THE MARCONI REVIEW

No. 25. *October, 1930.*

Technical Editor: H. M. Dowsett, M.I.E.E., F.Inst.P., M.Inst.R.E.
General Editor: W. G. Richards.

DESERT MOBILE WIRELESS TELEGRAPH STATIONS FOR THE EGYPTIAN GOVERNMENT

Mobile radio stations have been employed for many years for military services, but
stallation has a much wider
unted on six-wheeled chassis
Company to the Egyptian

ERRATUM.

Page 5, Line 6, should read :—
body with wireless generator weighs $1\frac{1}{2}$ tons.

iles of the earth's surface,
Isles, of which, however,
cultivated, the rest being
ıvans plod for weeks at a

Of the three Egyptian deserts, the smallest is the Wilderness of Sinai, which, about as large as Scotland, is a rocky and mountainous peninsula, rich in minerals, rising to a high, central wind-swept plateau called *Gebel Tih* or the "Desert of Wanderings."

The Arabian Desert, including Nubia, is likewise a place of high, barren mountains rising clear-cut, peak on peak, into the blue distance and honeycombed with the ancient gold-workings of the Pharaohs. The Arabian Desert is in Egypt, not Arabia, from which it is separated by the Red Sea. Herodotus first called it so, and the name has persisted.

Near the Mediterranean littoral the great Libyan Desert, the eastern and most inhospitable part of the Sahara, divided from the Arabian Desert by the Nile, consists of a desolate stone-littered plateau, changing further south to huge areas of fantastically eroded arenaceous rocks, while, still further south, where all the sandstone has been blown away to form dunes, there is a dreadful country of dazzling white chalk, geologically the same age as the Hampshire Downs, where the weary travellers as they trudge forward under the burning sun are wrapped in clouds of choking dust as with a mantle.

Hidden away securely in the eternal and petrified confusion and chaos of the great Libyan Desert are a number of deep and broad hollows containing fertile oases, supporting large populations, where a myriad crystal springs gush forth from the ground. These oases, all of which are guarded by tremendous limestone cliffs, are not only exquisitely beautiful but are famous in history. Herodotus called them "The Islands of the Blest."

The Egyptian Government is about to install fixed wireless stations at Dakhla, the Great Oasis of the Interior (pop. 20,000); Siwa, the Oasis of Jupiter Ammon (pop. 5,000); and Baharia, or the Oasis of the North (pop. 500); and is also putting into service mobile stations mounted on six-wheeled chassis. The control station will be at Cairo, near the Great Pyramids.

Mobile Equipment.

The mobile stations are equipped with both medium and short wave installations. The wave ranges are:—

Short wave transmission, 20/50 metres
Short wave reception, 20/75 metres
Medium wave transmission, 600/2,150 metres
Medium wave reception, 300/10,000 metres

These wave ranges were chosen by the Egyptian State Telegraphs so as to cover every exigency of service which the stations may be required to provide, including emergency ship-to-shore work, medium and short wave point-to-point communication, aircraft work, topographical survey, Frontiers defence and desert patrol communication duties.

The short wave transmitters are of the ZSB2 type, coupled, 100 watts rating, and employ rotary transformers worked from storage batteries. These transmitters are extremely robust and reliable. Associated with the ZSB2 transmitters are type AD20 short wave receivers, employing the latest screened valve circuits and designed to secure great sensitivity with maximum stability and ease of operation.

The short wave emissions are radiated from single wire drum-supported aerials at the top of 30 feet masts, the aerials being adjustable to one-quarter or one-half the wavelength on which it is desired to emit signals.

The short wave transmitters in the oases with which the mobile short wave transmitters will correspond are the simple and efficient Marconi type S100 quarter-kilowatt undriven sets, mounting copper-shielded valves and having a wave range of 15/20 metres.

The optimum short waveband for communication in the Egyptian deserts has been found to lie between 37 and 41 metres.

Medium Wave Apparatus.

