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THE MARCONI ORGANISATION AT THE LONDON TERMINAL AIR PORT

The following article describes the routine methods which are in force at the Croydon Aerial Terminus to enable the aircraft wireless apparatus installed there, both in the case of ground stations and on aeroplanes, to be maintained in a high state of efficiency.

The instruments and procedure of testing the component parts of the installations are dealt with, and the reasons which led to the adoption of the present system are given.

EVER since the inception of civil aviation the Marconi Company has been actively engaged in the development and application of wireless as an aid to aerial navigation.

Ten years ago the first cross-channel aeroplane services were inaugurated by the Aircraft Transport & Travel Co., and the Handley Page Transport Co., from Hounslow and Cricklewood Aerodromes. At each of these places the Marconi Company established a service station for the purpose of fitting, testing and maintaining in efficient condition the wireless apparatus which, even in those days, was considered to be a useful adjunct.

At the Handley Page Aerodrome, Cricklewood, the Company also installed and operated a private ground station, which did much useful work until the time came when the Croydon Aerodrome was selected as the London Terminal for all cross-channel traffic. Our two service stations were then amalgamated into one depot, established at the new Aerodrome, where nowadays a very active organisation exists to serve the needs of Imperial Airways and a number of foreign lines which use the Air Port daily.

The great problem which confronts all those engaged in the exploitation of civil aviation is to obtain the maximum ratio of paying load to the total weight carried.

It will thus be seen how very reluctant the companies are to contemplate the carrying of a special wireless operator, even on the largest passenger-carrying machines.

In the earliest days, therefore, it became essential to consider the possibility of making practical use of wireless telephony, as by this means the special operator could be dispensed with.

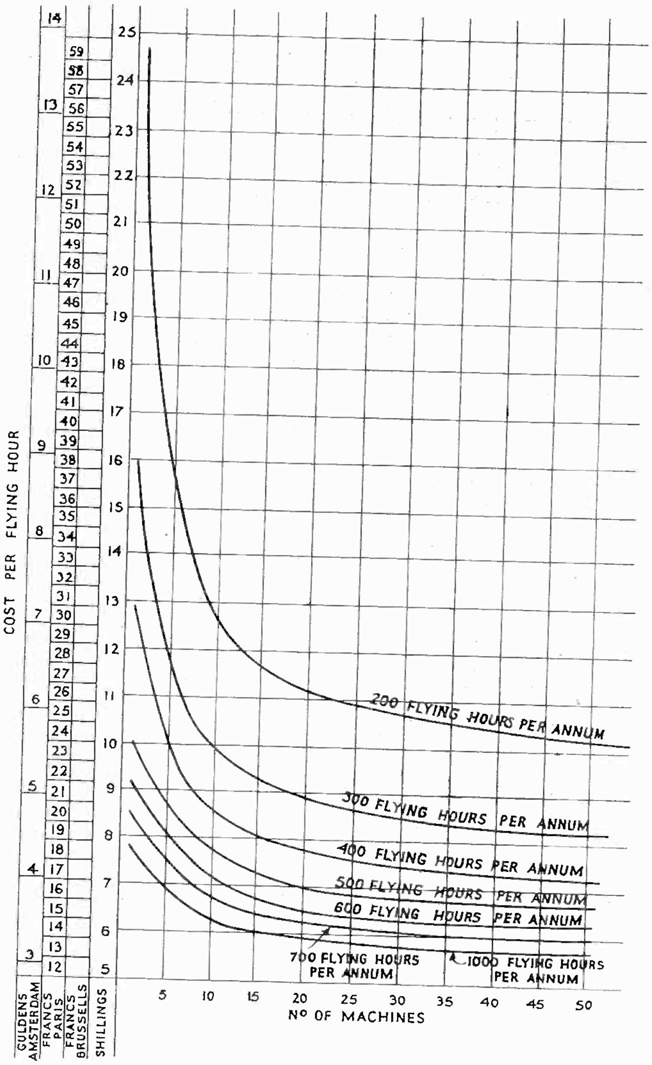


Fig. 1.

The Marconi Company were convinced, long before the advent of the broadcasting era, that in aerial communications there was a special application for wireless telephony; it was furthermore convinced that equipment could be designed which could be made sufficiently reliable to meet the very stringent requirements of commercial aviation.

After careful consideration of the problem the conclusion was reached that the most practical way of providing a service was to install, hire and maintain (by a system of ground tests) the apparatus for an inclusive sum per flying hour.

A sliding scale of charges was calculated and submitted to the authorities, and a rate agreed upon on the basis that only effective "flying hours" from a wireless point of view should stand for payment. This arrangement, which was suggested in the original instance by the Marconi Company, was equitable inasmuch as no payment was made for ineffective hours, and served to demonstrate in a practical manner that in those days, when some were sceptical as to the possibility of producing a wireless telephone apparatus which would give good results in flight, that the Company had ample confidence in its ability to solve adequately the difficult problems involved.

The diagram (Fig. 1) shows how the costs of the provision and upkeep of a given wireless installation, vary with the number of hours flown per annum, and the number of aircraft fitted.

This flying-hour scheme was accepted, and is still to-day in force (in a manner modified to suit present-day requirements) for British and some foreign machines as well.

The Marconi Company have also been the first to originate a Reciprocal Maintenance Scheme, in association with foreign companies, by virtue of which attention is given to the wireless equipment on British machines at foreign aerodromes, on request from the Pilot, while Dutch, Belgian and French aircraft are given any required attention when they land at Croydon.

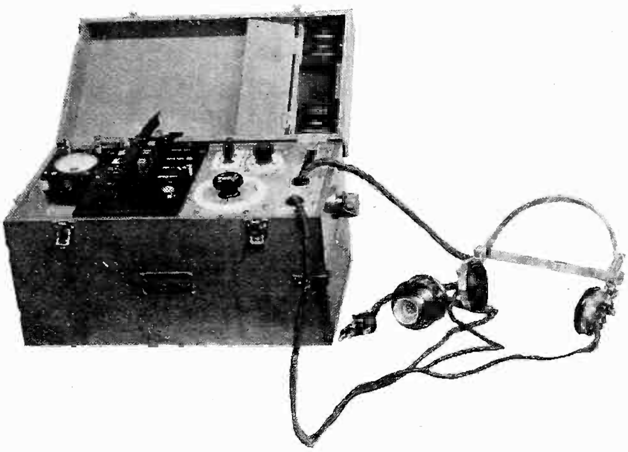


FIG. 2.

An office, workshop and stores are maintained, while special equipment has been developed for expeditiously testing the apparatus, either as installed on the machines, or in the workshops on the bench.

During the busy season there is often very little time available to the engineer in which to examine and check the performance of the apparatus prior to flight, and very little opportunity is afforded for witnessing results in flight.

Thus the engineer in charge has to rely on information obtained by ground test, by pilots' reports, and by special reports received by the ground station operators.

To facilitate routine testing, a special range of testing sets has been evolved, and a brief description of these may be of interest.

Firstly there is what is known as the No. 2 Testing Set (Fig. 2). This consists of a wavemeter unit and an artificial aerial unit, each fitted into a screened compartment, and both contained in a light wood box, readily capable of being carried into the cockpit of an aeroplane.

A fixed amount of coupling is introduced between the two screened compartments.

In use the artificial aerial is connected across aerial and earth—thus replacing the trailing aerial in flight—and the wavemeter is employed to induce a signal of known strength (by virtue of the fixed coupling) into the receiver, which, if normal, will give a strength of signal comparable with that of a calibrated variable tone which, by certain switch connections, is obtained from the wavemeter buzzer direct. By this means the engineer can check, with sufficient accuracy for practical purposes, both wavelength and sensitivity of the receiver under test.

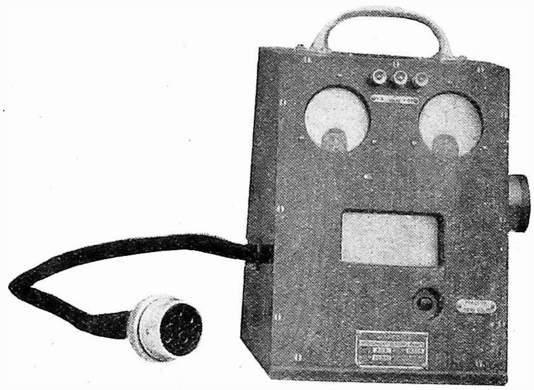


FIG. 3.

By the movement of a switch the transmitter can similarly be tested for wavelength, oscillation conditions and depth of modulation.

Arrangements are also provided for comparing the sensitivity of telephones and microphones, against a standard set provided with the testing set.

The No. 4 Testing Set (Fig. 3) consists of a set of instruments conveniently mounted and arranged to be automatically connected in the appropriate circuits, on being plugged into the set. By this means the anode voltage and current, and the low tension supply characteristics can be rapidly noted, and any necessary adjustment can be made.

