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SHORT WAVE RECEIVER
TYPE R.C.25

The following article describes a commercial form of Short Wave Receiver Type R.C.25, developed by the Marconi Company for use either on the Beam circuits or on Short Wave Telegraph Services using non-beam type aerials.

PRACTICALLY the first short wave receiver used at Brentwood in February, 1926, on the "via Marconi" services consisted of four stages of high frequency amplification; owing to the use of three electrode valves, great precautions in the way of screening and neutrodyning were required, the valves were decapped and were used in push-pull, but despite this, the receiver was difficult to handle and the use of H.F. amplification in commercial receivers seemed to have fallen into disrepute.

The introduction of the screened grid valve gave hope of reviving the use of H.F. amplification provided it could be shown to be advantageous and this was one reason for the design of the R.C.25 Receiver.

Certain difficulties in the operation of a multi-way short wave receiving station were becoming apparent.

There was the question of the short wave heterodyne getting back on to the aerials. The use of reaction was essential when receiving weak signals and it was also used to sharpen up the selectivity in cases of jamming from stations on the other side of the heterodyne, but its use was limited by varying frequency of the transmitter, the presence of heavy atmospherics and the use of two receivers on one feeder precluding its use altogether.

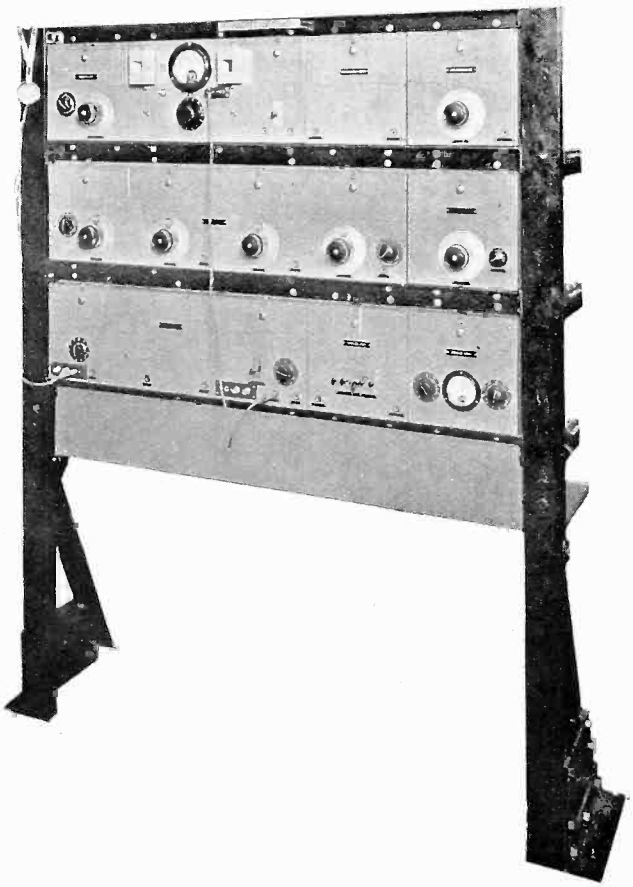
With the increasing crowding of the short wave band, jamming from strong stations the other side of the first heterodyne was becoming serious, and of course one had no redress against such a station.

Here then, the use of H.F. amplification and consequent selectivity offered advantages if it could be done.

Another consideration was the production of a cheaper form of receiver suitable for telegraph circuits of secondary importance using non-beam type aerials.

When it is considered that even on secondary circuits recording of the signal is necessary, such a disposition seems paradoxical and it was rather by improving the efficiency per stage than by lowering the effective results that any cheapening could be obtained.

While some non-Beam type aerials still had concentric tube feeders, another common feeder was of the open 2-wire type, and provision had to be made to correctly terminate either type.



Front View, Receiver Type R.C.25.

The design of suitable coils or transformers for amplification at frequencies in the short wave band presented some difficulty ; to cover the whole wave band from 14 to 100 metres necessitated plug-in coils, and the risk of limiting on heavy signals or static ruled out capacity-resistance coupling, so that plug-in transformers were required. This in turn meant the use of solid formers because self-supporting

transformers were not feasible. In a transformer of this type the loss of magnification of the coil is largely accounted for by the capacity between the primary and secondary and to keep this down the primary must be wound with fine wire. The construction adopted differed very little from that used in the H.F. receiver referred to at the beginning of this article. The formers are 3 in. ebonite tube, the primary winding of No. 40 D.S.C. copper wire is wound in the bottom of " V " slots, and the secondaries of No. 14 bare copper are wound on the top of the slots.

Back View, Receiver Type R.C.25.

For the sake of cheapness it was decided to mount the receiver in tinned plate boxes, and this led to the adoption of astatically wound coils, there being a gain in magnification despite the extra number of turns required.

The receiver itself is a double heterodyne receiver, with amplification at three different frequencies including the fundamental, a high frequency amplifier, an intermediate frequency amplifier and a low frequency band filter amplifier, together with suitable aerial terminating and signal recording equipment.

Screened grid valves, with high amplification factor, are used for the H.F. and intermediate magnifying stages, and thus sufficient amplification is obtained without the complication of neutrodyning or balancing to prevent feed-back effects.

For modern commercial working, a band filter width of 2,500 cycles gives the best compromise between selectivity and necessary latitude to cover varying frequency of short wave transmitters, and to allow the optimum reception of I.C.W. transmission (*cf.* Wells, THE MARCONI REVIEW, No. 22). Such a band width is obtainable with simple circuits at a frequency of about 20,000 cycles and the signal is therefore, heterodyned to this frequency.

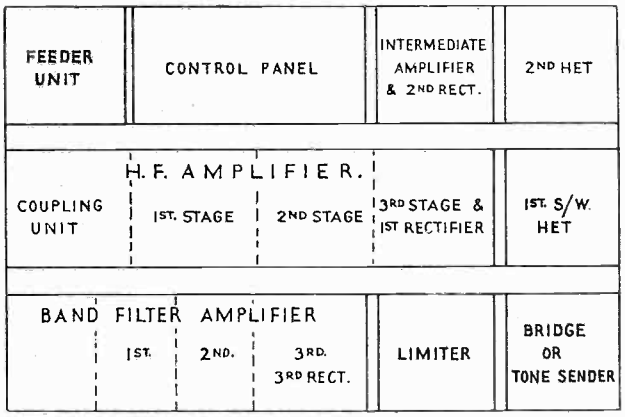


FIG. 1.

Unless, however, the circuits preceding this filter have a selectivity narrower than 40,000 cycles, twice the beat frequency, serious interference occurs from stations the same number of cycles away, on the other side of the heterodyne, as the wanted station. Such selectivity is not obtainable on short wavelengths without using such low-damped circuits that stability and the possible speed of signalling are sacrificed.

Consequently, resort has to be made to an additional heterodyne of frequency comparable to the selectivity obtainable. At 15 metres this is about 150,000 cycles in the high frequency amplifier and by heterodyning to an intermediate frequency of this value (2,000 metres) interference from the other side of the heterodyne is effectively eliminated.

The amplification obtained in the H.F. and band filter amplifiers is sufficient for all wavelengths down to about 20 metres ; below this, that of the H.F. amplifier falls off (it is between 2.5 and 3 voltage magnification per stage at 15 metres) and an additional stage of amplification at the intermediate frequency is then useful. By

using a screened grid valve in this stage also the magnification of the single stage is about 35 to 40 with perfect stability.

Construction.

The receiver is made up in unit form and each distinct unit is contained in a metal box. A lay out of the receiver is shown in Fig. 1.

These boxes are mounted in a rack in such a way that any unit is easily removable separately without disconnecting any others; also, the arrangement allows of the rack being extended in either direction for the fitting of more than one receiver and the layout of any one receiver is flexible to suit varying requirements of space; for instance, the receiver can be arranged in one, two, three or four rows merely by use of a suitable iron rack and with no alterations to the unit boxes.

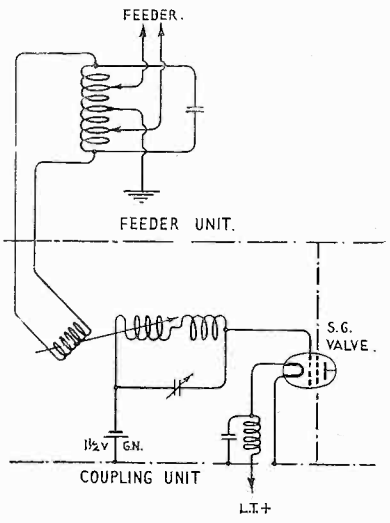


FIG. 2.