The medium wave transmitters for the mobile stations are the UC2 half kilowatt self-contained models. Rectifying valves are not used in these sets, energy being derived directly from 3,000 volts d.c. generators. Single inductance-units provide the required wave range.

For medium and long wave reception RG19a receivers have been installed. These instruments cannot be surpassed in performance by any general purpose receiver known, yet are extremely easy to operate. The tuning elements of the RG 19a receivers consist of four valve-coupled cascade circuits, operated by limited gang-control. The two high frequency amplifiers provide an overall magnification of from 500 to 1,000 times, controllable by resistances placed in series with the screened valve filaments. Both tuners and amplifiers are housed in very robust cases and are supported on shock-absorbers.

The independent power units are simple lightweight water-cooled petrol-electric sets, driving double-output two-field generators, which give 22 amperes at 12/16 volts and 300 milliamperes at 3,000 volts. Provision is also made for the charging by means of these generators of the power storage batteries with which the mobile stations are equipped, which consist of 36 volts 100 ampere hours lead acid shock-proof unspillable accumulator sets.

Normally these cells illuminate the mobile wireless office, but a switch enables the car-lighting battery to be used at will.

Special skids are provided for lowering and raising the generator sets from and into the vans. These skids are employed as bases for supporting the generators when they are being used on soft or sandy ground.

The two 70 feet sectional masts together with the short-wave mast are carried on the roof of the van.

Every component liable to damage by vibration and shock has been carefully sprung, " Sorbo " rubber pads being largely employed for this purpose.

Chassis.

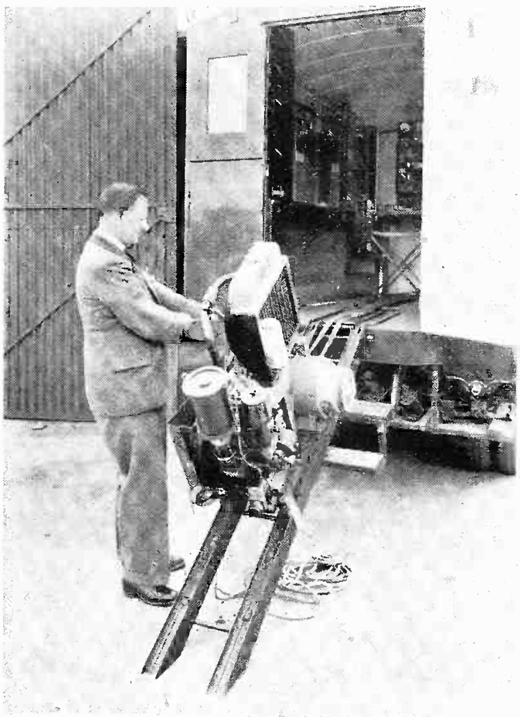
The specification of the six-wheeled pneumatic tyred chassis, conforming generally to the requirements of the Egyptian Frontiers Administration, embodies an exceedingly robust four-cylinder engine giving 35 b.h.p. at 2,500 r.p.m., mounted in a light but immensely strong deep-section channel frame of special alloy steel 17 feet $2\frac{1}{2}$ inches long, with 12 feet wheel base and 4 feet 8 inches track. Two gear boxes provide the vehicle with eight forward speeds. With the engine running at 3,000 r.p.m. the road speed on lowest gear is $3\frac{1}{2}$ miles an hour. On top gear 4 miles an hour can be maintained. The chassis in addition carries a special winch and steel cable operated by the driver, by means of which the vehicle may be extricated from deep, sinkages, while for exceptionally severe conditions such as dunes or stretches of loose sand, caterpillar tracks are provided. The main petrol tank capacity is 17 gallons, and there is also a reserve tank holding a similar amount, transfer being by means of engine-operated pump. A large water-tank is also carried. The chassis-weight has been kept down to two tons.

Bodies.

The detachable bodies are made of reinforced teak and are double, the space between the inner and outer shells being filled with cork-dust after the manner of a refrigerator, thus ensuring protection from the African sun for the operator and his gear.

