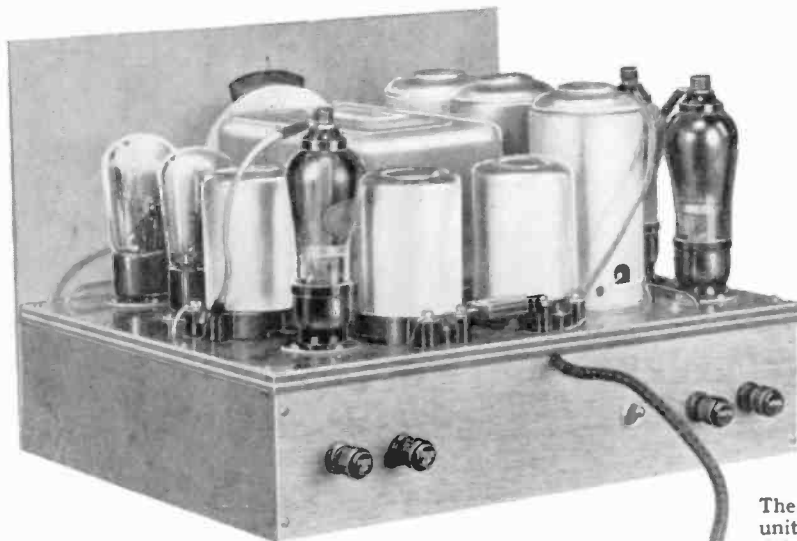
In cases where either the mains transformer or the L.F. transformer is of a different type from those specified, the L.F. transformer should not at first be screwed down, and it should be connected up with long, flexible leads. When the set is first tried out it can then be readily moved into the position of minimum hum, and once this is

HOW TO BUILD THE MONODIAL A.C. SUPER.

11

found it can be screwed down and permanently wired up. It should be emphasised that this procedure should be unnecessary if the specified components be employed.

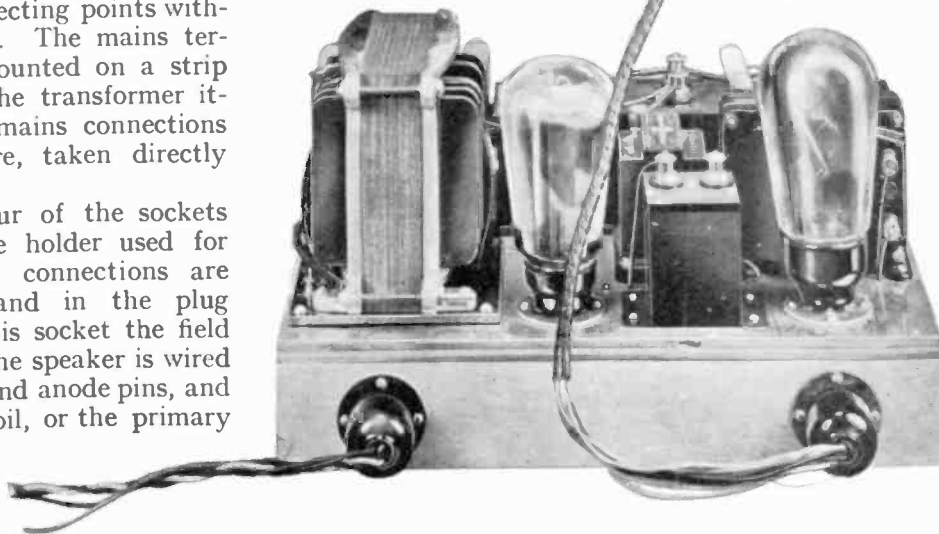
The mains transformer is fitted with coloured leading-out wires instead of terminals for the various secondaries, and care should be taken to connect these up correctly in accordance with the colour code supplied with the transformer. The leads are of amply



The receiver and power unit connected by cable. A four-member connector is used for the field and speech coil leads.

sufficient length to reach to the various connecting points without difficulty. The mains terminals are mounted on a strip carried by the transformer itself, and the mains connections are, therefore, taken directly from them.

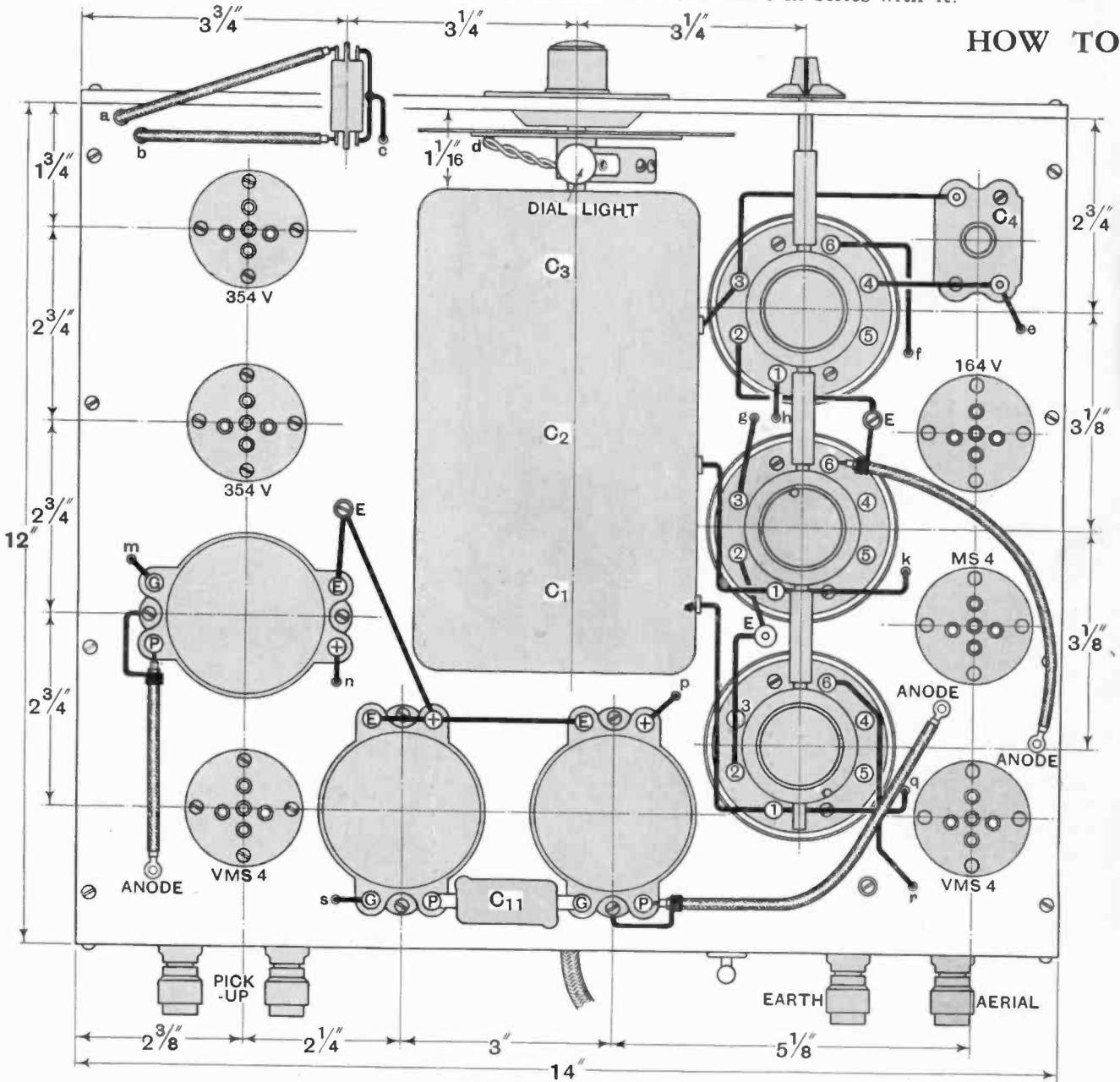
Only four of the sockets of the valve holder used for the speaker connections are employed, and in the plug which fits this socket the field winding of the speaker is wired to the grid and anode pins, and the speech coil, or the primary