The boxes have hinged doors on the front face for easy inspection of valves and, where necessary, changing coils; the backs of the boxes are removable without interfering in any way with either the internal or external wiring or controls and this makes the examination of the whole of the equipment and wiring a very simple matter.

The buss-bars are run on the under side of the boxes and, by a simple fitting, any box can be disconnected and removed from the rack without disturbing the remainder.

Description of Units.

There are nine units as follows :—

Feeder Terminating and Tuning Unit.
High Frequency Amplifier.
First (Short Wave) Heterodyne.
Intermediate Amplifier.
Second Heterodyne.
Low Frequency (20,000 cycles) Band Filter Amplifier.
Limiter.
Bridge.
Control Panel.

Feeder Terminating and Tuning Unit.—This unit is shown in Fig. 2 and contains an astatic inductance, tuned by a variable condenser, on which two tapping points are provided. The inductance is turned by a control and the tapping points move symmetrically over the two halves of the astatic coil, the centre of which can be earthed. This allows the correct termination of either a 2-wire or a Marconi-Franklin concentric tube feeder.

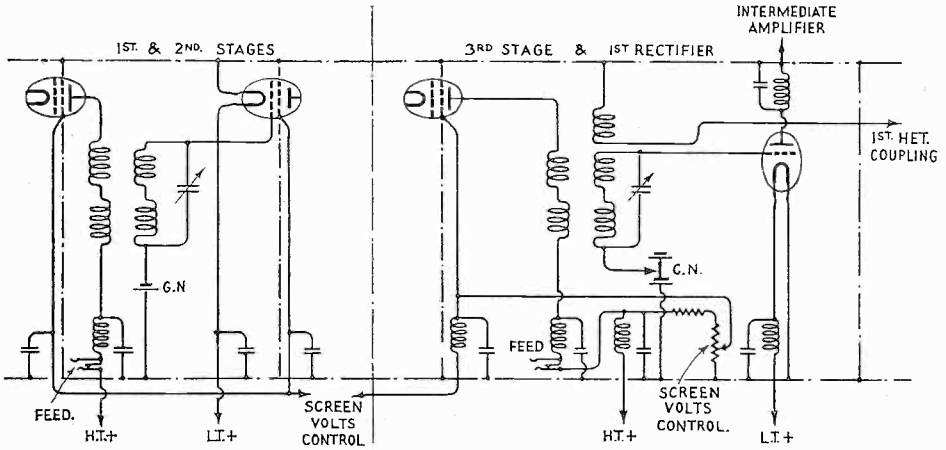


FIG. 2.

The coupling coil leads are connected across the tuned circuit and are taken out through a screening tube.

H.F. Amplifier (Fig. 3).—Consists of four screened sections :—

1. Coupling Unit.—Plug-in coupling coil variably coupled to a plug-in astatic grid coil tuned by a variable condenser ; 1½ volt grid negative battery for first H.F. valve ; H.F. choke and by-pass condenser being fitted in the L.T. positive lead which passes through the screening as pick-up on this lead would be magnified by the whole H.F. amplifier.

2 and 3. Plug-in Astatic H.F. Transformer coupling the H.F. Valves, the Secondary tuned by a Variable Condenser. The primary winding is of thin wire wound in slots beneath the secondary which is of thick bare copper wire. By-pass condensers are fitted on the H.T. and screen volts leads passing through the screening to the buss-bars.

4. Tuned H.F. Transformer, as above, across which is connected the first Rectifier Valve an H.L.610. Coupling coil from first heterodyne, fixed coupled to the H.F. transformer ; rectifier grid

negative battery; potentiometer for adjusting the screen volts on the 3 H.F. and 1 H.F. amplifier valves, approximately calibrated 0 to 90 volts. H.F. chokes and by-pass condensers in all leads passing through the screening are essential to ensure stability of the H.F. amplifier.

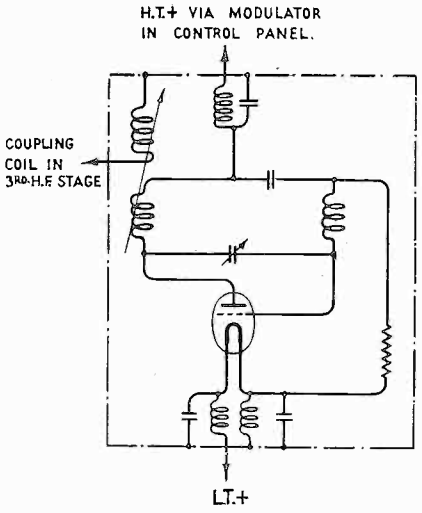


FIG. 4.

The screened grid valves, Type S.625, are carried in tubes in the screening partitions.

The voltage magnification per stage of the amplifier is about 12 to 14 at 34 meters and 2·5 to 3 at 15 meters.

The ranges of the two sets of coils which cover the normal commercial wave band are 14 to 35 meters and 21 to 52 meters. A third set is required to extend the range to 100 meters.

First (Short Wave) Heterodyne (Fig. 4).—Is a short wave oscillator with a D.E.5 valve and has been found to be very stable and free from dead spots over a wide wavelength range with given coils; only one set of coils is needed to cover the 14 to 52 meters band and a second set extends the range to 100 meters.

Only one coupling coil is required and, although the coupling is variable, is rarely adjusted in practice except when changing H.F. transformers and no adjusting means is brought through the screening.

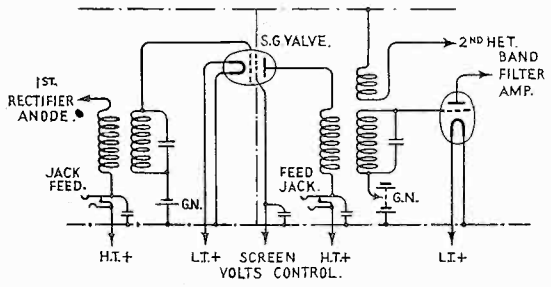


FIG. 5.

H.F. chokes and by-pass condensers are fitted in all leads passing outside the screening.

The vernier control on the main tuning condenser is sufficiently fine for ordinary purposes but a very fine adjustment is provided by a small earthed vane rotatable into the field of the grid coil.

The H.T. feed for the oscillator is taken direct from the control unit where it can be modulated by a note oscillator.

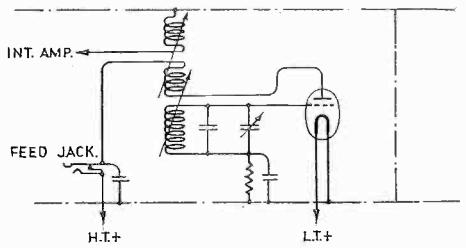


FIG. 6.

Intermediate Amplifier (Fig. 5).—Has two screened compartments.

1. A transformer, the primary being joined via a screening tube, in the anode of the first rectifier and the secondary, tuned by a small variable condenser to about 2,300 metres, is across the grid filament of a screened grid valve mounted in a tube in the partition ; 1½ volt grid negative battery.

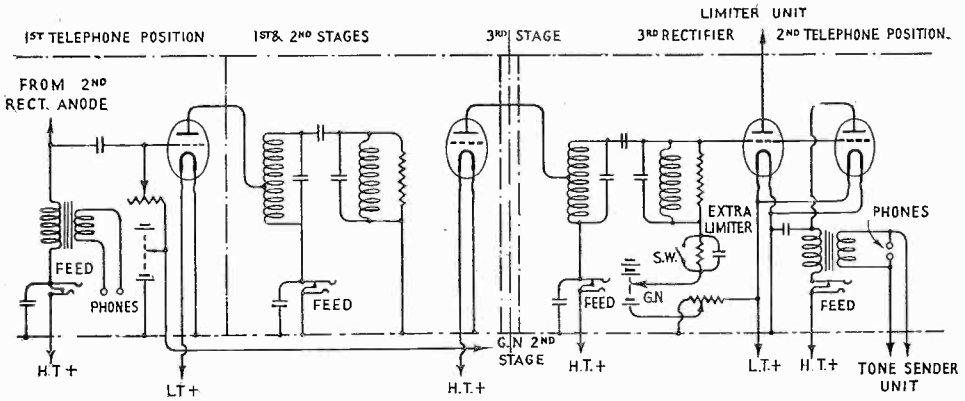


FIG. 7.