The wireless bodies are entirely independent of driving cabs and bearers, and are provided with an arrangement by which they can be easily lifted from the chassis, leaving the chassis with cab and bearers, free to receive another type of body, so that when the wireless apparatus is about to be stationed for some time at a particular point the chassis can be released for use elsewhere.

Every year, at the period when the moist westerly gales sweep down the Mediterranean from the Atlantic, deep depressions are formed in the atmosphere over the sea. The heated air over the deserts rushes in to fill up these depressions and sets up fierce dust storms in the Libyan Desert which rage for days at a time. To meet this situation the bodies are arranged so that they can be closed up hermetically. The complete body with wireless generator weighs 1½ tons.



Services Required.

One of the most important functions of the mobile sets will be to maintain communication between the Egyptian Royal caravan and the Egyptian capital when H.M. the King Fouad goes out into the deserts to visit those of his subjects who live there.

Some idea of the exacting conditions the mobile sets have been designed to meet may be gathered from the fact that they will have to cross the great lines of sand-dunes 300 feet high which stretch N.E. and S.W. across the face of the Libyan Desert for hundreds of miles and to accompany the Royal caravan to the Oases. The Egyptian Oases are guarded by cliffs a thousand to fifteen hundred feet high. Entrance to and exit from some of the oases is by means of a precipitous and dangerous pass which the lorries will have to negotiate.

Again, in some of the *wadis* of the Arabian Desert the summer noon temperature reaches 140° Fahr., whilst at some points on the Red Sea littoral the atmospheric humidity is 95%. In contrast to these conditions, snowstorms occur in winter on the Sinai peninsula, and on the mountain road leading to the famous monastery of Saint Katherina founded by the Roman Emperor Justinian, the temperature sometimes falls to 15 degrees below freezing point.

Desert Wireless Patrols.

The oases of the Libyan Desert are connected to each other and to the Nile Valley by tortuous tracks, worn smooth through the ages and lined with the skeletons of countless camels which have perished on the weary trek. One of these ancient trails, known to the Bedouin as *Darb el Arbain,* or " The Forty Days' Road," stretches from Darfur and Dongola in the Anglo Egyptian Sudan to Khargha, the Great Oasis of the Exterior, and thence to the Nile Valley near Assiut. Another equally old route is called *Darb el Towil,* or " The Long Road," and leads from Dakhla Oasis to Beni Addi on the Nile Valley.

It was along these ancient desert roads that vast quantities of spices and gums and great numbers of slaves were brought into Egypt in olden times, and they are still used by the camel caravans which come up from Morocco and Cyrenaica. In these caravans, which may consist of a thousand camels laden with merchandise, there are sometimes concealed international drug smugglers, disguised as simple caravaneers, and the new mobile wireless sets will enable the Egyptian Frontiers Administration patrols out in the desert to keep in touch with the police in Cairo and with the Customs officers in the Libyan oases through which the caravans must pass to obtain food and water, so that more effective steps can be taken to eliminate the traffic in cocaine, opium and hashish.

It is also proposed to employ the mobile sets to aid the Survey of Egypt parties working in the great Qattara Depression ; an immense hollow in the Libyan Desert, 7,000 square miles in extent, commencing 120 miles west of Cairo, and stretching nearly to Siwa Oasis, into which it is hoped one day to admit the Mediterranean Sea, by means of a tunnel, thereby creating an inexhaustible supply of cheap hydro-electric power and rendering Egypt independent of imported fuel supply.

H. WATTERSON.

251(

THE MARCONI DORY TRANSMITTER

This Transmitter has been designed for the purpose of assisting small dories leaving the parent ship in such a way that in the event of an accident or the impossibility of the dory being able to return to the parent vessel, the Transmitter can be used in the emergency and the Direction Finder on the parent ship can be used as a method of orienting the position of the dory.

THE Transmitter consists of a small watertight box approximately 18 in. by 8 in. by 9 in., provided with canvas flaps, and so designed that it can be slung under the seat of the dory in special metal brackets supplied for this purpose.