of the output transformer if this be used, to the two filament pins. In cases where the speaker does not require field current from the set the plug connections should still be retained, but the wiring to the grid and anode sockets omitted. Additional smoothing will be necessary, and a choke having similar characteristics to a speaker field should be wired between the high potential terminals of condensers C_{20} and C_{22} . This choke

HOW TO BUILD THE MONODIAL A.C. SUPER.

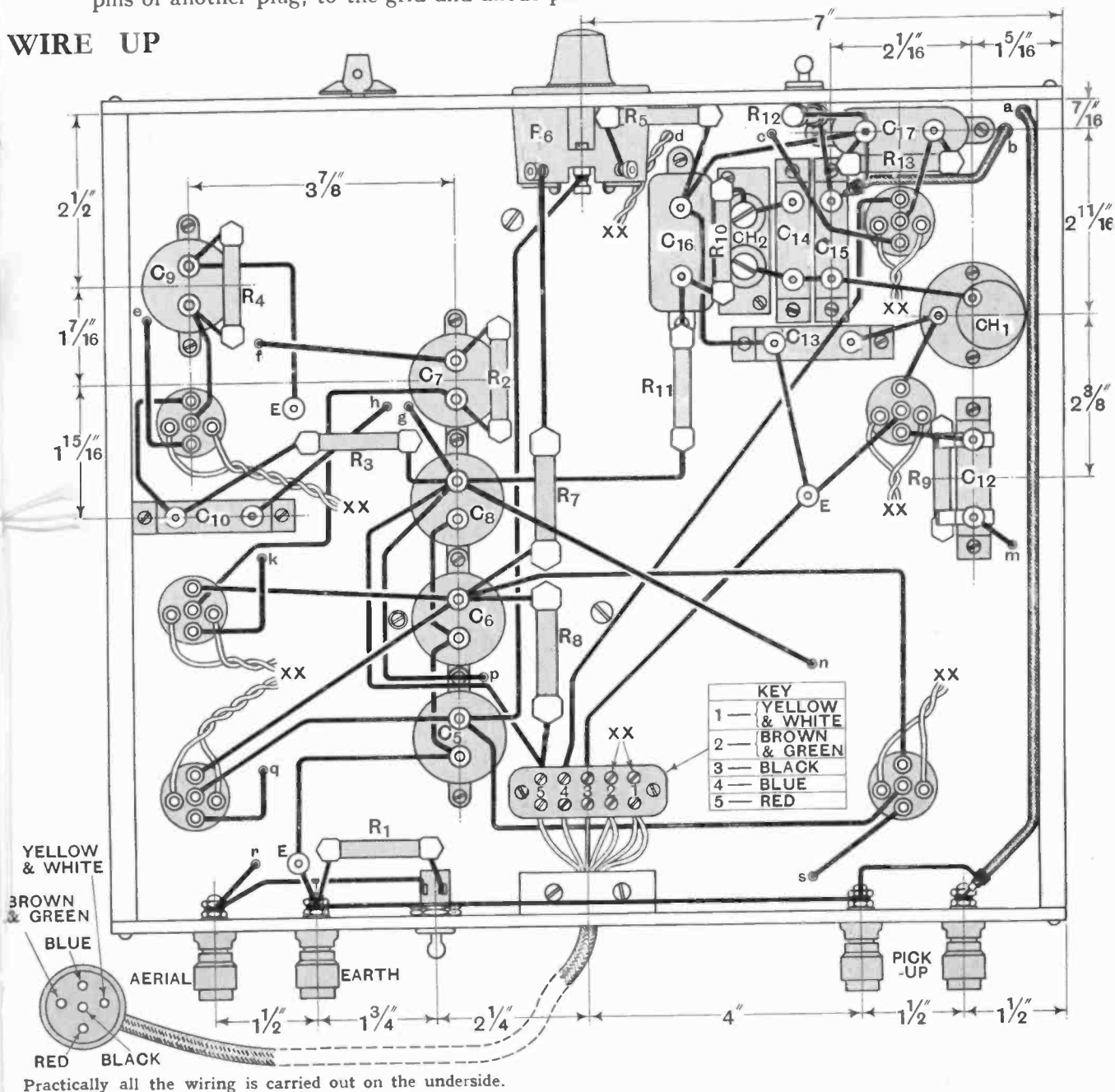
should have an inductance of some 60H. when carrying 50 mA., and a D.C. resistance of 2,500 ohms, and it is recommended that the special component described in *The Wireless World* for September 9, 1932, be used. Alternatively, it is possible to employ a choke of lower resistance, provided that the total resistance is made up to the correct value by the connection of a suitable fixed resistance in series with it.



Dimensional data of the components above and beneath the baseboard.

If it be desired at times to use an energised type of moving-coil speaker and at others to use a non-energised type, then the power-unit connections should all be made exactly to specification. The energised speaker should be connected in the normal way to its plug-connector, but the non-energised speaker should be wired to the filament pins of another plug, to the grid and anode pins of which are connected a choke of the

WIRE UP



type just described. In this way the alterations required to the smoothing system for the different types of speakers will automatically be made on inserting the plugs.