The No. 2 Testing Set and No. 4 Testing Set, together with a set of tools, a hand-motor for coupling to the wind-driven generator, and a set of batteries for driving it, are all accommodated in a mobile testing equipment (Fig. 4), which can readily be wheeled alongside a machine on the aerodrome, if tests are required immediately prior to flight.

The description of this testing equipment is not complete without reference to the portable petrol engine (Fig. 5), which, coupled to a standard aircraft generator, provides a convenient source of power supply, when prolonged tests, under full power of the aircraft installation, are required on the ground.

Routine tests are classified under 4 headings, viz. :—

"*A*" *tests* are undertaken as soon as possible after the aeroplane comes in after the day's flying is over. The installation in the machine is run up with the aid of the testing apparatus described above.

"B" tests consist of bench-testing of transmitting and receiving apparatus.

"C" tests, which are similar to "A" tests, are carried out immediately prior to the departure of the machine. They are of necessity of a more cursory nature than "B" tests. By the aid of the 6-volt accumulator, which forms part of the standard aircraft equipment, the wind-driven generator is "motored" and made to supply just sufficient energy to cause the transmitter to oscillate, and the receiver to become responsive. An experienced engineer can judge from the results obtained whether normal results can be expected under flight conditions, in a few moments.

"D" tests are carried out when the aeroplane is in for "Dock overhaul," and comprises an exhaustive inspection and test of the complete installation, both on the bench and *in situ*.

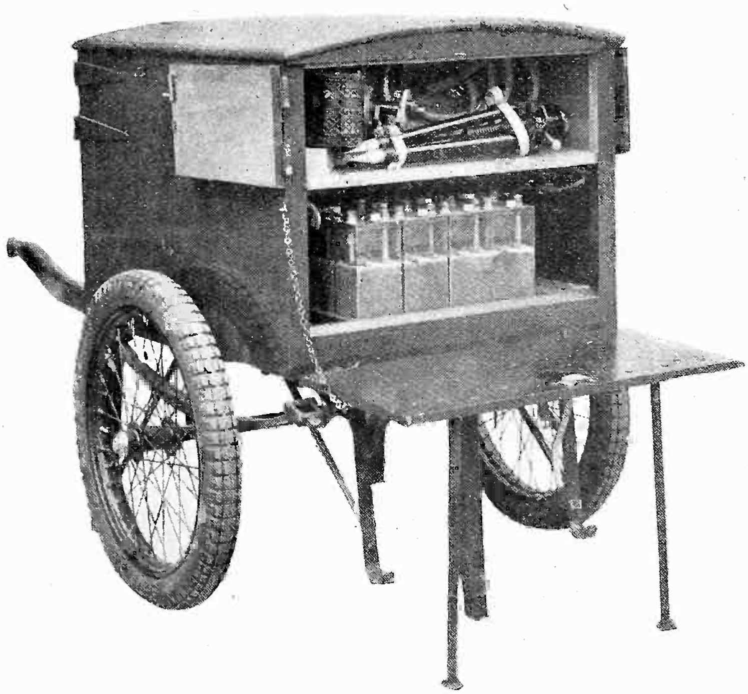


FIG. 4.

The conditions under which the apparatus has to work in an aeroplane are admittedly difficult. There is the engine and the propeller noise, which is to some extent mitigated by the use of a specially designed helmet (Fig. 6), in which rubber sponge is employed to surround the telephones, and thus to keep out a large measure of extraneous noise.

Then there is the interference caused by the ignition system of the engine and its associated wiring.

All the metalwork is, or should be, bonded together so as to form a conductive whole.

When faults occur in bonding, or there is insufficient special or natural screening of the engines, grave interference is caused, which may seriously interfere with the proper working of the wireless equipment.

Electric lighting systems may also be a potent source of trouble, due to induction noises picked up by the radio receiver.

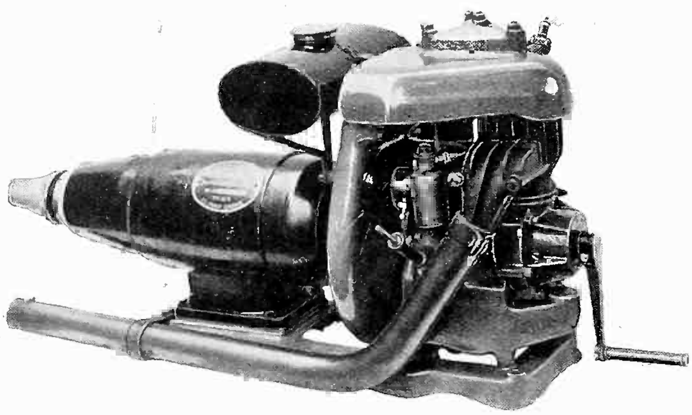


FIG. 5.

The maintenance of lights, the engine ignition system, bonding, etc., is a matter which is generally the responsibility of the aircraft owners, and hence, when trouble is experienced from these causes, action has to be taken by other authorities, in order to rectify the trouble.

Another source of inefficient working is interference due to jambing from other services, or from inadequate operation, either of the aircraft station, or of one or another of the ground stations, with which it is desired to communicate *en route*.

Here again these difficulties are outside the scope of the wireless company, and hence the supervision of the communication services as a whole, is a matter in which the Air Ministry, as being the competent government authority, actively participate.

Control is exercised in the case of British commercial aircraft communications through the medium of a small committee which meets at monthly intervals at the Air Port, under the Chairmanship of an Air Ministry representative, and which is attended by representatives of the Air Transport Company and the Wireless Company.

At these meetings each cause of ineffective working during the previous month is investigated and action agreed upon to reduce liability of recurrence.

The Air Ministry control and operate the ground station at the Air Port, which was installed by the Marconi Company, and hence, at these meetings, all the authorities responsible are duly represented.

Such is the reliability of present-day aircraft wireless, that payment for 99 per cent. of the total hours and miles flown with wireless is by no means uncommon.

The Air Ministry exercise control in another way. It has to satisfy itself that the wireless apparatus will not in any way endanger the airworthiness of the aircraft in which it is installed. Apparatus is therefore "approved" as a type suitable for installation on a licensed aircraft.

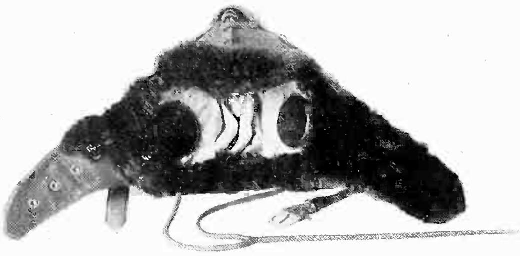


FIG. 6.

Subsequently, all apparatus of the approved type must be inspected and passed by the Aeronautical Inspectorate Department of the Air Ministry, but in actual practice this responsibility is delegated by the Department to the Company in this way :—

After examination of the Company's organisation for inspection and test at the Chelmsford Works, and upon due consideration, the Air Ministry have placed the Company in the category of "approved firms," that is to say, the Air Ministry recognise the competency of the Company to inspect, test and pass its apparatus, prior to despatch, as on behalf of the Air Ministry.

Our Engineer-in-Charge at Croydon is also similarly empowered to act as on behalf of the Aeronautical Inspectorate Department, and in this way assumes official responsibility in seeing that only sound material is installed.

A description of the Marconi Company's organisation at the London Terminal Air Port would be incomplete without mention being made to one or two other activities which are centred there. Although the Company does not assume responsibility for the operation or maintenance of the ground station, it has always had a considerable and active technical interest in the ground station equipment.

In the earliest days the Company demonstrated the utility of the direction-finding receiver as an aid to aerial navigation, and when the Terminal Air Port of London was created it installed for the Air Ministry one of the first specially designed Air Port Wireless Stations to be built in the world.

The station, which was designed by Captain P. P. Eckersley, was a remotely-controlled $1\frac{1}{2}$ kw. Telephone-Telegraph Station, operation being carried out from a direction-finding receiving station situated some distance away from the transmitter, and connected by landline to the aerodrome control tower.

This station did good service for about 7 years, but has lately been replaced by a more modern, more complete and more powerful plant.

The new plant, which will be described in a subsequent issue, has now been working successfully for the last 18 months, and is shortly to be elaborated in order that the ever-growing needs of the service can be adequately provided for.

Lastly, the Marconi Aircraft Development Section of the Company is centred on this aerodrome.

Here is carried out experimental and testing work necessitated by the continual investigations which the Company undertakes into the many problems which have to be solved in producing new and advanced types of apparatus.

The Company maintains a specially-equipped van for carrying out range tests from point to point on the ground, whilst a "Bristol" Fighter aeroplane is used to confirm results in flight.