2. A transformer coupling the screened grid valve to the grid of the second rectifier, a H.L.610, the secondary also tuned by a small variable condenser ; a fixed coupling coil from the second heterodyne is wound on the same former as the transformer ; rectifier grid negative battery.

The tuned circuits are normally fixed at about 2,300 metres but some latitude is allowed by the small variable condensers so that the intermediate frequencies of receivers in the same station may differ slightly or may be altered to avoid interference with 2,300 metre receivers operating in the same station. The controls of these condensers are not normally required and are not, therefore, brought out on the front of the unit.

Second Heterodyne (Fig. 6).—Comprises a H.L.610 valve, a 3-coil holder with standard plug-in coils. Grid, 250 turns tuned by a fixed condenser of ·0003 mfd. in parallel with a variable condenser of ·0002 max. ; anode, 75 turns and coupling, 25 turns the latter being joined in series with the fixed coupling coil in the intermediate amplifier.

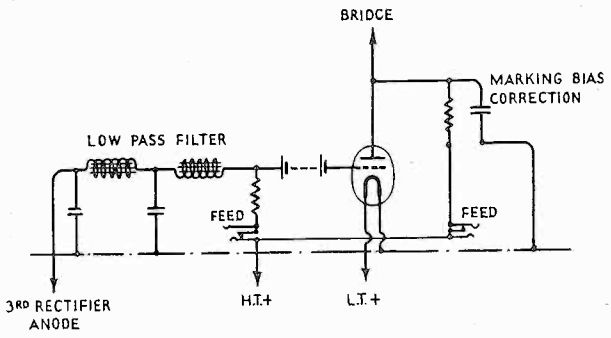


FIG. 8.

The anode and coupling coils rarely require adjustment, so their controls are not brought out on the front of the unit.

The variable condenser has two positions indicated on its dial : (1) for tuning to an audio beat note when using the first telephone position and searching on the H.F. amplifier and (2) for tuning to a beat frequency suitable for normal operation through the band filter. These positions can be varied to suit changes that may be required in the tuning of the intermediate amplifier.

Band Filter Amplifier (Fig. 7).—Contains four screened sections :—

1. First telephone transformer, coupling condenser and grid control resistance ; the second rectifier (in previous unit) is choke condenser coupled to the grid of the first screened grid valve in this unit and the telephone transformer primary acts as the choke; 9 volt grid negative battery.

2 and 3. Two fixed inductances tuned to 20,000 cycles by fixed condensers, the two tuned circuits being coupled together by fixed condensers and forming a band filter. The anode resistance of the valve is across part of the input and a fixed resistance of 100,000 ohms is across the output to which is connected the grid of the succeeding valve. By-pass condensers are fitted on the H.T. and grid negative leads.

4. A third band filter circuit as in 2 and 3, across the output of which are connected two rectifiers, H.L.610. The anode of one rectifier (the third rectifier of the set) is joined to the limiter unit ; the other rectifier has the second telephone transformer in its anode circuit At this telephone position only modulation of the signal, either inherent or introduced with the first heterodyne, can be heard. Potentiometer for controlling the grid negative volts of the third rectifying valves in this unit ; rectifiers grid negative battery ; extra limiter and switch.

The extra limiter which can be inserted by a switch consists of a 2 mfds. condenser shunted by a 30,000 ohms resistance joined in the grid negative lead of the rectifiers. It is useful under certain conditions of jamming and echo where the ratio of wanted to unwanted signal is small. It automatically adjusts the negative on the rectifier grids so that only the stronger of the two signals operates the bridge ; the condenser discharging, holds the rectifiers negative during a space and in the ordinary way its value is suitable for hand-speed signalling though this depends of course on the ratio on the two signals.

The extra limiter cannot be used during periods of deep sudden fades as it causes drop-outs which would not otherwise occur.

Limiter (Fig. 8).—Contains :—

The anode circuit of the third rectifier consisting of the anode resistance and a low-pass filter for removing modulation from the D.C. signal. The modulation is (A) the band filter frequency of 20,000 cycles ; (B) and modulation present in the original transmission and (C) that introduced by the note oscillator into the first heterodyne.

The grid of the limiter is coupled to the third rectifier anode by a grid battery of 120 volts.

A normal signal is that which just cuts off the limiter anode current by throwing its grid negative ; any further signal increase has no effect on this condition and, provided the time constant of the limiter grid circuit, including the anode circuit of the rectifier, is negligibly small compared with the period of signalling frequency, the grid of the limiter returns instantaneously to zero potential on the cessation of the signal ; hence there is no effect on the signalling bias.

Marking bias correction is applied in the anode circuit of the limiter ; it consists of 5 condensers, ·001, ·002, ·004, ·008, and ·016 mfd., which can be switched across the 0·5 megohm anode resistance.

Marking bias is a propagation effect, independent of the transmitter, the bias of which is assumed correct, or the receiver, in which a spurious component of the

signal tends to fill in the spaces between signals. Provided that at any speed, at least some space is left between signals it can be increased sufficiently to give good legible signals.

On reception of a signal the limiter cuts off, but the condenser, charging through the 0·5 megohm resistance, slows down the rise of volts on the anode. On cessation of the signal the D.C. resistance of the anode of the limiter drops to a value negligibly small compared with 0·5 megohm, the condenser discharges rapidly and the voltage on the anode drops practically instantaneously.

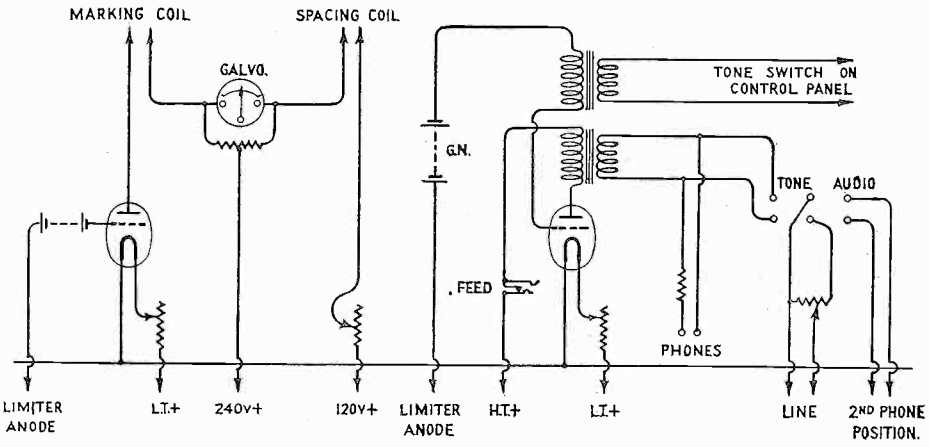


FIG. 9.

In the signal passed on to the bridge, therefore, the front of every mark is clipped while the end is unaffected resulting in a reduction of marking bias. Any value of condenser from 0 to ·031 mfd. can be obtained in steps of ·001 mfd.

This corrector is also quite useful in cleaning up clicks when atmospheric conditions are bad. If the signal is itself unbiassed the resulting spacing bias is unimportant compared with the advantage of reducing the clicks.

Bridge (Fig. 9).—This unit is supplied in two forms :—

1. For operating a relay or recorder.
2. For sending out a tone signal over a telephone line.

In (1) the grid of a marking valve, L.S.5 or P.625, with one coil of the relay or recorder in its anode circuit, is coupled by a 120 volt grid battery to the anode of the limiter valve, a steady current through the other coil provides the spacing effect when the marking valve is cut off, it is adjustable by a resistance and a centre zero galvanometer indicates balance.

An H.T. voltage of 240 is required for this bridge unit only when using L.S.5 valve ; for medium speeds, however, satisfactory operation of the relay can be obtained with only 120 volts when using P.625 valve.

In (2) the grid of the line valve is joined through the secondary of a transformer and a 120 volt grid battery to the anode of the limiter valve. The primary of this transformer is joined through a switch to the tone oscillator in the control panel. An output transformer in the anode circuit of the line valve connects via a volume control potentiometer to the telephone line ; a telephone position is provided across the output of this transformer.