Throughout the apparatus, all nuts should be well tightened up so that secure connections are made, but care should be taken, in the case of the valve holders, not to apply too much force, or wires may be cut through. The coil and condenser covers should fit tightly, and screened leads should not be allowed to rub against metalwork, for, even if both be earthed, an intermittent contact may cause noisy reception.

The wiring should be carefully checked over before putting the set into operation, and it is a wise plan to check the continuity of the various circuits with the aid of a voltmeter and battery, for it is easy to overlook one of the many earth connections. It is a safe plan, also, to test the various components before building the set, as it eliminates one possibility of trouble. Coils should be tested for continuity, and condensers to make sure that there is no internal short-circuit.

If desired, a switch of the quick-make-and-break type can be joined in series with one of the mains leads, and mounted on the power unit. The position of such a switch

TABLE OF VALVE VOLTAGES

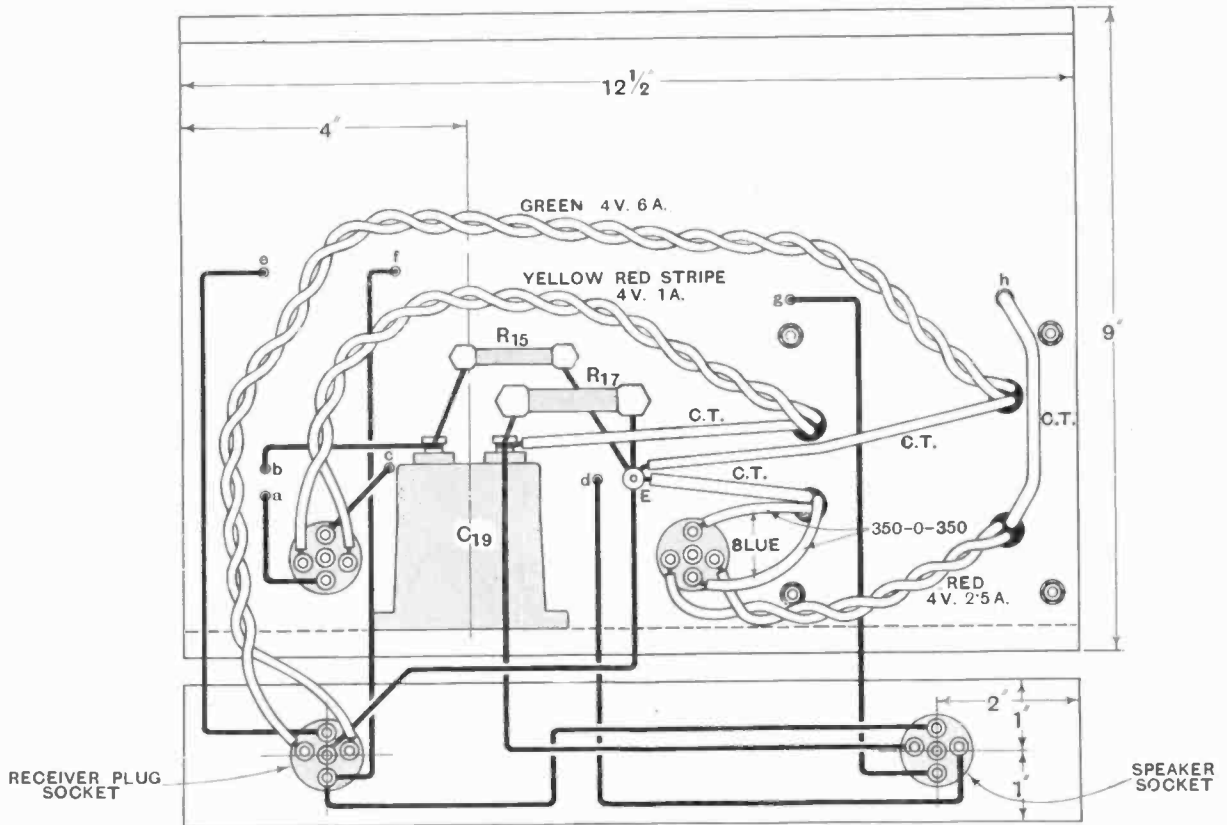
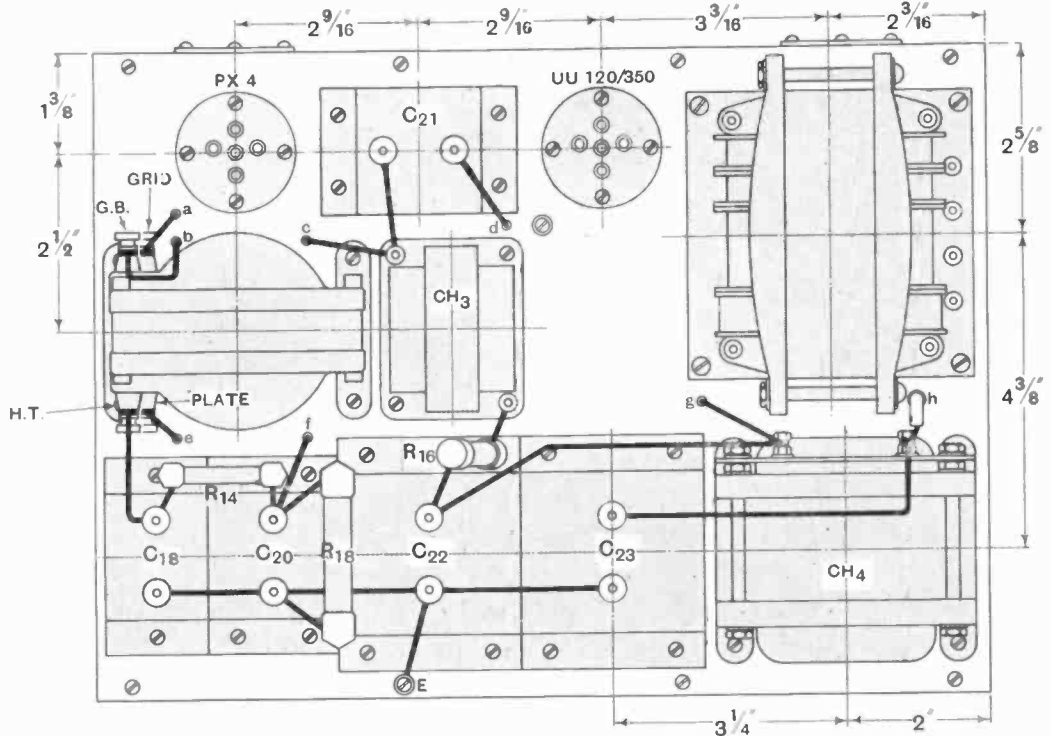
| | Volts anode | Volts screen | Volts bias | Current mA. |
|--|----------------|-----------------|---------------|----------------|
| H.F. ; V.M.S.4 | 200 | 84 | - 2.6 | 8.4 |
| 1st detector ; M.S.4 | 200 | 80 | - 6 | 0.7 |
| I.F. ; V.M.S.4 | 200 | 84 | - 2.6 | 8.4 |
| Oscillator ; 164V. | 76 | — | - 3.8 | 4.8 |
| 2nd detector ; 354V. | 96 | — | — | 5.2 |
| Tone Corrector ; 354V. | 164 | — | - 3 | 3.7 |
| Output ; P.X.4 | 240 | — | - 35 | 50 |
| Across C20 | 200 | — | — | — |
| Across C22 | 340 | — | — | — |
| Across C23 | 357 | — | — | — |
| Volume control at maximum for all the foregoing. | | | | |
| Speaker Field Current. | | | | |
| Volume control at maximum | .. | .. | .. | 54 |
| Volume control at minimum | .. | .. | .. | 42 |