J. M. FURNIVAL.

SHORT WAVE SIGNAL STRENGTH MEASURING APPARATUS—II

In the May Number of THE MARCONI REVIEW *a technical description was given of a Short Wave Signal Strength Measuring Set recently developed by the Marconi Company.*

The article concluded with an account of the methods used for calibrating such a set and showed how the performance of the attenuator used can be checked against the mutual inductance by which the auxiliary calibrating signal is introduced into the aerial.

IN the type of Signal Strength Measuring Set discussed in the present article, relatively large currents are used at the input end of the attenuator (50 to 100 milliamps.) and microamps. are required in the primary of the mutual, so that it is essential that the performance of the attenuator unit, where the reduction takes place, shall be accurately known.

For D.C. currents or low frequency alternating currents, a "T" network of resistances, Fig. 1, is a very suitable arrangement for reducing the known input i to a known fraction at the output, but difficulties arise if the arrangement is used at very high frequencies.

The chief difficulty is this: Owing to the capacity between input and output the voltage induced on B may, at sufficiently high frequencies, be large compared with the voltage at B, on account of the resistance drops in the various members of the network from which the performance is calculated. There is a spurious jump-over from A to B which is not calculable, and the attenuator in this form is useless.

The effect shows itself in a most marked manner if one of the series resistances is broken. According to calculation there should be no voltage at B, but actually B may have a large voltage induced in it by capacitative induction from A. Very perfect shielding between input and output is therefore necessary.

This has been achieved in the following design, which is illustrated in Fig. 2. Each unit of the "T" is in a separate screening box, as shown below, but the box cannot be completely screened, as there must be a connection from one box to the next. This connection is made through the brass tubes A and B by the 47 gauge Eureka wire placed axially in the tube.

The performance of such a resistance tube, as it may be called, can be accurately calculated even at the highest frequencies used.

Thus the potential drop down the tube is only dependent on the Zi drop along the wire where Z is the effective impedance of the wire, in particular if the wire is disconnected there is no potential jump-over from P to Q. This has been tested and found to be the case.

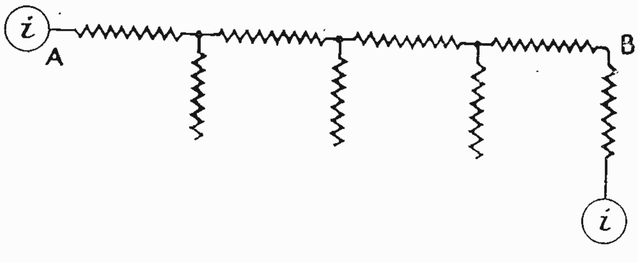


FIG. 1.

Thus there is no capacity jump-over from one box to the other and consequently from one end of the attenuating chain to the other.

Double screening is provided by the extra shielding box C, which is a sliding fit on to the two tubes A and B and into which the short resistance R_2 screws.

The performance of the attenuator can then be calculated from the filter formula

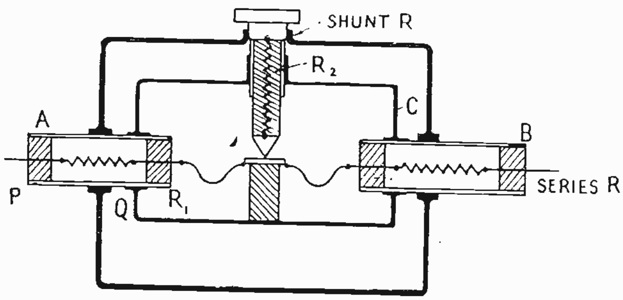


FIG. 2.

$$\cosh a = \frac{1}{2}\frac{Z_1}{Z_2} + 1$$

where e^{-a} is the reduction per stage
Z_1 is the impedance of a series unit
and Z_2 that of a shunt unit.

The mean value of Z_1 is 10·448
" " Z_2 is 2·957
which gives the mean attenuation per stage as 5·33.

There are four stages in the attenuator, numbered 1, 2, 3, 4 (Fig. 3), and since the resistances are not all equal the attenuation per stage is not quite the same for all stages. They are given in the following table, which is self-explanatory :—

TABLE I.

Arrangements of Shunts. Out	In	I_o/I_i (Ratio of output to input current). I_o = output current of attenuator. I_i = input current of attenuator.	
A 1, 2, 3, 4	—	1	$=1$
B 1, 2, 3	4	$\frac{1}{5 \cdot 18}$	$=0 \cdot 193$
C 1, 2	3, 4	$\frac{1}{5 \cdot 18 \times 5 \cdot 18}$	$=0 \cdot 0373$
D 1	2, 3, 4	$\frac{1}{5 \cdot 18 \times 5 \cdot 18 \times 5 \cdot 26}$	$=0 \cdot 00708$
E —	1, 2, 3, 4	$\frac{1}{5 \cdot 18 \times 5 \cdot 18 \times 5 \cdot 26 \times 5 \cdot 75}$	$=0 \cdot 001232$

The total attenuation is 812/1.

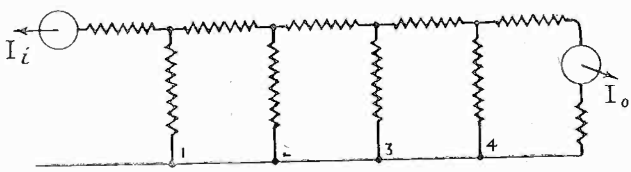


FIG. 3.

Attenuator Mutual Inductance Check.

The test may be followed with reference to the skeleton diagram below, and was arranged as follows (Fig. 4) :—

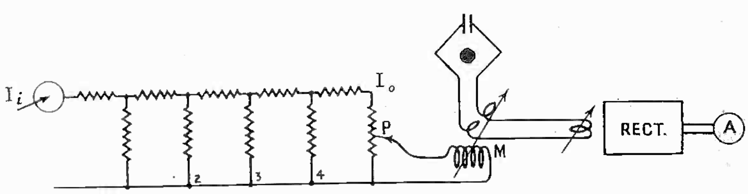


FIG. 4.

No. 1 shunt of the attenuator was removed. A convenient input current I_i was obtained on the required wavelength. The mutual M was adjusted to near the top of the scale with a value M_1, and the receiver was adjusted to give a measurable output A on the recording ammeter. Let the current in the primary of **M** be i_1.

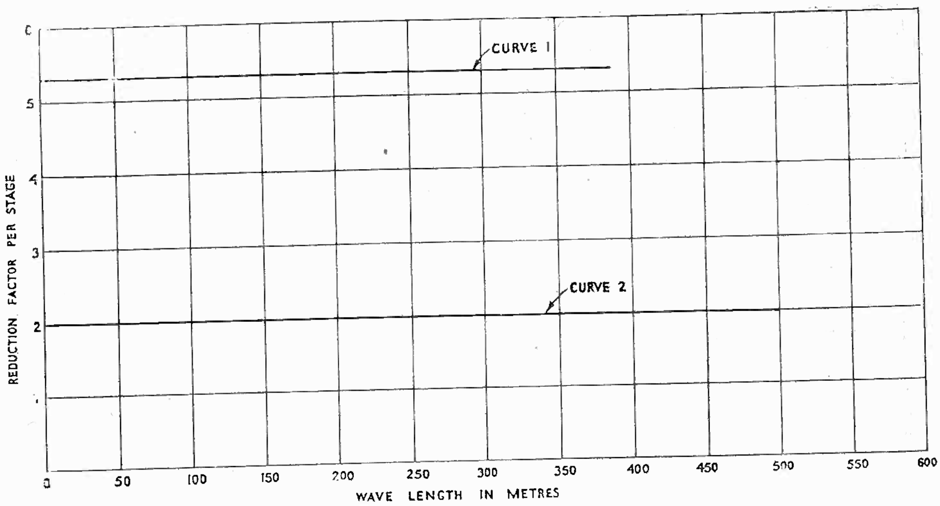
Shunt No. 2 was then removed and the input current I_i and λ were adjusted to their previous values. Then according to calculation the output current I_o should be 5·26 times as great as previously (see table) and consequently the current in the primary of **M** i_2 should be increased in this ratio. Now leaving the receiver untouched, **M** was reduced until the same output current in A was recorded. Let this value of **M** be M_2.

Since the output in A is the same in both cases, $M_1 \; i_1 = M_2 \; i_2$, or $\frac{M_1}{M_2} = \frac{i_2}{i_1}$; but $\frac{i_2}{i_1}$ should be the calculated ratio for the attenuation of stage Z, *i.e.*, 5·26.