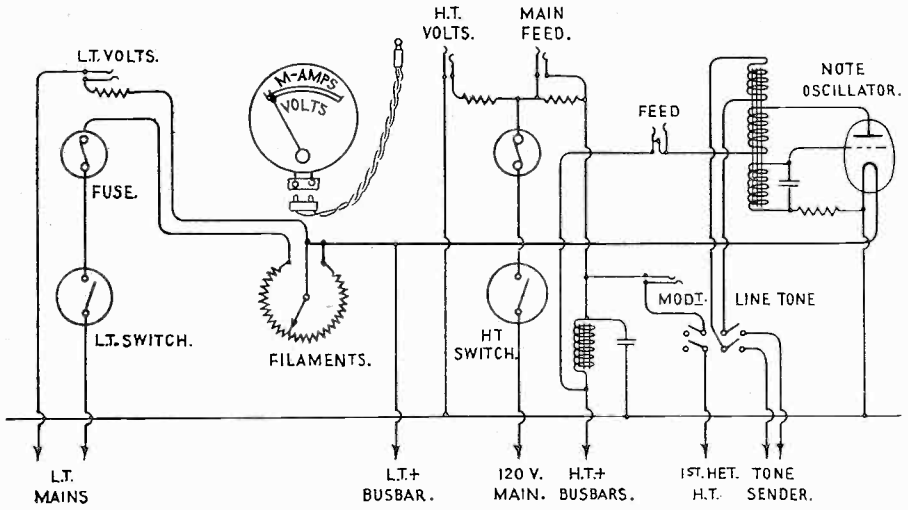


FIG. 10.

A switch enables either this output or that from the second telephone position (band filter amplifier—4) to be joined to line. The latter is used when, due to fading or conditions, there is insufficient signal to operate the bridge satisfactorily.

120 volts H.T. is used on the valve.

Control Panel (Fig. 10).—Contains :—

Note oscillator.
H.T. and L.T. switches and fuses.
Filament resistance.
Main feed choke and condenser.
Meter, resistors and shunt.

By plugging the meter into appropriate jacks, the H.T. volts, filament volts and the main feed can be read on their corresponding scales. Jacks are also provided

on all units into which the meter can be plugged to read the individual feed of all valves in the set except the marking valve in bridge (1) which has its own meter.

The note oscillator is of fixed frequency ; by means of a switch the output can be arranged to modulate the first (short wave) heterodyne or to supply a tone to the bridge (2) or both simultaneously.

General.

Control of amplification of the receiver is affected by (1) screen volts on the H.F. and I.F. amplifiers ; (2) grid control resistance on the first valve of the band filter.

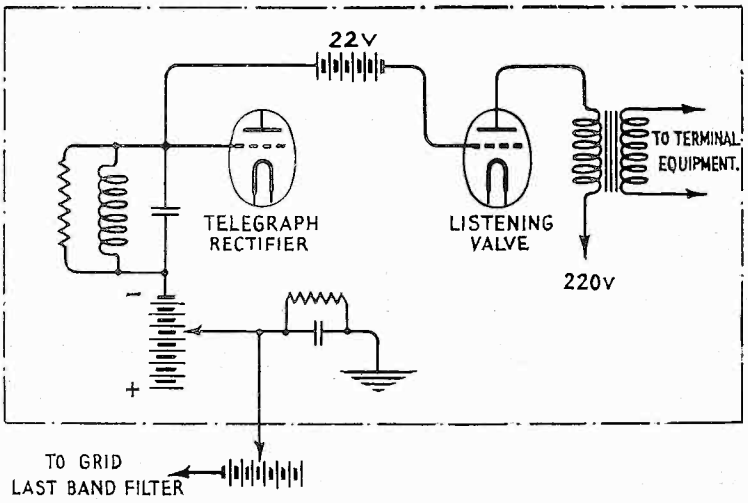


FIG. 11.

In special cases, where the maximum efficiency, normal to commercial receivers, is not required, simplified receivers can be made up of standard units. For instance, highly effective aural reception, using an ordinary aerial wire without feeder can be obtained while dispensing with the following units :—Feeder, intermediate, amplifier, second heterodyne, limiter and bridge, *i.e.*, 25 per cent. of the box capacity of the full receiver.

Telephony.

Although the frequency width of the band filter amplifier is only 2,500 cycles and somewhat narrow for telephony, quite good commercial speech is obtainable. Only minor circuit modifications are necessary to meet the requirement of maintaining a constant level of speech and with the arrangement to be described, the variation of signal strength is of the order of plus or minus 2 decibels.

The results depend on the use of the extra limiter previously described for use with telegraph under certain conditions of small signal margin ; it is in fact a means of automatic adjustment of grid bias. In the present case it is used to adjust not only the potential of the final rectifier grid, but also the grid setting of the values in the final amplifier.

As in all forms of limiting, the method only works for reasonably strong signals. For comparatively small changes of signal strength, the automatic adjustment of the final rectifier grid potential is sufficient to maintain a good level. For greater signal strengths the slide-back effect comes into action on the grids of the amplifier valves and reduces the amplification of that stage ; the correct initial adjustment of the standing bias on the amplifier valves is of course important, so that the slide-back effect comes into action as soon as the signal passes a predetermined level. However, it is not critical.

Fig. 11 shows the connections required, a lead is taken from the top end of the condenser-resistance combination via a grid negative battery to the normal grid negative connections of the band filter amplifier valves.

The grid current control is obtained from the final rectifier normally used in telegraphy and the second telephone position valve is changed for one of lower M value and provided with additional grid negative.

This is done to avoid saturation of this rectifier which is used for obtaining the speech modulation for the output. The normal telegraph limiter and bridge units are not in use for telephony.

This arrangement was used very successfully for operating the loudspeakers at the Somerton Beam Receiving Station on the occasion of the visit of the Empire Press Conference delegates in July ; reception was from the Yacht (*cf.* THE MARCONI REVIEW, No. 22.).

J. A. SMALE.

R560.04

ULTRA SHORT WAVE EQUIPMENT FOR TANKS AND ARMOURED CARS

TYPE S.B.1A

Wireless communication between modern high power tanks moving across country at full speed does not, at first sight, appear to be a very encouraging proposition to the radio engineer.

The S.B.1A equipments recently installed in 7-ton vehicles of this class manufactured by Messrs. Vickers Armstrongs, Ltd., are the result of very successful endeavours to solve the many problems involved.

THE controlling factors in the design of the S.B.1A ultra short wave tank equipments described below have been (1) robustness to meet the severe conditions of vibration and mechanical shock; (2) compactness conforming to the limited space available in the vehicle; (3) simplicity of control for operation by unskilled personnel under conditions of severe physical stress and possibly nervous tension; and (4) the mechanical limitations placed by the nature of the service upon the construction of an aerial system.

The range required for intercommunication between similarly equipped vehicles is not extensive—1 to 2 miles as a maximum when on the move. Too great a range might in fact under service conditions be a definite disadvantage.

The problem of providing an aerial having sufficient radiation was an interesting one, inasmuch as the aerial for such service must also be inconspicuous, present as small a chance of damage under fire as possible, withstand the violent pitching and rolling of the vehicle when travelling over rough ground without collapsing, and yet be sufficiently flexible and resilient to brush under low obstructions such as branches of trees without damage to itself.

To some extent the wavelength to be employed was governed by these considerations and the use of a half wave aerial and a wavelength of 7 to 8 metres was decided upon. The remaining conditions were successfully fulfilled by the employment of a self-supporting vertical aerial constructed of jointed sections of special steel tubing of small diameter, and approximately 12 feet long. The tubing was heavily copper-plated to provide high conductivity. This aerial is supported at the base by a robust insulating bush in the roof of the tank. So resilient is the material employed that it is possible to drive the tank under an obstruction giving only 18 inches clearance above the aerial base without the slightest permanent distortion of the aerial occurring. Fig. 1 shows a general view of the tank with aerial in position.