is in no way critical, but on no account should the mains leads be allowed to wander near the output valve or the L.F. transformer. When the receiver is first switched on hum will be found, and will persist for, say, thirty seconds, after which it will gradually die away as the early valves warm up.

The set may not function for half a minute or so after the hum has disappeared, for the oscillator valve takes the longest to warm up, and until it is working nothing at all will be receivable. Apart from its circuit constants, the exact frequency generated by the oscillator depends to some extent upon its anode voltage and heater temperature. As completely stable conditions are not reached for some time after the set is switched on, the oscillator frequency may wander slightly during the first quarter of an hour or so. Any station which is tuned in during this time, therefore, may require slight re-tuning when conditions have become completely stable, but thereafter stability should be maintained indefinitely.

Although results should be obtainable as soon as the construction has been completed, correct functioning cannot, of course, be expected until the various preliminary adjustments have been carried out. These adjustments are a matter of the first importance, for, if the receiver be correctly built, its success depends entirely upon the accuracy

HOW TO BUILD THE MONODIAL A.C. SUPER.



The power unit from above and below. It is important that the relative dispositions of the L.F. and mains transformers should be maintained.

with which they are carried out. It is necessary, therefore, to treat them at some length.

As explained above, completely stable conditions are not reached for a short time after the set is switched on, and some quarter of an hour should be allowed to elapse before starting the adjustments, and this interval may well be occupied by making a rough check on the operating voltages and currents. These should be measured with the volume control at maximum, with the wave-range switch set for the medium wave-band, and with the aerial disconnected so that no signal is audible.

The values obtained should agree fairly closely with the figures given in the table, but complete agreement cannot be expected, since individual valves and components vary somewhat, and the mains themselves may not have their rated voltage at the time of testing. Provided, therefore, that the various voltages and currents are of the same order as those obtained with the original receiver, it may safely be assumed that the mains equipment, feed-circuits, and valves are functioning, and the initial adjustments can be proceeded with.

These initial adjustments fall into three categories, and must be carried out in the order named: first, the tuning of the I.F. circuits; secondly, the ganging; and, lastly, the balancing of the selectivity and quality. The two earlier processes are carried out by tuning for the maximum signal strength, and, if care be taken, the ear is a sufficiently accurate indicator. If a milliammeter be available, however, the adjustments are made much easier by connecting it in the second detector anode circuit, and using the change of anode current with a signal as a precise indicator of signal strength. A convenient point at which to connect a meter, which should have a full scale reading of about 10 milliamperes, is in series with R_{11} shown in Fig. 1.

THE I.F. TUNING

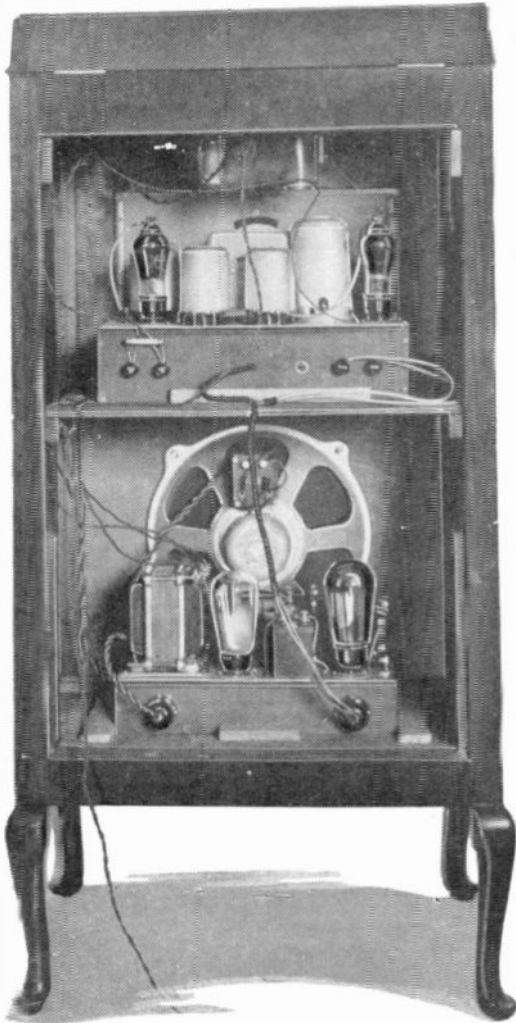
The coils in all three I.F. transformers should be set at nearly their maximum distance apart, and a station tuned in as accurately as possible. The strength of this station should be adjusted to a conveniently low level, at which changes of strength are readily detectable, by means of the volume control. Each of the six levers projecting from the bases of the I.F. transformers must then be adjusted in turn for the maximum response, and when this has been done it should be found that a movement of any lever in either direction results in a reduction of signal strength. If it be found that maximum strength occurs with any lever pushed over to the full extent of its travel, then the settings of all the other levers should be appropriately altered and the station retuned by the gang condenser. This changes the intermediate frequency slightly, and a re-adjustment of all the levers should now allow of the correct conditions being obtained. If this condition cannot be secured, the most probable cause is the use of a type of screened wire for the anode leads which has an excessively high capacity.

During this process it will probably be found necessary to lower the setting of the volume control as the circuits come into tune, so that the increased signal strength does not lead to overloading of the second detector. This point should be carefully watched, for it is hopeless to attempt to adjust the circuits on a signal so strong that the valves are overloaded.