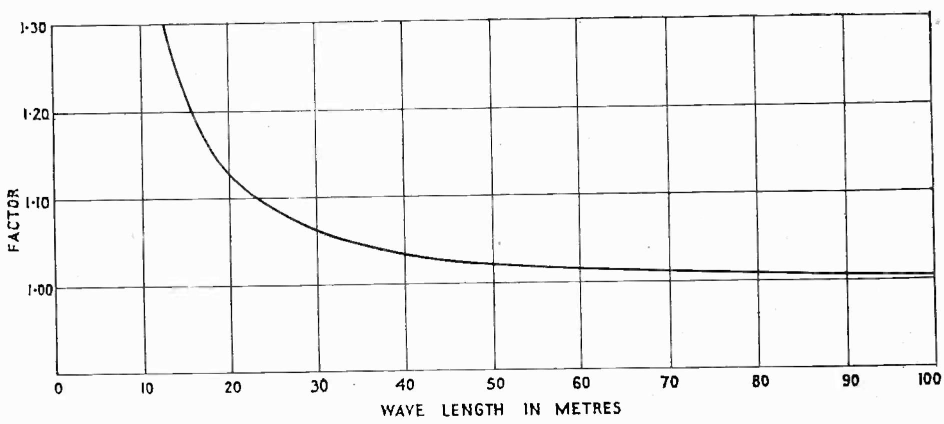
The results obtained on wavelengths down to 15M. are shown in the following table and curve. See Curve No. 1.

TABLE 2.

λ	I_i	Shunts In	M	Ratio
300	55 MA	2 3 4	·665	
				= 5·31
,,	,,	3 4	·125	
240	56	2 3 4	·6565	
				= 5·31
,,	,,	3 4	·1235	
100	82	2 3 4	·6555	
				= 5·35
,,	,,	3 4	·1225	
48	85	2 3 4	·6425	
				= 5·24
,,	,,	3 4	·1125	
30	62·5	2 3 4	·6475	
				= 5·35
,,	,,	3 4	·122	
20	56	2 3 4	·635	
				= 5·20
,,	,,	3 4	·122	
15	55	2 3 4	·656	
				= 5·33
,,	,,	3 4	·123	



Curves i and ii. Internal calibration of Signal Measuring Set.



Curve iii. Correcting factor for Z potentiometer.

TABLE 3.

λ	I_i	Potr	M.	Ratio
550	60	1	·61	
,,	,,	2	·3175	= 1·92
400	60	1	·6365	
,,	,,	2	·3175	= 2·0
250	55	1	·6325	
,,	,,	2	·3195	= 1·98
100	82	1	·6325	
,,	,,	2	·3185	= 1·982
48	65	1	·651	
,,	,,	2	·3315	= 1·967
20	56	1	·474	
,,	,,	2	·260	= 1·86
15	62	1	·622	
,,	,,	2	·328	= 1·896

The observed ratio even at the short wavelength is within the limits of experimental error of the calculated value, and seems to be a very satisfactory check of the attenuator and mutual inductances.

It is, of course, conceivable that the errors in M compensate those in the attenuator at some given wavelength, but that this should be the case on all the wavelengths tried seems almost inconceivable.

A further check is as follows: The potentiometer wire has two tappings, the resistances being respectively 0·982 and 1·847, with a ratio of 1·98. A similar test to the previous one was made, keeping the attenuator the same but varying the potentiometer tapping. The ratio of the M for constant receiver output should then be 1·98. The table and curves give the results, which are again within the limits of experimental error. (See Table 3. Curve No. ii.)

Calculation of the voltage induced by the auxiliary oscillator.

If I is the input current in the milliammeter (Fig. 5)

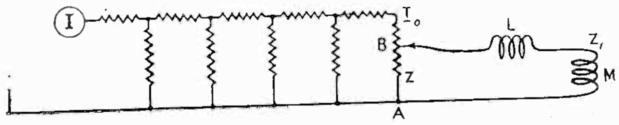


FIG. 5.

then $I_0 = \dfrac{I}{k_1\ k_1\ ---\ k_n}$ where k is the reduction factor for each stage (where I_0 is the output current).

If we assume that the impedance Z_3 of the circuit consisting of the primary of the mutual and the choke L is very large compared with Z, then the voltage across AB is $\dfrac{Z\ I}{k_1\ ---\ k_n}$ (where Z is the impedance between A and B).

The current in the primary M is therefore $\dfrac{Z\ I}{k_1\ ---\ k_n} \cdot \dfrac{1}{Z_3}$ and the voltage induced in the frame aerial is $\dfrac{Z\ I}{k_1\ ---\ k_n}\ \dfrac{Mp}{Z_3}$, so that in addition to knowing $k_1\ ---\ k_n$ and M (which have been checked according to the tests described above), the values of $Z + Z_3$ must be known. (I is read direct from the milliammeter.)

The impedance Z of the potentiometer may be taken as equal to its resistances for wavelengths down to 60 metres. The potentiometer check test shows that it is at least proportional to the resistance. At very high frequencies the inductive drop down the wire becomes of the same order as the resistive drop. When the wire and return are concentric cylinders the inductance per unit length can be accurately calculated from the formula

$$L/\rho = 2 \log b/a$$

where a is the diameter of the wire and b is the internal diameter of the return tube. In this case it is 12·01 cm. per cm. of wire.

If R is the resistance of 1 cm. wire

$$Z^2 = R^2 + p^2L^2$$

$$Z = R\sqrt{1 + \frac{p^2L^2}{R^2}}$$

$$R = 2{\cdot}35 \text{ for No. 47 Eureka.}$$

Table 4 gives the correcting factor. This multiplied by R gives the effective Z at the corresponding frequency.

The correction is negligible above 60M, but increases to 23 per cent. at 15m. The correcting factor is shown in Curve No. iii.

TABLE 4.

λ	$\frac{pL}{R}$	$\frac{pn^2}{R^2}$	$\sqrt{1+\frac{p^2L^2}{R^2}}$
100	·0107	0·01142	1·00571
80	·01338	0·01783	1·00891
60	0·1783	0·03180	1·0159
40	0·2575	0·0662	1·0331
30	0·3565	0·1275	1·0625
20	0·5356	0·2756	1·130
15	0·7120	0·5060	1·2270

It might at first be thought that this change in impedance of the resistance wires with frequency would invalidate the attenuator calculation, the same resistance wires being used in this as in the potentiometer, but it will be observed that the attenuation per stage represented by the formula

$$\cosh a = \frac{1}{2}\frac{Z_1}{Z_2} + 1$$

only depends on the ratio of the impedance of the series and shunt arms of the attenuator, which remains constant however Z_1 and Z_2 may vary so long as the two arms are made of the same wire.

The attenuation per stage should therefore be independent of this frequency correction, and is actually found to be so.

The impedance Z_3.

Z_3 includes the calibrating choke and the primary of the mutual inductance. These can be measured by low frequency and high frequency methods. The small mutual which is used on the high frequency range is 11·65 mics. measured on low frequency and 11·75 mics. with the extra inductance of leads measured at about 100M. This last measurement was made by inserting a known calibrating condenser where the calibrating choke is usually placed and tuning the circuit beyond (Fig. 6).

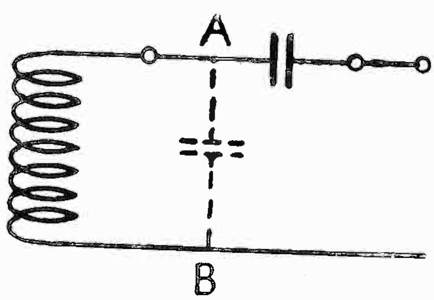


FIG. 6.

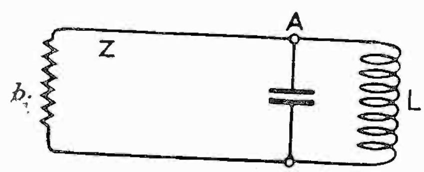


FIG. 7.

At higher frequencies the effective impedance Z_3 increases on account of stray capacity across AB. Z_3 is then very nearly

$$\frac{jLp}{1 - p^2 LC}$$

where C is the stray capacity across AB.

But it must be observed that in the working condition which may be represented by Fig. 7, so long as the impedance Z_4 of the lead to A is small, the voltage $V = ZI_0$ is across L and the current through it is $\frac{V}{jpL}$ in spite of the presence of the stray capacity. In fact, on account of the increase in impedance of the circuit AL when resonance is approached, the drop down Z_4 will be reduced.

It is therefore accurate to specify the current in L as $\frac{ZI_0}{jpL}$, but it is important that the calibrating choke must not be inserted for waves below 100M (where the stray capacity begins to be effective), as this would make Z_4 large.

T. L. ECKERSLEY.

THE USE OF SHORT WAVES FOR LONG DISTANCE COMMUNICATION

The following article is an attempt to recapitulate, very briefly, some of the most salient features of long distance Short Wave transmission.