Fig. 2 shows the instrument box and the auxiliary units in position in the tank. The instrument box is constructed of teak and metal lined. The receiver components are contained in the uppermost compartment and normally the receiver panel is covered by a metal screening lid which is removed in the photograph to

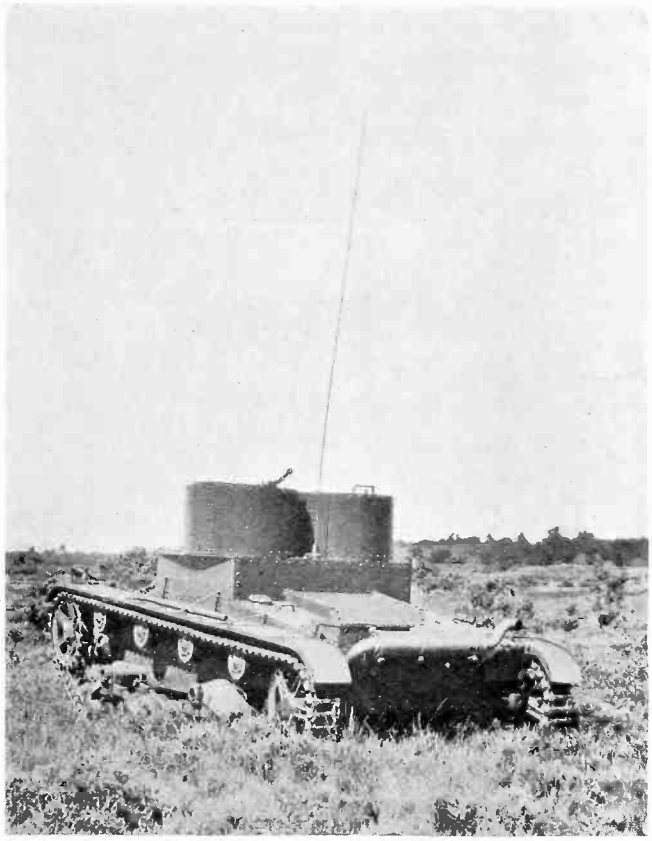


FIG. 1.

show the panel. A teak front cover completely protects the whole of the apparatus when not in use. The set is insulated from vibration by sponge-rubber, which lines the walls of the recess in which the instrument box is housed.

The intercommunication unit allows of telephonic communication between the two members of the crew provided with head sets, without their speech being transmitted. Alternatively either of them can transmit speech and both hear the received signals.

Power for the transmitter is derived from a 12-volt accumulator which may be the lighting or other accumulator in the equipment of the vehicle. High tension

current is generated by a small rotary transformer driven by this accumulator, from which latter current is also taken for the transmitter and receiver valve filaments.

The H.T. supply for the receiver is derived from a dry battery.

The various units composing the equipment are inter-connected by armoured flexible leads provided with non-interchangeable plugs and sockets.

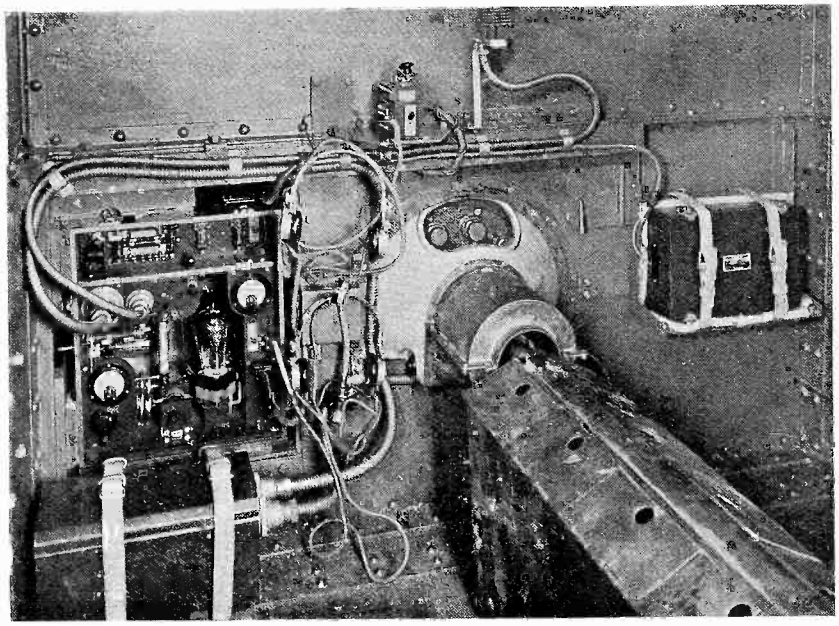


FIG. 2.

The transmitter provides for telephony and " tonic train " telegraphy. The half wave aerial feeder circuit is variably coupled to a close oscillatory circuit containing two self-oscillating valves (Type D.E.T.1) connected in " push-pull."

The frequency of the oscillations is controlled by the variable capacity connected across the grid circuit inductances.

Modulation is effected by the choke control method, two control valves (Type L.S.5B) being employed in parallel. For " tonic train " transmission, an interrupter disc mounted on the shaft of the rotary converter and a Morse key in series with it, are connected in the primary circuit of the microphone transformer in lieu of the microphone. By this means the current in the transformer primary when the key is closed is interrupted at audio frequency and these interruptions impressed on the grids of the modulators.

The receiver employs the "super-regenerative" system wherein a high degree of amplification is obtained, with stability.

The grid of a self-oscillating detector valve (Type D.E.Q.) is variably coupled to the aerial feeder circuit by a single turn coil. Its oscillations are intermittently quenched at supersonic frequency by those of the oscillator valve (Type D.E.V.) during one half of their cycle, by means of a variable coupling between the detector and the oscillator anode inductances.

The detector is followed by two transformer coupled stages of low frequency magnification employing D.E.V. Type valves, the output from which is passed through the primary of a step-down telephone transformer, low resistance headphones being employed.

The last stage of L.F. magnification may be switched out of circuit at will, and in order to maintain constant load conditions on the accumulator a resistance equivalent to the filament of the valve is put in circuit automatically by the switch, thus leaving the filament temperatures of the other valves unchanged.

When the receiver has been once adjusted correctly, the only controls the operator may be called upon to handle are the tuning condenser and the second L.F. amplifier switch referred to above.

The receiver valve filaments remain heated during transmission as well as reception, allowing use to be made of the L.F. magnifier stages for the amplification of inter-communication speech by means of a third winding in the first inter-valve transformer which is connected in the microphone circuit for inter-communication.

The high degree of amplification provided by this receiver is necessitated by the fact that when the tank is on the move the unprotected ear is quite unable to distinguish words shouted a few inches away, so deafening is the noise.

For this reason also, the earphones are fitted with special sound-resisting sponge-rubber pads, fitting close to the head and supported by adjustable webbing "harness," the ordinary type of anti-noise helmet as used by air operators being ruled out on account of the high temperatures experienced.

Laryngaphones are employed for telephony to avoid as far as possible the transmission of extraneous noises.

The effective range of the equipments is naturally affected to a considerable extent by the type of intervening country and particularly by the immediate surroundings of the transmitting aerial.

The following figures are the average results of extensive range trials for two-way communication between similarly equipped tanks over fairly thickly wooded country.

Conditions.	Effective range.	
	Telephony	I.C.W.
Both tanks stationary	5 miles	6 miles
One tank moving	3 miles	4 miles
Both tanks moving	1½ miles	2½ miles

The photographs illustrating this article are reproduced by the kind permission of Messrs. Vickers-Armstrongs, Ltd., the manufacturers of the tanks, to whom our thanks are also due for their co-operation in carrying out the various trials in connection with the wireless installations.

TYPE R.g.29c RECEIVER

The Type R.g.29c Receiver, described below, combines sensitivity with extreme selectivity.

Embodying arrangements for directive reception, it is particularly suitable for use on duplex telephony services under exacting conditions of frequency separation and space separation between receiver and transmitter.

It is, however, suitable for all general purpose reception demanding a high standard of performance, and where directive working is not called for the standard receiver may be fitted without its frame aerial, for use with any reasonable size of open aerial.

THE R.g.29c receiver consists of two units, photographs of which are shewn below.

They are :—

(A) The receiver.

(B) The frame aerial.

The Receiver.

The instrument employs one screen-grid Type H.F. stage, a detector capable of self-oscillation, and a L.F. stage.

Its waverange is 500/1,200 metres.

The receiver, complete but for H.T. and L.T. batteries, is contained in a metal cabinet shown in Fig. 1, divided into four compartments, and having a removable lid.