When the I.F. tuning has been completed it should be found that, although the input circuits are not correctly ganged, a number of stations is receivable, and the setting of the tuning dial should be critical. A station on a low wavelength should be chosen so that the ganging adjustments can be carried out. This station should preferably tune in within the first ten degrees on the dial, and it should not be one greatly subject

to fading. If it be found, however, that the circuits are so badly out of tune that no very low wavelength station can be heard, a somewhat higher wavelength station, such as the London National, should be used to get the circuits approximately in tune.

Before tuning in this low wave station, the trimmer on the oscillator section of the gang condenser should have been slacked off by one or two turns, and the other two trimmers nearly fully unscrewed.



The disposition of the moving coil loud speaker and the two units connected by flexible cable can be seen when the back of the gramophone cabinet is removed.

THE GANGING

The station is tuned in as accurately as possible by the main tuning control, and the two trimmers on the first two sections of the gang condenser each adjusted for maximum response. The trimmer on the oscillator section should not be touched unless it be found that either of the other trimmers has reached the full extent of its capacity range. If, for instance, it be found that one of the pre-selector trimmers is fully unscrewed, then the oscillator trimmer should be screwed up slightly and the station retuned at a slightly lower setting of the main dial. By proceeding on these lines it will readily be possible to arrive at settings such that any further alteration to the pre-selector trimmers gives a reduction in signal strength.

The circuits are now accurately ganged at the high-frequency end of the tuning range, and it should be found that stations can be tuned-in over the whole of the medium waveband. Unless the stray circuit capacities have their correct relative values, however, the ganging may be slightly out at high dial readings, and so the next step is to correct for this. A station working with a frequency of about 550 to 600 kc. (550 to 500 metres) should be tuned-in, and the trimmer on the oscillator section of the gang condenser adjusted while rocking the tuning dial backwards and forwards over a few degrees until the optimum combination of settings be found. On no account should the pre-selector trimmers be adjusted at this wavelength.

When this adjustment is completed, a return should be made to the high-frequency (low-wavelength) station, and the pre-selector trimmers re-adjusted. This completes the medium waveband ganging, and the next step is to perform the same operation on the long waveband. This is considerably easier, since there is only one adjustment, and it is far less critical. Either Huizen or Radio-Paris should be tuned-in with the padding condenser C_4 set at about one-half its capacity. If any difficulty be experienced

in finding one of these stations, the tuning dial should be set for it in accordance with the list of dial settings given herewith, and the adjustment carried out by means of C_4 alone. When the station has been found, C_4 is adjusted while rocking the tuning dial backwards and forwards until the optimum combination of settings has been obtained.

This completes the ganging, and it should be found that stations are receivable, and tune-in very sharply, at all points over the dial, but both the sensitivity and the quality of reproduction will be below normal. Before proceeding to discuss the quality adjustments, however, it is as well to repeat that, while carrying out the ganging on the medium waveband, the pre-selector trimmers must be adjusted only at a low wavelength, and never at a high, and the oscillator trimmer only at a high, and while rocking the gang condenser. *On no account must any of the three trimmers on the gang condenser be adjusted on the long waveband, otherwise the medium wave ganging will be seriously wrong.*

The final points to receive attention are the coil positions of the I.F. transformers, and these should be adjusted for the best quality of reproduction. In general, the coils in the first transformer should be set with $29/32$ in. between the adjacent faces of the formers, and the coils in the third transformer with $1/4$ in. between adjacent faces. The second transformer coupling can then be regulated to suit the characteristics of the particular loud speaker which is being used.

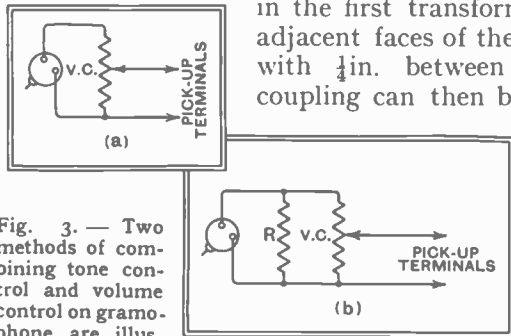


Fig. 3. — Two methods of combining tone control and volume control on gramophone are illustrated. At (a) the volume control is given such a resistance that the desired tone is obtained, while at (b) the volume control has a high resistance, and the correct tone is secured by adjusting the value of R.

With the particular speaker used during testing this distance was found to be $1/2$ in. When carrying out this adjustment care should be taken to select a station which is known to be transmitting with good quality, for certain foreign stations are sometimes defective in this respect.

A general test should now show that the sensitivity has increased considerably, and it should be possible to tune-in stations over the whole of the dial, with each trans-

mission quite separate and distinct from its neighbours in cases where their separation is not less than 9 kc. An efficient aerial and earth should be used in most cases, but where the set is to be worked at a very short distance from a powerful local station it may be found that better results are possible with a small aerial.

On test, the 120 stations given in the accompanying list were logged in a single evening, and while the Brookmans Park stations were working, the receiver being located some nine miles away. Prague and Breslau both suffered somewhat from second-channel interference due to the two London transmitters, which were also responsible for a considerable amount of interference on Graz, Leipzig, and Moravska-Ostrava. Mühlacker, which is spaced 11 kc. from the London Regional and is a stronger signal, could normally be received without serious interference. Any interference, of course, took the form of sideband heterodyning, and was at its worst during deep modulation of the London transmitter, being particularly bad during the reading of the News Bulletin.

On the remainder of the more powerful Continental stations no interference was experienced other than occasional chirps due to sideband heterodyning. Except where the transmission itself was distorted, the quality on all stations was equally good, and reached a standard which would satisfy the most critical. The sensitivity proved ample for the reception of the weakest stations, and at no time had the volume control to be set at maximum, even although the aerial was of only a moderately efficient type.

Of the 120 stations which can be received, some forty to fifty are at times available sufficiently free from interference for their programmes to be of entertainment value, and on any given night a choice of about twenty stations is obtainable. During the summer months, of course, atmospheric conditions make reception poorer, but a reasonable number of alternatives to the local should be available. Even when conditions are poor the receiver is sufficiently sensitive to bring in distant stations, and it is the background produced by atmospherics, rather than a lack of amplification, which is likely to prove the limiting factor. Background noises introduced by the set itself are at a minimum, and, in the case of the stronger stations, are inaudible.

Some general remarks on the receiver may be of interest. The quality of reproduction is very largely dependent upon the loud speaker employed, and as good a type as possible should be used. If advantage be taken of the provision for free field current, the speaker should be a model requiring some four to six watts for field excitation, since these figures represent the minimum and maximum powers obtainable at the minimum and maximum settings of the volume control. Unless it is already of the correct impedance, the speaker should be fitted with a transformer of such ratio that its average primary impedance is 4,000 ohms, but the output choke must be retained whether a transformer be used or not.