The subject is discussed under the following headings :—

(1) *The extent of the Short Wave frequency spectrum.*

(2) *Conditions under which short wave communication over long distance is possible.*

(3) *Effect of light and darkness on various wavelengths.*

(4) *Allocation of wavelengths.*

FOR the purposes of discussion, the short wave, or high frequency spectrum may be considered as embracing all wavelengths between 100 metres and zero, or frequencies of between 3,000 kilocycles and infinity. In practice, however, this band may be considerably reduced.

The upper limit of wavelength is fairly definitely fixed, for we know that if the behaviour of the wave propagation is to conform to the usually accepted short wave theories, *i.e.*, to the generally accepted theories of ionic refraction in the upper ionised layers of the atmosphere, the conditioning factor is that the electrons can make many oscillations in the time between collisions with the molecules of the atmosphere.

It has been shown that this mean time at heights above 80 km. is greater than about 3×10^{-7} sec., from which it can be seen that ionic refraction effects are limited to wavelengths $\lambda < 100$ m.

As regards the lower limit, we may, for present purposes, fix this as being somewhere in the neighbourhood of 8·6 metres, this being the value given by Mr. T. L. Eckersley for the short wave day limit for long distance communication.

The frequency band to be considered on the above assumptions extends from 3,000 kilocycles to 34,880 kilocycles, *i.e.*, there is a spectrum of nearly 32,000 kilocycles available for short wave working.

Now the two necessary conditions for satisfactory long distance radio communication are :—

(1) The waves should be bent sufficiently round the curvature of the earth, *i.e.*, they should suffer sufficient refraction in the ionised layers, and should not pass through them.

(2) The attenuation experienced by the waves should be small.

If we consider (1) first, it can be shewn that a definite value of $\lambda_{min.}$, where this is the value of the shortest wave that will be sufficiently bent to come down to earth, will be given by the expression :—

$$\lambda^2_{min.} = 2h\pi m / RNe^2$$

where h = height corresponding to a density N ;
m = mass of electron ;
e = charge of electron.

The value of h/N, which is really the deciding factor of the above expression, will, of course, alter according to the degree of light and dark prevailing at the time, but definite values can be given to it for fixed conditions, and from these the minimum wavelength which can be used for these conditions can be found. It must be understood, however, that the wavelength found in this manner is not necessarily the best as regards small attenuation. Different wavelengths experience different attenuations under differing degrees of light and darkness through which they pass. In a recent paper issued by the Marconi Company, a series of empirical curves are given, which can be used to obtain the signal strength of a station of known power at various distances under different degrees of light, for various wavelengths. These curves will, it is hoped, prove very useful in predetermining the wavelength of a station over any route at any time.

A table, giving the approximate distances in miles at which signals cease to be audible at different wavelengths assuming a transmitter of approximately 10 kw. power is given below.

These figures are for intense daylight routes, and refer to the use of a simple receiver at the receiving end.

Wavelength in metres.	Distance in miles.
15	12,000
20	7,000
25	4,500
30	3,000
40	1,500
50	900

For a route entirely in twilight, the attentuation on all wavelengths is greatly reduced. Signals on wavelengths of the order of from 15 to 30 metres will generally be found to be the best for use on such a route.

The attenuation of wavelengths above 40 metres is slight under conditions of complete darkness. On wavelengths below about 20 metres, signals are reduced, due probably to the fact that the ray is insufficiently bent.

From the above summary, it will be seen that considerable care must be taken before a wavelength can be allocated to any route from the point of view of obtaining minimum attenuation. Another problem has arisen of late years which threatens to become very serious. This is the crowding of the frequency spectrum by the

EXTRACT FROM RADIOTELEGRAPH REGULATIONS, WASHINGTON, 1927, *re* ALLOCATION OF WAVELENGTHS ON SHORT WAVES.

Frequencies in kilocycles per second (kc./s).	Approximate Wavelengths in Metres.	Services.
2,850– 3,500	105–85	Mobile services and fixed services.
3,500– 4,000	85–75	Mobile services. Fixed services. Amateurs.
4,000– 5,500	75–54	Mobile services and fixed services.
5,500– 5,700	54–52.7	Mobile services.
5,700– 6,000	52·7 –50	Fixed services.
6,000– 6,150	50 –48·8	Broadcasting.
6,150– 6,675	48·8 –45	Mobile services.
6,675– 7,000	45 –42·8	Fixed services.
7,000– 7,300	42·8 –41	Amateurs.
7,300– 8,200	41 –36·6	Fixed services.
8,200– 8,550	36·6 –35·1	Mobile services.
8,550– 8,900	35·1 –33·7	Mobile services and fixed services.
8,900– 9,500	33·7 –31·6	Fixed services.
9,500– 9,600	31·6 –31·2	Broadcasting.
9,600–11,000	31·2 27·3	Fixed services.
11,000–11,400	27·3 –26·3	Mobile services.
11,400–11,700	26·3 –25·6	Fixed services.
11,700–11,900	25·6 –25·2	Broadcasting.
11,900–12,300	25·2 –24·4	Fixed services.
12,300–12,825	24·4 –23·4	Mobile services.
12,825–13,350	23·4 –22·4	Mobile services and fixed services.
13,350–14,000	22·4 –21·4	Fixed services.
14,000–14,400	21·4 –20·8	Amateurs.
14,400–15,100	20·8 –19·85	Fixed services.
15,100–15,350	19·85–19·55	Broadcasting.
15,350–16,400	19·55–18·3	Fixed services.
16,400–17,100	18·3 –17·5	Mobile services.
17,100–17,750	17·5 –16·9	Mobile services and fixed services.
17,750–17,800	16·9 –16·85	Broadcasting.
17,800–21,450	16·85–14	Fixed services.
21,450–21,550	14 –13·9	Broadcasting.
21,550–22,300	13·9 –13·45	Mobile services.
22,300–23,000	13·45–13·1	Mobile services and fixed services.
23,000–28,000	13·1 –10·7	Not reserved.
28,000–30,000	10·7 –10	Amateurs and experiments.
30,000–56,000	10 – 5·35	Not reserved.
56,000–60,000	5·35–5	Amateurs and experiments.
Above 60,000	Below 5	Not reserved.

continually increasing number of stations which are working on the short wave band. The partial solution of this problem has been attempted by the various International Conferences which have been called from time to time. An extract from the Washington Conference of 1929 is given above, which attempts to allocate specific wavelengths for definite purposes.

In this extract, all commercial land stations are included under the heading of fixed services. Ship stations, etc., are included in mobile services, and certain wavelengths are allocated to broadcasting stations and for amateur use.

At a Conference held at Ottawa in January, 1929, between the representatives of the United States and Canada, the following decision was reached :—

"A channel shall be regarded as a band of frequencies, the width of which progresses numerically from the lower to the higher frequencies as shown in the following table :—

Frequency (K/C)	Channel Width (K/C)
1,500—2,198	4
2,200—3,313	6
3,316—4,400	8
4,405—5,490	10
5,495—6,000	15

"The Governments agree to adopt for the present in their National plan of allocation a separation of 0·2 per cent. between radio frequency channels, and to permit stations under their respective jurisdiction to occupy the assigned frequency and the adjacent frequencies to the limit permitted by the frequency maintenance tolerances and necessitated by the type of emission the station may be authorised to use.

"For commercial telephony, a band width of six kilocycles shall be permitted.

"For the present, a 100 kilocycle band width shall be considered standard for television."

The whole question is, however, under review at the "Comité Consultatif International Technique des Communications Radioélectriques" being held at The Hague at the present time.

Another limitation to the number of communication channels available on the short waves is the lack of perfect constancy on the part of the station frequency. A very small variation of this frequency is sufficient to cause one station to invade the frequency limits of another.

The practical limit at present is just about sufficient to enable consecutive stations to work if great care is taken on the part of the station operator. This accuracy may be expected to increase later when improved apparatus is put into use at the less efficient stations.

A SHORT WAVE PORTABLE MILITARY TRANSMITTER

TYPE Z.S.A.3

The essential features of a military wireless station are :—

(1) *That it should be extremely simple to operate and simple in design ;*

(2) *That it should be light and easily portable.*

A full consideration of these conditions has led the Marconi Company to produce two distinct types of portable stations. These are :—

(A) *The X, Y and Z series in which the transmitting and receiving circuits are contained in one or two cabinets.*

(B) *The U series in which the apparatus is divided into several units of more or less open construction.*

The former are specially suitable for temporary or permanent installation in any suitable type of vehicle which may be obtainable, the prefix X denoting a telephone, Y a telegraph and telephone, and Z a telegraph set, while the latter are intended for permanent installation in a chassis specially equipped for the purpose.

The stations of the " U " type are, in general, more flexible and powerful than those of the " X," " Y " and " Z " type.

One of the most recent of the " Z " type of transmitter, the Z.S.A.3 is described below.