A useful mechanical feature is that all the components in each compartment are assembled as a unit, being mounted on a framework secured inside the cabinet by three screws easily removable from the front of the receiver. Each unit may be, therefore, quickly removed for inspection. No soldered connections have to be removed in this process, all connections entering the various units by flexible leads ; screws readily accessible on removing the lid of the receiver, free these leads from their anchor points on the cabinet itself.

Before proceeding to a general description of circuit arrangements, the following points may be mentioned.

In cardioid reception, it is often the practice to couple the vertical aerial to the frame aerial circuit by a valve. This arrangement is generally referred to as a "valve-heart." It possesses the advantage that a comparatively small vertical aerial may be employed, the amplification of the valve being available to magnify the vertical aerial E.M.F.'s to the value necessary to balance the frame E.M.F.

The use of a " valve-heart " is perfectly satisfactory where cardioid diagrams are used to obtain the general direction of signals on a directional receiver, and it has been used for this purpose with considerable success on many commercial traffic systems. Where a clear minimum is required, however, it suffers from certain disadvantages.

The valve in the " valve-heart " arrangement is subject, like all valves, to amplitude distortion. This means in effect firstly that if a perfect balance is obtained between frame signals and vertical aerial signals amplified by the valve, this balance

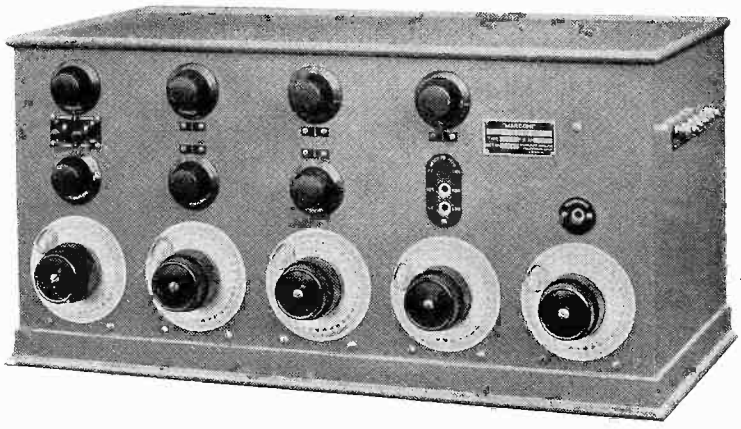


FIG. 1.

will fail with change in the signal amplitude—a state of affairs which at once precludes the use of the heart diagram for cutting out atmospheric and similar disturbances.

Secondly, the non-linearity of the heart valve gives rise to partial rectification of received E.M.F.'s. This means that the receiver as a whole may function as a super-heterodyne, the fundamental or harmonics of a strong local transmitter beating with incoming signals to a frequency which may be amplified by the receiver, the beats being rectified by the heart valve.

For the above reasons the R.g.29c embodies no valve-heart.

The actual aerial circuit arrangement employed for cardioid reception is shewn in simplified form in Fig. 2. It is sufficiently standard to call only for the following comment.

The resistance " R " must be large enough to mask the reactance of the vertical aerial circuit at all working frequencies. On the other hand it must not be too large to permit of the vertical aerial current inducing the required E.M.F. in the frame circuit.

To effect the necessary compromise over a wave range of 500 to 1,200 metres, the switch " S " is inserted. When the latter is in position 1, the two windings L and L' are in parallel, and tune a normal single-wire aerial of 100 feet length to 700 metres. In position 2, only L is in use, giving the vertical aerial a natural wavelength of 900 metres. In position 3, L and L' are in series, tuning the vertical aerial to 1,100 metres.

Brief consideration will show that by setting " S " as follows :—

Position	1	for wavelengths	500/800	metres.
,,	2	,, ,,	800/1,000	,,
,,	3	,, ,,	1,000/1,200	,,

then the maximum value of vertical aerial reactance which arises is much limited. It has been found possible by this precaution and with a vertical aerial of 100 feet total length, to achieve excellent cardioid diagrams on all wavelengths between 500/1,200 metres with the value of " R " fixed at 3,000 ohms.

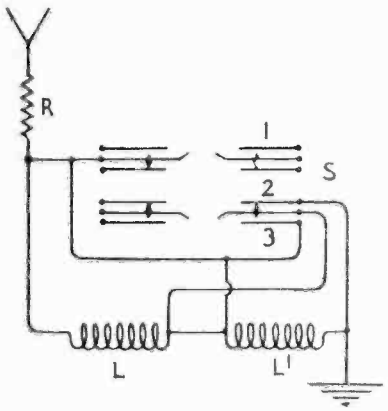


FIG. 2.

The complete circuit diagram of the receiver is shown in Fig. 3.

In the following the circuits are dealt with in the order in which they are mounted in the screening compartments, starting with the left-hand compartment. Reference is made to the photograph in identifying control handles.

Compartment 1.—This compartment contains the aerial circuit. On the left of it are mounted : (A) the terminals for connecting up the frame aerial ; (B) three sockets, into one of which the vertical aerial is inserted, according to the type of diagram of reception required ; and (C) the earth terminal.

It will be seen that the tuning condenser is used to tune either the frame aerial or the vertical aerial, according to the position of the " directive-nondirective " switch (situated on the top left-hand corner of the receiver). With the switch at " directive," cardioid or figure eight working is selected by placing the vertical aerial plug into the appropriately marked socket. On switching to " non-directive," the vertical aerial should be plugged into the " non-directive " socket.

Immediately below the "directive-nondirective" switch will be seen two switching keys. One of these is the series-parallel switch "S" controlling the inductance in the vertical aerial circuit when working "cardioid." The other switches in or out a loading condenser in parallel with the aerial tuning condenser. Between these two keys and the tuning condenser is situated the variable coupling for achieving the necessary balance between open aerial and frame signals for cardioid working.

Compartment 2.—This contains a variable coupling coil which forms part of the tuned aerial circuit, and a tuned intermediate circuit into which the former couples. The coupling coil is controlled by the handle immediately above the intermediate circuit tuning condenser (the second tuning condenser from the left). The switch above the variable coupling provides a means of cutting out the intermediate circuit when not required. In this case the variable coupling to the intermediate circuit is replaced by a similar variable coupling to the H.F. grid circuit.

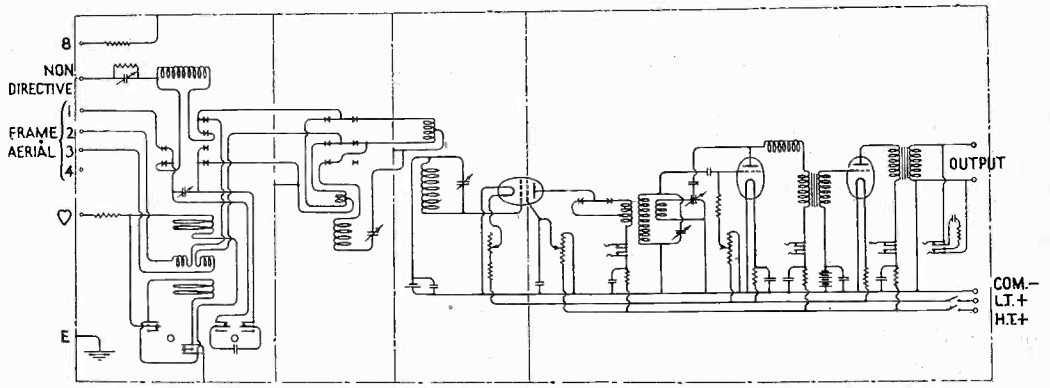


FIG. 3.

Compartment 3.—This contains the tuned H.F. grid circuit. Above the variable condenser tuning this circuit will be seen the variable coupling from the previous circuit (either aerial or intermediate according to whether the latter is "out" or "in").

Above this variable coupling is a variable filament resistance for the H.F. valve. This provides a useful volume control.

The H.F. valve is mounted horizontally between the 3rd and 4th compartments.