In perhaps the majority of cases the "local-distance" switch will prove an unnecessary refinement. Where the set is used close to a local station it may prove advantageous in avoiding distortion with that station. Furthermore, under such conditions it may be necessary to avoid cross-modulation when receiving stations within about 20 kc.

of the local. For general reception, however, it should be kept in the "distance" position. When tuning, the volume control should be kept at a low setting to avoid valve overloading. The circuit conditions are so adjusted that it is impossible greatly to overload the output valve, and if the volume control be turned up too far it will be found that the second detector overloads and reduces the output. As a result, greatly excessive volume when tuning through a strong station is avoided.

The dial settings given in the accompanying list of stations should be found fairly accurate, although one cannot expect that they will be reproduced exactly. They will, however, serve as a guide when first trying out the set, and if the actual dial settings for a few widely spaced stations are noted it should prove possible to obtain a reasonably accurate estimate of the settings for any particular receiver.



The layout is so arranged that there is easy access to the trimmers on the ganged condenser members. The oscillator trimmer is behind the valve in the foreground.

A modern radio set must do more than receive broadcasting, for it is usually desired to employ it in the electrical reproduction of gramophone records. The Monodial A.C. Super is readily adaptable for this purpose, and, indeed, provision is made for the connection of a gramophone pick-up. It is, therefore, an ideal receiver for building in radio-gramophone form, for it will give not merely high quality reproduction of the local station and gramophone records, but even in congested districts it will maintain that high quality on the most distant of foreign transmitters.

In order that full advantage may be taken of its inherent properties, it is naturally important that the various initial adjustments be correctly carried out. So far as the operation of the radio side is concerned these adjustments have already been fully described, and it only remains to offer some suggestions for the attainment of the best quality from records. That portion of the L.F. amplifier which is used for gramophone reproduction has a substantially flat frequency characteristic over the range of frequencies met with in gramophone work, and as a result the quality of reproduction is almost entirely dependent upon the loud speaker and the pick-up.

The loud speaker will often have a series of resonances at high frequencies, which gives the effect of an abnormally strong upper register, and on radio this deficiency is turned to advantage by using it to provide additional compensation for the sideband cutting of the tuned circuits. No such compensation is necessary on gramophone, however, for many pick-ups themselves give an increased response to the higher frequencies. In general, therefore, the reproduction of gramophone records sounds too high pitched, and in order to obtain the correct balance it is usually necessary to reduce the amplification of the higher notes.

ADJUSTING THE TONE

One of the simplest methods of achieving this result consists merely in shunting the pick-up by a small capacity fixed condenser. The correct capacity must always be found by trial, since it will depend not only upon the frequency response of both the pick-up and the loud speaker, but also upon the impedance of the former. In the case of some high impedance types of pick-up 0.0001 mfd. will prove sufficiently large to give the correct tone, whereas with others of lower impedance the capacity may have to be as large as 0.001 mfd. ; in general, about 0.0003 mfd. will best suit the average pick-up.

The maximum input required by the amplifier, however, is but 0.285 volts peak, while many good pick-ups are capable of delivering an output of about 1.5 volts. A considerable reduction in the output of the pick-up is necessary, therefore, to avoid overloading, and advantage may be taken of this fact by adopting a type of tone control which consists merely of a resistance shunt to the pick-up. This resistance shunt may be the normal volume control potentiometer, but with a lower total resistance than usual. With the circuit of Fig. 3a, for instance, the control could be given a value of 100,000 ohms, or even 50,000 ohms, instead of the more normal value of 250,000 ohms.

THE COMPENSATING RESISTANCE

In general, however, the exact resistance value required is unknown, and it is obviously inconvenient to try different values of volume control. It is suggested, therefore, that for preference the circuit of Fig. 3b be used. In this case, the volume control potentiometer VC should have a total resistance of not less than 250,000 ohms, and the resistance R be given a value to be determined experimentally for the best quality.

If desired, this resistance may also be made variable, in which case it should have a maximum value of some 500,000 ohms in order to give a sufficient range of control. The optimum value for R will vary in different circumstances, but will be most often in the neighbourhood of 100,000 ohms.

PICK-UP INTERFERENCE

Although not exactly a matter connected with the quality of reproduction, a point which is worthy of mention is the possibility of hum. The set itself should give no audible hum whatever, but it is often found that on gramophone a high-pitched hum makes itself evident. This type of hum is always due to induction in the pick-up leads, and once heard is readily recognisable. It may be cured by seeing that the leads to the pick-up are as short as possible, that they are run with earthed screened wire, and that the pick-up frame itself, if of metal, is earthed. The volume control, furthermore, is better fitted close to the receiver, or even within it, than near the pick-up.

Careful attention to details of this nature will enable the reproduction of gramophone records to be as hum free as radio reception, while the quality from the records can be made to approach that given by broadcasting. The quality from records can never quite equal that of broadcasting, of course, on account of the well-known deficiencies of the recording.

INCREASING POWER OUTPUT

The output of the standard power stage, some 2,500 milliwatts, is ample for all normal domestic purposes, but in cases where exceptionally large volume is desired the need may be felt for a larger outfit. An output stage, capable of delivering some 6 watts to the loud speaker, has been prepared, therefore, and is built as a unit with its own mains equipment, and it is recommended that it be employed by those who consider the output of the standard Monodial power unit insufficient for their purpose. Although this new power unit has been built primarily for use with another receiver, it has been designed specially with a view to its being employed with the Monodial receiver unit, and when it is so used no modification to either is necessary. This power unit was described in *The Wireless World* under the title of "The Modern Straight Five."¹

¹ See issues dated June 22 and June 29, 1932.

Blueprints of this set are also
available at 1/6d. post free.