THE Z.S.A.3 is a small, portable, short-wave transmitter, extremely simple in design, and intended for use, in conjunction with the Z.S.A.2 receiver, as a military transmitter on a spot wave length of 30 metres.

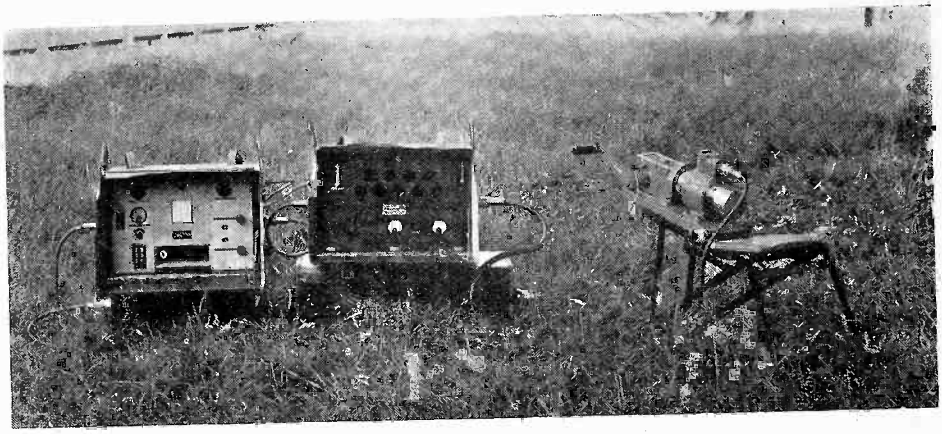
Power is supplied to the set by means of a hand-driven generator, with an output of 800 volts at 65 m α for the high tension supply to the D.E.T.1 valve used in the transmitter, and of 7 volts 2 α for the filament lighting.

The diagram of connections of the transmitter is shown below (Fig. 1).

It will be seen from this that provision is made only for continuous wave signalling. This is achieved by breaking the grid circuit of the valve and the negative of the high tension supply, together from the filament.

The circuit is of the ordinary bottom feed fundamental type, the coil " A " representing the inductance in the oscillatory circuit. No capacity, other than that existing in the valve itself, is provided in the closed circuit.

The high tension supply is taken through a fixed tapping on the inductance "A" and reaches the anode through another tap which is adjustable. The grid of the valve is taken through a blocking condenser to an adjustable tap on the side of the inductance remote from the anode tap.



The valve used as the oscillator is a D.E.T.1.S.W. This has a maximum continuous anode dissipation of 40 watts, a voltage magnification factor of 8·5, and

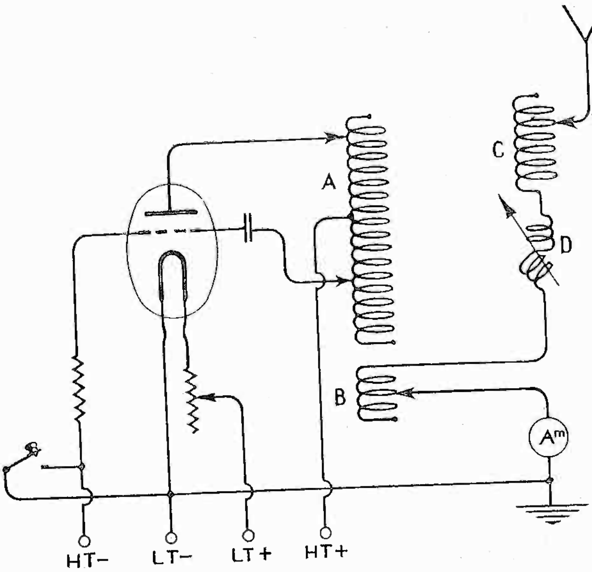
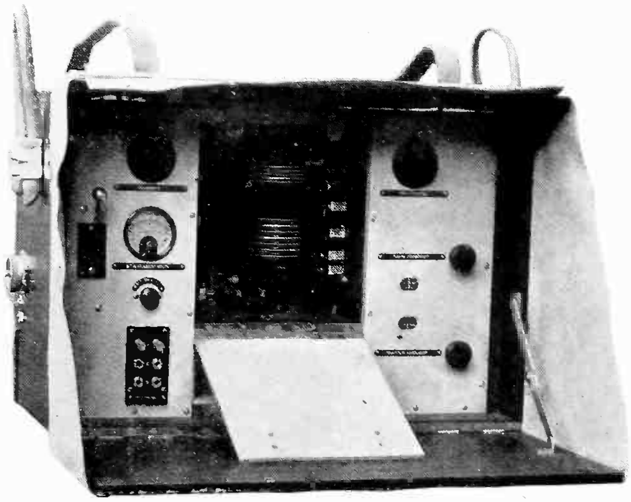


FIG. 1.

a value of R_p of 5,000 w. It is designed to have a very small internal grid-anode capacity, the anode and grid being taken out at opposite ends of the valve.

A ·001 by-pass condenser is also provided between H.T. and earth, to render the impedance of the H.T. generator negligible as regards high frequency currents.

The aerial circuit is magnetically coupled to the closed circuit, and consists of a loading coil, a variometer, a coupling coil and aerial ammeter, all in series. The coupling coil serves to couple into the closed circuit, and the variometer serves



as a fine adjustment of wavelength. The tappings on both the coupling and loading coils are adjustable.

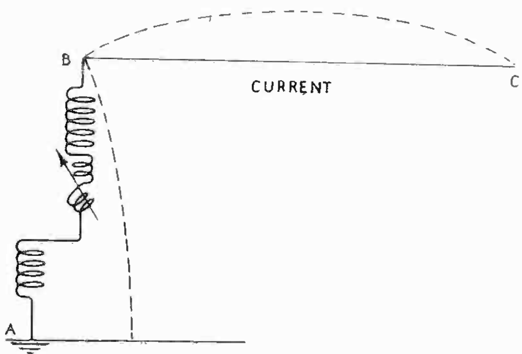


FIG. 2.

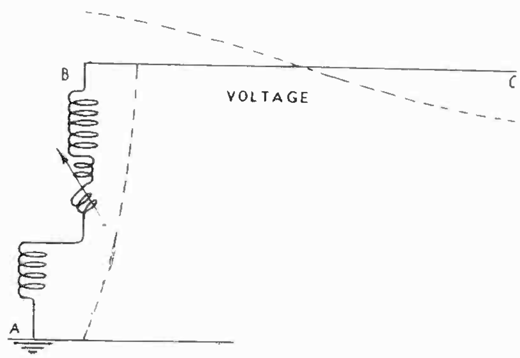


FIG. 3.

The closed circuit consists of 18 turns of No. 10 copper wire wound on porcelain slats supported on a wooden former. The coupling coil is wound over the closed circuit coil, and is spaced $\frac{3}{8}$ inches from it. It consists of 3 turns of wire. The aerial coil has 20 turns of No. 10 copper wire wound on a 3-inch former and the variometer is wound on a spherical wood former and consists of $4\frac{1}{2}$ turns of No. 10 copper wire.

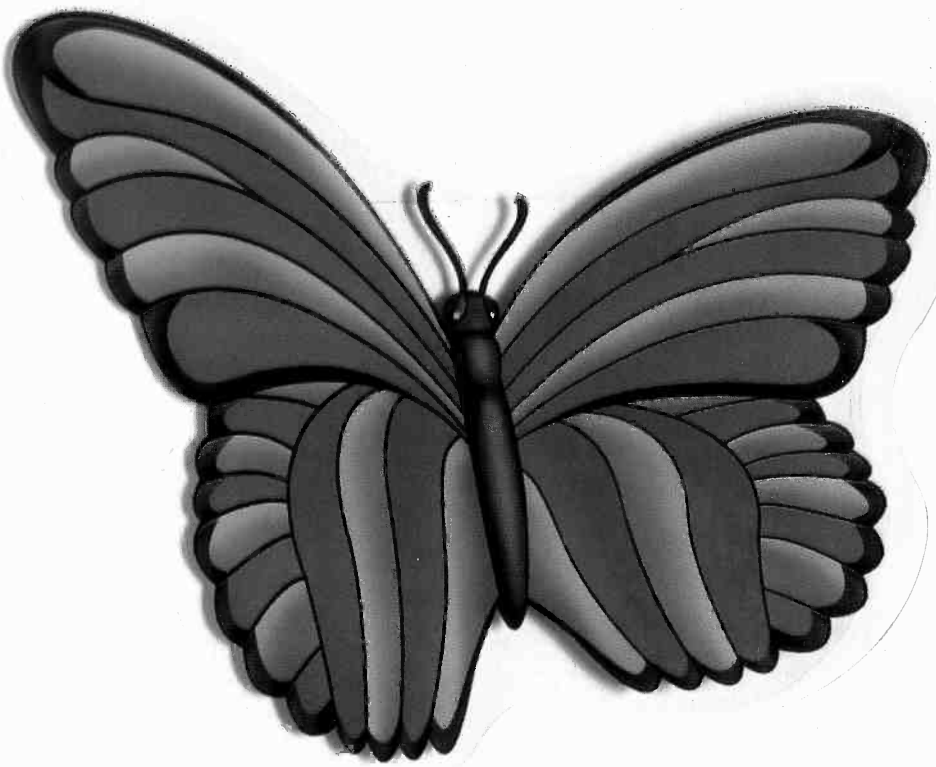
The transmitter radiates on a half-wave aerial, the aerial circuit of the transmitter loading the entire aerial system to $\frac{3}{4}$ of a wavelength.