Compartment 4.—This contains the tuned circuit coupling the detector and the H.F. valve, together with the detector and L.F. valves, and associated components. On the front of this compartment will be seen the tuning condenser, the reaction control condenser, main "on-off" switch, and the telephone and valve feed sockets,

all readily identifiable in the photograph. Immediately above the tuning condenser is the "C.W.-Telephony" switch shown in the circuit diagram. The object of this switch is as follows :—

In the C.W. position (*i.e.*, when the rectifier is used in a condition of self-oscillation) it limits the coupling between the H.F. and detector stages so that re-radiation of the local oscillation is avoided, and so that the beat tone being received is unaltered by tuning through the predetector circuits.

In the "telephony" position, where so rigid a limit is not imposed on the coupling between H.F. and detector valves, it increases this coupling to give the best compromise between gain and selectivity.

On the right of this compartment are situated the supply terminals, and output terminals. The latter are for permanent connection to line-linking-equipment, a monitoring point being supplied by the telephone jack on the front of the receiver.

Only a single H.T. supply of approximately 11 m/a. at 120 volts is necessary, the screen-grid voltage being obtained from a potentiometer inside the receiver.

The receiver, as standard, employs 2 volt valves working from a 4-volt supply, the necessary breakdown resistance being inside the receiver.

Frame Aerial.

This is a very robust unit.

Reference to the photograph will show that it is fitted with a control wheel by means of which the frame can easily be rotated by an operator sitting in front of the receiver.

A webbed connector is provided for linking this frame to the receiver.

The frame carries a rotating scale, which may be set relative to the axis of the frame after the position of the pedestal has been fixed.

Connection from the frame winding to the terminal block on the frame does not depend on brush contacts.

A permanent connection is effected via a cable, and a stop device is fitted to the frame which permits its rotation through 375 degrees.

This ensures ability to rotate the frame through a minimum even if this occurs after 360 degrees of rotation, and at the same time prevents undue twisting of the connecting cable.

R. B. ARMSTRONG.

MARCONI NEWS AND NOTES

IMPERIAL DELEGATES AT MARCONI BEAM STATIONS

With the Imperial Conference delegates at Bridgwater Beam Station. Left to right (front row) : Mrs. J. H. Thomas ; the Rt. Hon. J. H. Thomas, Secretary of State for the Dominions ; Marchesa Marconi ; Marchese Marconi ; and Mrs. F. R. S. Balfour. To the left of Marchesa Marconi in the second row is the Earl of Midleton ; and to the left of Mr. J. H. Thomas is Mr. W. Lunn, Under-Secretary of State for the Dominions.

DELEGATES to the Imperial Conference in London visited the Marconi short wave Beam stations at Dorchester and Bridgwater as the guests of Imperial and International Communications Limited on Saturday, November 8th.

At Dorchester the delegates inspected the seven Beam transmitters which are engaged in commercial telegraphic communication with North and South America, Egypt, Japan and the Far East, and had an opportunity of seeing the compactness and ingenuity of the Beam aerial and feeder system.

At Bridgwater they witnessed the first public demonstration of Beam wireless telephony direct to Canada by means of the Marconi-Mathieu Multiplex system. For this demonstration a Post Office telephone and loud speakers were installed in a large marquee adjoining the station buildings. Here, seated at a table with the telephone, Mr. J. H. Thomas, Secretary of State for the Dominions, spoke for some time to Mr. E. W. Beatty, President of the Canadian Pacific Railway, at his office in Montreal. They conversed with the greatest ease, as was evident to all the

visitors by the loud speaker reproduction of their talk. Mr. and Mrs. Thomas also spoke to their son and daughter in Ottawa, and other guests exchanged greetings with friends in Canada.

Transmission for these conversations was effected through the Multiplex system at the Marconi short wave Beam station at Bodmin, the reception being carried out at the Bridgwater station.

Marconi Beam Developments.

After luncheon at Weymouth, Sir Basil Blackett, Chairman of Imperial and International Communications Limited, welcomed the delegates and said the Communications Company was not merely a symbol but also an agent of Imperial unity. By means of their wireless stations Dominion talked with Dominion, Colony with Colony, and all of them with the Mother Country. The unity of the Empire depended more on communications than anything else.

Referring to the two stations visited during the day, he said : " The Dorchester station, which you have seen this morning, and the Bridgwater station, which you will see this afternoon, are two of the first stations erected to work on short waves with Beam aerials. Brought into being through the experimental work of the Marchese Marconi and his assistants and through the faith placed in them by the Marconi Company, these stations have revolutionised wireless, for until they were erected no commercial stations utilising short waves and directive wireless had as yet been used. The leadership then held—for these stations were built as long ago as 1926—has since then been fully maintained. The stations have been kept up to date, and every useful invention or improvement which has been developed during the past years has been, or is being, installed.

" Substantial improvements have been made in Beam aerials, resulting in greater concentration of the rays in the vertical plane. Modulation has been provided to the transmitters, thereby reducing rapid fading. Adaptation has been provided so that telephony can be at once made use of where required. Methods have been adopted whereby Multiplex working can be effected, enabling two telegraph channels and one telephone channel to be served from the same transmitter simultaneously. The constancy of the carrier frequency—which was already very good—has been, or is being, substantially improved.

Facsimile by Beam.

" Facsimile has just been installed on the South African circuit, and the Canadian circuit, and will shortly be installed on the other Imperial circuits. This enables a cheque or any document to be faithfully reproduced at the receiving end, no matter what the distance may be between the two stations. A few weeks ago the Beam from Australia transmitted experimentally a photograph of Commander

Kingsford-Smith on his arrival in Australia. It was published in *The Times*. A few days ago a letter from Mr. Bennett was sent in facsimile to Canada by the Canadian Beam. I may justly say that the Empire has been provided with the finest system of wireless communications in the world, and I am confident that—thanks to the work of operators, technicians and research workers, among whom there stands out pre-eminent our Director the Marchese Marconi—this country's leadership in the sphere of wireless communications is being maintained and will be maintained in the future."

Sir Basil Blackett added that in 1929 the cable and wireless systems of Imperial and International Communications Limited carried 104,000,000 words between Empire countries, and 73,000,000 words between Empire and foreign countries.

Replying on behalf of the delegates, Mr. J. H. Thomas said he was proud to be the guest of a Company with whose name was linked the name of Marchese Marconi, "who will be remembered long after politicians and statesmen have been forgotten."

Irish Broadcasting Development.

The Irish Free State authorities have placed an order with the Marconi Company for the supply of a high power broadcasting transmitter, which will be erected in a central position in the Irish Free State to serve the whole of the Dominion. The new transmitter, which is to be manufactured at the Marconi Works at Chelmsford, will embody the latest refinements of broadcasting technique. With an aerial energy of 60 kilowatts it will be one of the most powerful broadcasting transmitters in Europe, while arrangements have been made to enable the aerial energy to be doubled at a later date if required.

The frequency emitted by the station will be maintained by an oscillating quartz crystal, thermostatically controlled. The principle of low-power modulation will be employed. This will ensure the constancy of the transmitted wavelength within very fine limits, an essential condition of modern broadcasting, which requires transmitting stations to adhere strictly to their allotted wavelengths.

The aerial will be suspended between two lattice steel masts each 330 feet in height. It will be situated at a considerable distance from the transmitting building, and, in accordance with modern practice, the energy from the transmitter will be conveyed by a feeder to a small building situated directly under the aerial, where the energy is transferred to the aerial system by a coupling device.

The wavelength for the new station, which is expected to begin operation in the autumn of 1931, will probably be 413 metres.

Marconi Veterans' Third Annual Reunion Dinner.

This popular function was held at the Holborn Restaurant on the 14th November last, Mr. H. W. Allen, the Secretary of the original Marconi Company—the Wireless Telegraph and Signal Co., Ltd.—being in the Chair.

Of 76 veterans on the roll, there were 55 present.

Marchese Marconi as chief guest was heartily welcomed, as it was realised that the important work on which he had been engaged in Italy might have prevented his appearance this year. Another guest of honour was Mr. A. Carpmael, representing Messrs. Carpmael and Ransford, the firm of patent agents who in 1896 filed the first Marconi patent in England, and are still acting as patent agents for the Marconi Co. Mr. K. Poupart, a veteran of 1902 from the Belgian Co., was another welcome guest, having travelled from Belgium specially for the occasion.

Letters and telegrams of regret were received from Sir Ambrose Fleming, Marchese Solari, and others.