CONDENSER DIAL READINGS FOR 120 STATIONS

| Kc/s. | Station. | Dial Reading. | Kc/s. | Station. | Dial Reading. |
|--|---|---------------|---------|---------------------------------|---------------|
| LONG WAVE BAND | | | | | |
| 155 | Kaunas | 90 | 860 | Barcelona | 41 |
| 160 | Huizen | 86 | 869 | Strasbourg | 40 |
| 167 | Lahti | 80 | 878 | Brno | 39 |
| 174 | Radio-Paris | 74 | 887 | Brussels, No. 2 | 38 |
| 183.5 | Koenigswusterhausen | 67 | 896 | Cadiz (or Poznan) | 37 (?) |
| 193 | Daventry National | 60.5 | 905 | Milan | 36.1 |
| 202.5 | Moscow | 56 | 914 | Poste Parisien | 35.3 |
| 207.5 | Eiffel Tower | 51.5 | 923 | Breslau | 34.5 |
| 212.5 | Warsaw | 48.6 | 932 | Göteborg | 33.5 |
| 222.5 | Motala | 45.5 | 941 | Naples | 32.5 |
| 230 | Moscow | 40 | 950 | Marseilles | 32 (?) |
| 238 | Baku | 36 | 959 | Genoa | 31 (?) |
| 260 | Kalundborg | 28.5 | 968 | Cardiff | 30.5 |
| 268.5 | Moscow | 26 | 977 | Zagreb | 29.5 (?) |
| 277 | Oslo | 23 | 986 | Bordeaux-Layfayette | 29 |
| 300 | Moscow | 20 | 995 | North National | 28 |
| 320 | Kharkov | 17 | 1,004 | Tallin | 27.2 |
| 353.4 | Rostov-Don | 12.5 | 1,013 | Hilversum | 26.6 |
| | | | 1,022 | Limoges (or Kosice) | 26 (?) |
| | | | 1,031 | Vupuri | 25 (?) |
| | | | 1,040 | Scottish National | and |
| | | | | British Relays | 24.4 |
| | | | 1,049 | Montpellier | 23.9 (?) |
| | | | 1,058 | German Relays | 23 |
| | | | 1,067 | Copenhagen | 22.5 |
| | | | 1,076 | Bratislava | 22 |
| | | | 1,085 | Heilsberg | 21 |
| | | | 1,096 | Turin | 20.3 |
| | | | 1,105 | Rennes | 19.9 |
| | | | 1,112 | Bremen | 19.2 |
| | | | 1,121 | Spanish Relays | 18.8 |
| | | | 1,128.5 | Lille | 18.4 (?) |
| | | | 1,137 | Moravska-Ostrava | 17.8 |
| | | | 1,147 | London National | 17 |
| | | | 1,157 | Frankfurt | 16.5 |
| | | | 1,167 | Hörby | 15.9 |
| | | | 1,176 | Toulouse | 15.4 |
| | | | 1,185 | Gleiwitz | 14.9 (?) |
| | | | 1,193 | Spanish Relay | 14.5 |
| | | | 1,211 | Trieste | 13.5 |
| | | | 1,220 | Common Wave | 13 |
| | | | 1,229 | Basle | 12.5 |
| | | | 1,238 | Belfast | 12 |
| | | | 1,345 | Fécamp, Radio-Normandie | 11.5 |
| | | | 1,256 | Nürnberg | 11.1 (?) |
| | | | 1,265 | Bordeaux, Sud-Ouest | 10.8 |
| | | | 1,274 | Kristiansand | 10.5 (?) |
| | | | 1,283 | Lodz | 10 (?) |
| | | | 1,292 | Kiel | 9.2 (?) |
| | | | 1,301 | Swedish Relay | 8 (?) |
| | | | 1,310 | Uddevalla | 7.9 (?) |
| | | | 1,337 | Cork | 7.5 (?) |
| | | | 1,365 | Beziers | 7 |
| | | | 1,373 | Salzburg | 6.8 |
| | | | 1,382 | Common Wave | 6.4 |
| | | | 1,391 | Common Wave | 6 |
| | | | 1,400 | Aberdeen and Warsaw | 5.6 (?) |
| | | | 1,460 | Ornskoldsvik | 3.5 (?) |
| | | | 1,470 | Gavle | 3 (?) |
| | | | 1,530 | Karlskrona | 1.5 (?) |
| MEDIUM WAVE BAND | | | | | |
| <i>A query against the dial reading indicates that a station was received but not definitely identified.</i> | | | | | |
| 530 | Hanover | 98 | | | |
| 533 | Wilno | 97 | | | |
| 536 | Common Wave | 94.6 (?) | | | |
| 545 | Buda-Pesth, No. 1 | 92.8 | | | |
| 554 | Sundsvall | 90 | | | |
| 563 | Munich | 88 | | | |
| 571 | Riga (or Palermo) | 86.2 | | | |
| 580 | Vienna | 84.4 | | | |
| 589 | Brussels, No. 1 | 82.4 | | | |
| 599 | Florence | 80.1 | | | |
| 614 | Prague, No. 1 | 77.5 | | | |
| 625 | North Regional | 75.1 | | | |
| 635 | Langenberg | 73.5 | | | |
| 644 | Lyons la Doua | 71.8 | | | |
| 653 | Schweizerischer Landes- sender | 70 | | | |
| 662 | Common Wave | 68.8 | | | |
| 671 | Paris, P.T.T. | 67 | | | |
| 680 | Rome | 65.5 | | | |
| 689 | Stockholm | 64 | | | |
| 698 | Belgrade | 62.8 | | | |
| 707 | Madrid | 61 | | | |
| 715 | Berlin | 59.9 | | | |
| 720.5 | Rabat | 58.8 | | | |
| 725 | Dublin | 58.1 | | | |
| 734 | Katowice | 57 | | | |
| 743 | Radio Suisse Romande (Sottens) | 55.9 | | | |
| 752 | Midland Regional | 54.5 | | | |
| 761 | Bucharest | 53 | | | |
| 770 | Leipzig | 52 | | | |
| 779 | Toulouse | 50.8 | | | |
| 788 | Lwow | 49.5 | | | |
| 797 | Scottish Regional | 48.5 | | | |
| 806 | Hamburg | 47.2 | | | |
| 810.5 | Radio L.L. | 46.4 | | | |
| 815 | Common Wave | 46.1 | | | |
| 824 | Bergen | 45.2 | | | |
| 825 | Algiers | 44.8 | | | |
| 832 | Mühlacker | 44 | | | |
| 843 | London Regional | 43 | | | |
| 852 | Graz | 42 | | | |

It may be found that a few of the stations of low power have undergone a slight change in wavelength since the above were logged. The latest details of transmissions and programmes of all the foreign stations appear every week in THE WIRELESS WORLD.

LIST OF PARTS

23

After the particular make of component used in the original model suitable alternative products are given in some instances.