In this case the current and voltage curves are given above (Figs. 2 and 3).

In each of these figures the aerial circuit of the transmitter is represented from A to B, and the aerial proper from B to C.

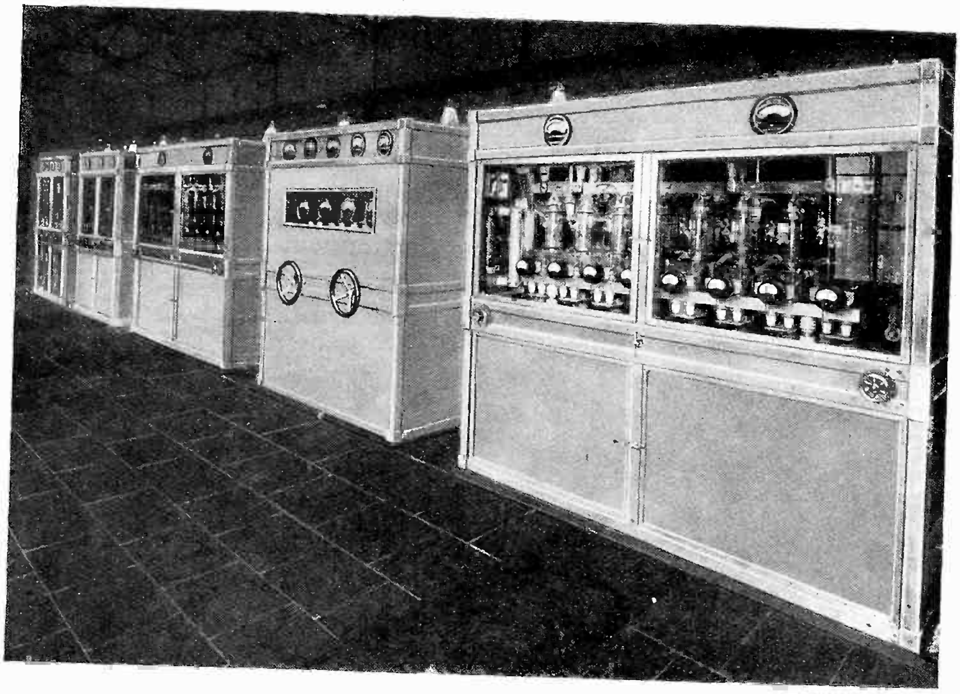
The transmitter is provided with one earth, for the closed circuit and filament and for the aerial and aerial circuit. This consists of two brass or copper rods driven into the ground and connected to the common earth lead.

The receiver intended to be used in conjunction with the set is that supplied for use also with the Z.S.A.2 set. The receiver circuit is a simple detector and oscillator followed by two note magnifiers. A detailed description of the receiver will, however, be given later with the description of the Z.S.B.2 transmitter.



MARCONI NEWS AND NOTES

MARCONI BROADCASTING INSTALLATIONS



Marconi 50 kw. high-power broadcasting transmitter, Type P.B.

The New British Regional Stations.

The British Broadcasting Corporation announced on September 14th, that the new London regional broadcasting station at Brookman's Park would begin its preliminary test transmissions on September 16th, on 2 LO's normal wavelength of 365·3 metres (342 kh.) after the close of the ordinary London daily programme.

The British Broadcasting Corporation's announcement proceeds :—

"Primarily designed for the provision of an alternative programme service this station consists of two separate high-power transmitters. The alternative programme, however, will not be introduced until such time as listeners have become accustomed to receiving the single programme from the new station.

"The schedule of preliminary transmissions will be as follows :—

"Starting on Monday night a few minutes after the close of the London programme, there will be test transmissions of music for one hour every night for a fortnight, excluding Sundays.

"On and after Monday, September 30th, the last section of the London programme, which is usually dance music, will be transmitted from the new station every night for two or three weeks, excluding Sundays.

"Notice will be given later of the date on which Brookman's Park will take over the entire service."

The Marconi Company's part in the New Service.

The new regional broadcasting transmitters at Brookman's Park have been manufactured, in accordance with the special requirements of the British Broadcasting Corporation, by Marconi's Wireless Telegraph Company Limited, and therefore represent the highest standard in the manufacture of wireless broadcasting apparatus.

Marconi broadcasting transmitters are accepted throughout the world as being of the highest standard of design and performance as is shown by the fact that broadcasting installations manufactured by the Marconi Company and its affiliated companies are in service in the following countries :—

Australia.	Czecho-Slovakia.	Jugo-Slavia.	Russia.
Austria.	Great Britain.	Korea.	South Africa.
Belgium.	India.	Norway.	Spain.
Brazil.	Irish Free State.	Peru.	Sweden.
Canada.	Italy.	Poland.	Switzerland.
China.	Japan.	Roumania.	Etc., etc.

Other Important Broadcasting Developments—Iceland.

During the month the Marconi Company has been associated with other important developments in broadcasting in various parts of the world.

The announcement was made on September 13th, that the Marconi Company had obtained from the Iceland Government a contract for the first broadcasting station to be erected in Iceland.

This station will be situated at Reykjavic, the capital of the island, and is to be completed in time for the thousandth anniversary of the discovery of Iceland, which will be celebrated in June next year.

The transmitter will be of a new design based on the wide experience of the Marconi Company which, as shown above, has supplied wireless broadcasting stations for service in over twenty countries. It will have a power of 15 kw. in the aerial and will work on a wavelength of about 1,200 metres.

Special circuits will be incorporated to enable it to be used for telegraph transmission as well as broadcasting. This will enable the station to be used for meteorological services.

Meteorological information from Iceland is of great importance in forecasting weather conditions for Europe and the Atlantic. The power of the new station which the Marconi Company is building, will enable reports from

Iceland to be received over a wide area. It will thus form an important addition to the meteorological services.

Poland.

The Marconi Company has also been successful in obtaining the order for a large extension of the Polish Broadcasting organisation. This order is for six transmitters and forms one of the largest orders given in recent years in connection with broadcasting services. Following the English example, the Polish Broadcasting organisation is to be remodelled so as to provide alternative programmes.

The new equipment will comprise one 120 kw. aerial input broadcasting transmitter with full modulation, two high-power regional stations with 16 kw. aerial input, and three local relay stations.

The new installations will be of the most modern and up-to-date type both as regards technique and design.

Provision will be made for simultaneous reception throughout the whole of Poland, the relay stations transmitting on a common wavelength employing the tuning fork system of control, such as is in successful operation in Great Britain.

In addition to the simultaneous broadcasting of programmes throughout Poland, arrangements will be made for the transmission of high-class Polish programmes to foreign countries.

The 120 kw. station will be situated near Warsaw, and will be used in addition to the 12 kw. Marconi Station which is already giving such an excellent service at Warsaw and has been in operation there since 1927.

The new high power station will take the wavelength of the present 12 kw. station, which is 1,411 metres, and the 12 kw. station will work on a lower wavelength. The two stations will be employed simultaneously for the transmission of alternative programmes.

The two new 16 kw. stations will be situated at Lemberg and Vilna to provide programmes for the areas outside the range of the lower-powered station at Warsaw.

Of the three local relay stations, one will be situated at Lodz, the Polish Manchester, 80 kilometres from Warsaw. The provision of this station is interesting seeing that it is for the definite purpose of providing an alternative crystal programme for a working-class district.

The Marconi Company is entrusted with the supply of everything connected with these stations, including all constructional services. The whole of the technical resources of the Company will be concentrated in carrying out the scheme.

When the work is completed it is confidently anticipated that Poland will possess one of the most modern and the most efficient broadcasting services in the world, providing alternative programmes available to users of crystal and valve receivers over the greater part of the country.

Arrangements are being made for alternative programmes to be available from Warsaw before the end of this year, and the whole scheme is expected to be in operation before the end of 1930.

5,000 mile range of a Marconi Broadcasting Station.

Reports are constantly being received of the excellent range and quality of the transmissions from the Marconi broadcasting stations throughout the world. The latest report from the *Cape Argus*, of August 17th, gives interesting particulars with regard to the reception in South Africa of the Marconi station at Bratislava in Czecho-Slovakia.