The toast of " Our Guests " was proposed by Mr. H. W. Allen, and was suitably responded to by Marchese Marconi ; and Mr. F. S. Hayburn in an excellent speech proposed the health of the Chairman to which Mr. H. W. Allen replied.

The proceedings were enlivened by a first-class musical programme, and it was agreed by everyone that the reunion was a great success.

The election of officers for the ensuing year took place at a general meeting of veterans held at Marconi House on the 14th October, when Mr. H. W. Allen was appointed Chairman, Mr. C. E. Rickard, Deputy Chairman, Mr. H. M. Dowsett, Secretary, and Mr. W. J. Collop, Treasurer.

It was unanimously decided at this meeting that the qualification of a member should be :—" A total of twenty-five years' service with one or more of the companies in the Marconi Group or elsewhere in the interests of that group."

The Veterans' Roll has accordingly been corrected from this standpoint and the revised list is published in this issue.

This decision has been communicated to some 18 foreign companies associated with the Marconi Co., and the names of veterans in their service entitled to be included on the roll will be entered thereon in due course.

New European Broadcasting Stations.

Marconi Broadcasting stations are also to be installed in the near future at Trieste, Italy, and Viipuri, Finland.

The Italian broadcasting station, which is to be erected in accordance with the Italian Broadcasting Company's plan for the development of its service, will

1895

Marchese G. Marconi

1897

Col. H. Jameson Davis, H. W. Allen, G. S. Kemp,

1898

P. W. Paget, C. E. Rickard, R. F. Cave,

1899

W. Densham, Andrew Gray, H. M. Dowsett, R. T. Munson,

F. S. Stacey, F. Woodhouse, C. S. Franklin, P. J. Woodward, A. B. Blinkhorn

1900

H. W. Corby, R. N. Vyvyan, A. J. Clark, F. Archer, J. Harvie Clark,

Sir. Ambrose Fleming, A. H. Atkinson, E. E. Triggs,

1901

W. S. Entwistle, W. J. Willey, G. H. Green, A. Eve, F. J. Leathers,

Capt. C. V. Daly, G. Pells, E. G. Tyler, F. E. D. Pereira, F. K. May, A. H. Ginman,

1902

E. Berry, W. F. Thomas, R. D. Bangay, F. E. Burrowes. W. Davies

Capt. H. J. Round, H. A. Ewen, E. C. Richardson, A. A. Kift, J. Lewis,

1903

D. W. Tullock, J. R. Stapleton, F. Jones, J. Harvey,

A. J. Huff, H. T. Worrall, E. T. Hills,

1904

H. J. Tattersall, A. J. Irvene, T. Iddon, W. A. Taylor, W. I. McGhee,

J. R. Robinson, W. Platt, W. J. Collop, W. N. Ball, F. S. Hayburn,

P. L. Rowland, A. Cappelaere, W. Tasker, H. Cornwall,

1905

S. C. Parish, J. N. Johnson, W. B. Cole, E. J. Wagstaff, G. A. Manson,

C. A. Mason, H. M. Burrows, C. James. F. W. M. Herring.

Marconi Veterans' Roll.

have an aerial energy of 15 kilowatts, C.C.I.R. rating, with a maximum modulation of 100 per cent. It is designed to cover broadcasting wavebands between 200 and 545 metres, but the normal working wavelength of the station will be 247·7 metres. Low power modulation is provided.

A new type of valve drive, which has been developed in the Marconi Research laboratories, will be incorporated in the new Trieste transmitter and this will ensure a constancy of carrier wavelength well within the limits specified at the Hague Conference of 1929.

The Finnish Broadcasting Station.

The Broadcasting station for Finland will have an aerial energy of 13·2 kilowatts C.C.I.R. rating at 80 per cent. modulation. The transmitter is of similar design to that which is to be installed at Trieste, but the frequency control will incorporate an oscillating crystal instead of the valve drive control.

An oscillating crystal enclosed in a thermostatically controlled heat insulated box is employed in this system to provide the drive frequency of the station. The thermostat box ensures the minimum variation of the rate of oscillation of the crystal, so that the transmitted wavelength remains quite steady.

When the new station is completed simultaneous broadcast transmissions will take place from Viipuri and the existing Finnish station at Helsingfors, and for this purpose suitable land-line and speech control equipment is being supplied by the Marconi Company.

Marconi "Talkie" Apparatus.

One of the latest developments in electrical sound reproduction is in connection with talking pictures, and in this field researches carried out by the Marconi Company have resulted in the development of inventions for sound recording apparatus for cinematograph films which are acknowledged to be far ahead of anything previously attained.

Those who know of the results obtained by Captain H. J. Round in electrical recording for gramophone records will not be surprised to hear that the film recording apparatus, which also embodies inventions resulting from his researches, is regarded as the most efficient apparatus of its kind yet produced.

The Stoll Picture Production Company, one of the most important cinematograph interests in Great Britain, which is manufacturing this apparatus under patent licence from the Marconi Company, is the first to use this system, which has been given the name of "Visatone" and has been installed in the Stoll Studios in London.

One picture, "Such is the Law," has already been made with talk and sound effects by the Visatone process, and the film critics of the leading British newspapers have written enthusiastically of the new reproduction system.

"Extraordinary Purity."

"Spotlight," of the *Sunday Referee*, made the following comments in a recent issue :—

"An entirely new and entirely British system of talking picture production has been installed on the new sound stage which is now at work in the Stoll Studios at Cricklewood.

"The reproduction by this Stoll process, which is called Visatone, and which has been perfected under patent licence from Marconi, is as fine as anything I have heard. Most notably there is a complete absence of ground hum or burr and entire freedom from blasting. Moreover, it seemed to me that voices were more natural and less mechanical than by any other system. Visatone appeared to me to have gone further from the mechanical and nearer to the real than anything else. In short, from what I have experienced, I should say that Visatone is the Rolls-Royce system. It has complete freedom of movement on the film stage. It has quite extraordinary purity of tone in the theatre. It has apparently complete reliability in the laboratory. The absence of the first and the last of these virtues has entailed. many studio headaches in numerous other instances. The absence of the second has caused many headaches elsewhere."

"Subtlety and Distinctness of Tone."

The film critic of the London *Times* gave the system his considered appreciation in the following terms :—

"Judged by this production the new system, operated under a patent licence from the Marconi Company, need not fear comparison with any other method now in use. In subtlety and distinctness of tone it left little to be desired."

The principal cinematograph trade newspapers were greatly impressed with the technical excellence of the Visatone reproduction. The following extract from *To-day's Cinema* of November 15th typifies trade opinion :—

"Something of a sensation was caused at the trade show yesterday of the first picture made by the Visatone process.

"The recording in this picture rivals that of any system yet heard, although the film was made within a few weeks of the installation being completed, and by sound engineers who were not experienced in the actual technique of talkie making.

"At the Palace trade show, dialogue was clear-cut and every word plainly audible ; the difficult 's' and 'f' sounds which are the crucial tests of a recording system reached a high degree of purity.

"The system is that of Marconi's Wireless Telegraph Company, Limited.

"The apparatus, designed by Captain H. J. Round, entirely justifies Sir Oswald Stoll's enterprise in deciding to equip the studio with Visatone."

North Sea Navigation by Wireless.

Valuable navigational assistance given by the Marconi Direction Finder on a North Sea passage in a dense fog is reported by a London Trinity House pilot, who comments on the relief it was to have such an instrument aboard the ship. The pilot reports that the Commonwealth and Dominion Line steamship "Port Denison" on passage from Middlesbrough to Hamburg left Tees Bay in a dense fog and set course S.72 E. direct for Elbe No. 1 Lightship at a distance of 320 miles.

"After running 22 hours," he records, "we got bearing of Borkum Riff which put the ship 13 miles ahead of the patent log. We got two other bearings on Borkum Riff and with the last also a bearing on Nordholz which made an excellent cross. After about an hour we got a bearing on Norddeich which fitted in well with the others.

"I consequently altered the course to pass four miles north of Nordeney Lightship and picked it up exactly where I wanted, the bearings being absolutely accurate. This was the first mark we had seen since the Fairway Buoy in Tees Bay, and after the ship had been going at various speeds, slow, half, stop, etc., and running across the tides, it speaks volumes for the accuracy of the Direction Finder. I can only say it was a great relief to have such an instrument aboard the ship in the dense fog we had on the passage across."