RECEIVER

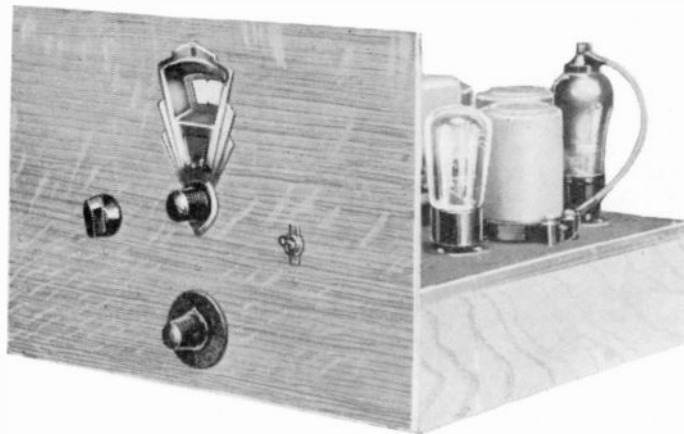
- 1 Fixed condenser, 2 mfd., 400 volt, D.C. test, C₁₆ (Dubilier type BB)
- 1 Fixed condenser, 1 mfd., 400 volt, D.C. test, C₁₇ (Dubilier type BB)
(Ferranti, Formo, Peak, T.C.C., Telsen).
- 5 Fixed condensers, 0.1 mfd., 500 volt, D.C. test, non-inductive, C₅, C₆, C₇, C₈, C₉ (Dubilier type 9200)
(T.C.C., Telsen).
- 2 Fixed condensers, 0.01 mfd., C₁₄, C₁₅ (Dubilier type 620)
- 1 Fixed condenser, 0.001 mfd., C₁₃ (Dubilier type 620)
- 1 Fixed condenser, 0.0001 mfd., C₁₂ (Dubilier type 620)
- 1 Fixed condenser, 0.0005 mfd., C₁₀ (Dubilier type 620)
(Ferranti, Hydra, Loewe, T.C.C., Telsen).
- 1 Fixed condenser, 0.0001 mfd., C₁₁ (Dubilier type 670)
(T.C.C.).
- 1 Potentiometer, 5,000 ohms wire-wound, R₆ (Watmel)
(Colvern, Claude Lyons, Rothermel).
- 1 Semi-fixed condenser, 0.0005 mfd./0.002 mfd., C₄ (R.I. Varicap)
- 1 5-way insulated connector (Wilburn)
- 1 Variable condenser, 0.0005 mfd., 3-gang, screened, superhet. type with trimmers
on right (British Radiophone)
- 1 Slow-motion dial, and dial lamp, for above (British Radiophone)
- 2 Metallised resistances, 100 ohms, 1 watt, R₁, R₅ (Dubilier)
- 3 Ditto, 1,000 ohms, 1 watt, R₄, R₁₀, R₁₃ (Dubilier)
- 1 Ditto, 6,000 ohms, 1 watt, R₂ (Dubilier)
- 1 Ditto, 25,000 ohms, 1 watt, R₁₁ (Dubilier)
- 1 Ditto, 30,000 ohms, 1 watt, R₃ (Dubilier)
- 2 Ditto, 250,000 ohms, 1 watt, R₉, R₁₂ (Dubilier)
- 1 Ditto, 7,500 ohms, 2 watts, R₇ (Dubilier)
- 1 Ditto, 10,000 ohms, 2 watts, R₈ (Dubilier)
(Colvern Strip Type, Claude Lyons)
- 3 I.F. transformers, 110 kc. (Colvern Colverdynes)
- 6 Valveholders, 5-pin (Clix chassis mounting type)
- 1 H.F. choke, Ch₁ (Wearite type HFO)
- 1 H.F. choke, Ch₂ (McMichael Binocular Junior)
- 1 Battery cable, 7-way (Harbros)
- 1 Set of B.P. canned coils (Belling-Lee). (Varley Square Peak BP19)
- 4 Ebonite shrouded terminals (Belling-Lee type B)
(Burton, Clix, Eelex, Igranic, Swain).
- 1 Change-over switch (Claude Lyons B.A.T. 729)
- 1 Switch (Claude Lyons B.A.T. 728)
- Metal Screened Sleaving (Goldtone)
(Lewcos, Harbros).
- 1 Venesta board, aluminium-faced, 12 in. × 14 in. × $\frac{3}{8}$ in. (Peto-Scott)
- 1 Panel, oak-faced ply, 14 in. × 9 $\frac{1}{2}$ in. (Peto-Scott)
- Plywood, $\frac{3}{8}$ in., screws, wires, systoflex, etc., etc.

POWER UNIT

- 4 Valve-holders, 5-pin (Clix chassis mounting type)
- 1 Fixed condenser, 2 mfd., 1,000 volt, D.C. test, C₂₁ (Dubilier type LSA)
- 1 Fixed condenser, 2 mfd., 800 volt, D.C. test, C₂₀ (Dubilier type LSB)
- 2 Fixed condensers, 4 mfd., 1,000 volt, D.C. test, C₂₂, C₂₃ (Dubilier type LSA)
- 1 Fixed condenser, 2 mfd., 500 volt, D.C. test, C₁₈ (Dubilier type BC)

LIST OF PARTS (Power Unit)—*continued.*

- 1 Fixed condenser, 1 mfd., 400 volt, D.C. test, C₁₀ (Dubilier type BB)
 1 L.F. choke, 10H., Ch₄ (Ferranti B2). (Sound Sales)
- 1 L.F. choke, 30/20H., Ch₃ (R.I. Hypercore)
- 1 Mains transformer, 200/240 volts, 40/100 cycles, 350-0-350 volts, 100 mA., 4 volts, 6 amps., C.T., 4 volts, 2½ amps. C.T., 4 volts, 1 amp. C.T., with screened primary (Challis)
- 2 Plugs, 5-pin (Bulgin)
- 1 L.F. transformer (Ferranti AF5)
- 1 Metallised resistance, 10,000 ohms, 1 watt, R₁₄ (Dubilier)
- 1 Ditto, 50,000 ohms, 1 watt, R₁₅ (Dubilier)
- 1 Ditto, 700 ohms, 2 watts, R₁₇ (Dubilier)
- 1 Ditto, 1,000 ohms, 2 watts, R₁₆ (Dubilier)
- 1 Ditto, 25,000 ohms, 3 watts, R₁₈ (Dubilier)
 (Colvern strip type, Claude Lyons).
- 1 Venesta board, aluminium-faced, 9 in. × 12½ in. × ¾ in. (Peto-Scott)
 Plywood ¾ in., screws, wire, systoflex, etc., etc.
- Valves : 2 Marconi or Osram V.M.S.4, 1 Marconi or Osram M.S.4, 1 Mullard 164v or Marconi or Osram M.H.L.4, 2 Mullard 354v or Marconi or Osram M.H.4 or Mazda AC/HL, 1 Osram or Marconi P.X.4, 1 Mazda U.U.120/350
- If an energised speaker is not used, an additional choke will be needed as explained in the text. A suitable component is the Sound Sales Speaker Field Replacement Choke.



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