This station is a Marconi 12 kw. broadcasting transmitter, type P.A.5, employing the principle of low-power modulation. Its wavelength is 278·8 metres (1·80 kh.), and among its special features is the half wavelength aerial. Bratislava is about 5,000 miles from Cape Town, where, according to the *Cape Argus*, a number of listeners are getting excellent reception.

Empire and the Schneider Trophy Races.

Not only was the British Broadcasting Corporation's description of the Schneider Trophy Race broadcast to English listeners, but it was also transmitted for the benefit of other countries through the short wave experimental station 5SW at the Marconi Works at Chelmsford, and reports have been received of excellent reception of this programme in Canada, the United States, and Australia, among other places.

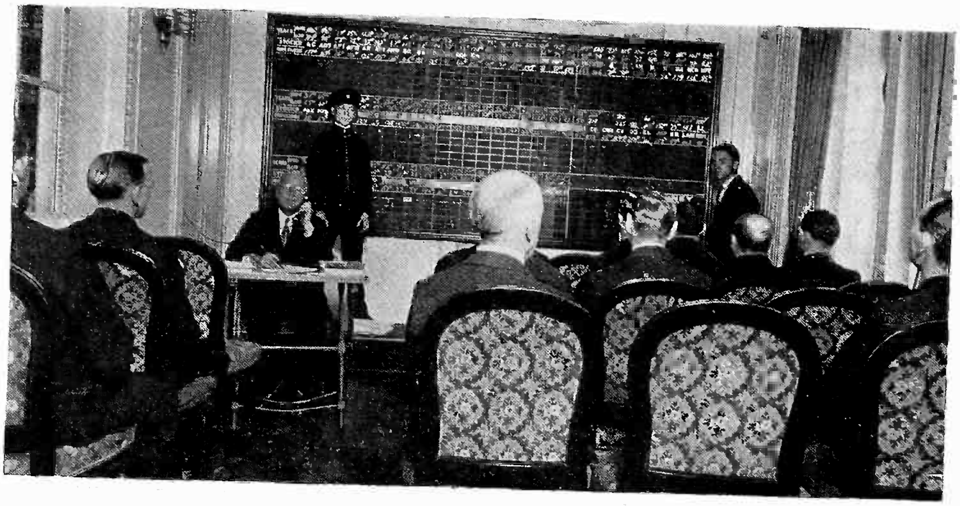
In the United States, the transmission was relayed from more than twenty stations associated with the National Broadcasting Company. Engineers stated that the quality of the transmission was better than on any previous occasion and they were surprised at its exceptional clearness and quality.

Stockbroking at Sea.

Stockbroking on board ship has made the latest demands on the wireless service at sea, and the Marconi International Marine Communication Company has provided wireless apparatus to meet the very exacting conditions of this service on the ships of the White Star Line. Special Marconi short wave apparatus ensures direct and instantaneous communication with New York even when the ship is off the British coast, and enables business men in mid-Atlantic to take advantage of the speed and directness of wireless communication to transact highly important financial affairs with the greatest facility as well as certainty.

The following account of this achievement has been taken from the London newspaper, the *Daily News*, of September 10th :—

"A remarkable technical wireless achievement lies behind the successful operation of the Stock Exchange service on the White Star liner 'Majestic,' by



Stockbroking office in White Star Liner "Majestic"—the largest ship in the world—where every fluctuation in 80 stocks quoted on the New York Stock Exchange may be seen on the board during New York business hours.

which the broker's office on board is linked with the Stock Exchange in Wall Street, New York.

"The tremendous difficulties of working an independent Duplex wireless service within a few yards of the ship's main transmitting installation were tackled by experts of the Marconi International Marine Communication Company, and completely overcome by the use of special screened aerials for each set.

"The ordinary telegraph service between ship and shore can be carried on as usual without in any way interfering with, or being interfered with by the special brokerage service which is working in a nearby cabin.

Four Operators Busy.

"The main Marconi installation of the 'Majestic' used for the normal wireless services consists of a 2 kw. valve transmitter with a receiver and direction-finder.

"Messages are transmitted principally on the wavelengths of 600 metres and between 2,100 and 2,400 metres. An enormous volume of traffic—sufficient to keep four operators hard at work—is handled throughout each voyage, in addition to official navigation and press messages.

"For the brokerage service a separate cabin has been equipped with a Marconi short wave transmitter and receiver for communication with the Louisburg (Canada), Tuckerton (U.S.A.), and Portishead (Wiltshire), radio stations, on 23 metres.

"In addition, a long wave receiver is used to pick up the special brokerage messages from Rugby Radio on 18,750 metres.

"The special design and arrangement of the aerial system are such that the two wireless cabins are completely screened from each other, and no interference occurs between them whatever.

Speedy Business.

"As a result of this installation, business men travelling on the Atlantic can keep in touch with the movements of stocks and shares in which they are interested, and can continue their dealings almost as rapidly as from their offices ashore.

"The reply to the first brokerage message from the 'Majestic' asking for a special stock quotation was in the hands of the passenger concerned within 2½ minutes after he had handed in his request at the broker's office on board.

"The rapidity and facility with which actual business can be transacted from mid-Atlantic were praised by Mr. Harry V. Dougherty, a United States business man, who said he asked for a bid and offer on Air Reduction Shares, and received a reply from the newly-opened brokerage office in exactly seven minutes."

Ship-to-Shore Telephony.

Attention has recently been directed again to the subject of wireless telephony as a means of communication between ships at sea and telephone subscribers ashore, and the growth in recent years of what may be termed "the international telephone habit" may now lead to the extension of telephone facilities to liners at sea.

The Marconi Company was a pioneer in this phase of wireless communication and its records show that the Company has for a number of years realised that the rapid progress of communication facilities to all parts of the world will eventually lead to a public demand for marine telephone services.

A Record of Achievement.

The Rt. Hon. F. G. Kellaway, P.C., Chairman of the Marconi International Marine Communication Company, in a recent letter widely quoted in the Press, drew attention to the following achievements of the Marconi engineers in ship-to-shore and ship-to-ship telephone communications :—

> "In the summer of 1920, when the Imperial Press Conference was held in Canada, wireless telephone conversations took place by means of Marconi installations between the delegates travelling from England on the S.S. 'Victorian' and Poldhu and Chelmsford in England and St. Johns, Newfoundland, over distances exceeding 1,000 miles.
>
> "In May, 1923, a wireless telephone transmitter was installed on board the S.S. 'Olympic' of the White Star Line, and good clear speech from the 'Olympic' at sea was received on the 'Celtic,' which was then in New York harbour.

"In August, 1923, the Marconi Company fitted a wireless telephone installation on the S.S. 'Lorina,' belonging to the Southern Railway Company. Good clear speech was maintained both ways between Marconi House and the 'Lorina' while crossing the Channel. This was the first direct conversation between passengers on a ship at sea and an ordinary telephone subscriber on land in England, as distinct from a telephone conversation between a wireless station on board a ship and a wireless station on land, or between two ships at sea.

"In February, 1925, the Marconi Company installed duplex wireless telephone apparatus on the S.S. 'Princess Ena,' belonging to the Southern Railway Company, and good speech was maintained between the 'Princess Ena' when crossing the Channel and telephone subscribers in London, Glasgow, Leeds, Cardiff, Bristol, Portsmouth, Southampton and Bournemouth. This installation was subsequently dismantled as the owners found that the demand for the facilities did not justify the cost.

Telephoning over the Arctic Circle.

"In January, 1927," Mr. Kellaway continued, "telephone communication was carried on over the Arctic Circle at distances of 600 miles and 1,100 miles, between the Hudson Bay Company's ships 'Bayrupert,' 'Baymaud,' and 'Baychimo,' by means of Marconi wireless telephone apparatus.

"In England over 30 Marconi wireless telephone stations are in constant use between the Lightships, Lighthouses and Shore Stations of Trinity House, the Mersey Docks and Harbour Board, the Dundee Harbour Trust and the Northern Lighthouse Board, while a number of similar wireless telephone stations have been installed for other Port Authorities in different parts of the world.

"The technical problem of establishing a telephone service between ships' passengers and telephone subscribers in any part of the United Kingdom was solved by the Marconi Company several years ago and such a service can be established whenever shipowners desire to instal the necessary equipment and a suitable wireless receiving station is available in this country."

Telephony between Ships.

In the same way, the Marconi Company is able to provide facilities for passengers to telephone from one ship to another. On this subject Mr. Kellaway wrote:—

"I would remind your readers that telephony between ships at sea has been in regular and growing use during the past three years. This Company has fitted wireless telephone installations on forty whalers operating in the Antarctic. These installations are from 100 to 500 watts power and give a normal range under favourable conditions up to 500 miles."