The Transmitter is a self-contained unit, carrying in its box a 6-volt jelly electrolyte accumulator as a source of power. This type of accumulator has been adopted so that in rough weather there will be no possibility of electrolyte being spilt inside the Transmitter and so damaging any of the essential parts.

Circuits.

The circuits consist of a small plain gap Transmitter with an associated closed oscillatory circuit consisting of a fixed condenser and variable inductance. This closed circuit can be tuned to any wavelength of the order of 180 to 300 metres, dependent upon the size of the aerial used in the dory. The aerial circuit is coupled directly to the closed circuit and an additional lengthening coil included so that the specified wavelength may be tuned without any fine tuning arrangements such as variometers, etc.

All the apparatus is totally enclosed in the watertight box, the only exposed terminals being the aerial and earth terminals.

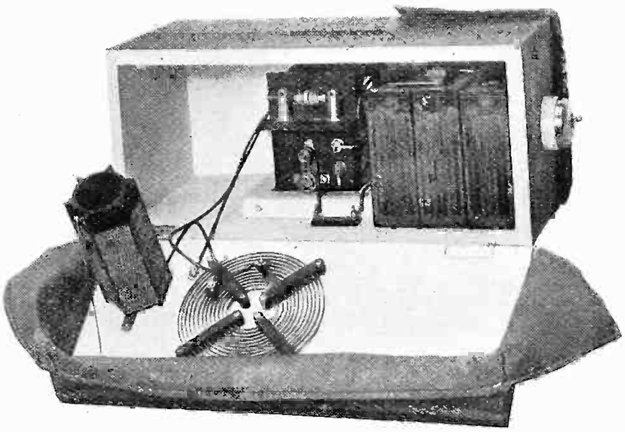
Keying.

A special feature of this Transmitter is the fact that it is foolproof, both from the point of operation and from the point of keying. It is appreciated that the personnel who will handle this Transmitter have no knowledge of the morse code, and to provide for this keying is accomplished by the slow rotation in a clockwise direction of a small handle which carries a wheel, the periphery of which is cut in such a way as to carry a letter, and this letter is then followed by a long dash. The letter is chosen to designate the particular dory on which the Transmitter is fixed, and the object of following up this letter by the long dash is that once the operator of the parent ship hears the dory calling, he knows the particular dory from the letter transmitted, and the long dash enables him to take an accurate D.F. bearing on the position of the dory.

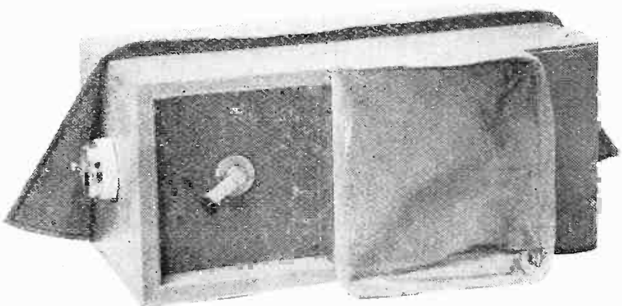
In actual operation it is essential to press a small switch on the end of the Transmitter in order to complete the circuit with one hand, and to rotate the handle of the transmitting wheel slowly with the other.

Adjustments.

All adjustments are made by the Wireless Operator on the parent ship before the dory leaves the vessel. They consist of determining the wavelength which is to be used by the group of dories, tuning the enclosed circuit to this wavelength, and regulating the aerial circuit to interresonance with the particular closed circuit wavelength chosen. The only possible adjustment other than this that might be



required from the Operator is the adjustment of the make and break on the induction coil. This make and break is specially designed to give almost continuous working over an indefinite period, provided the contacts are kept reasonably clean. Spare contacts and springs are provided with the Transmitter, but these contacts should only be adjusted by the Wireless Operator in charge of the parent vessel.



Range.

The Transmitter gives approximately ·3 amps. in an average dory aerial, and with a modern Direction Finder it is anticipated that this range will be sufficient for 15 to 20 miles good direction finder working.

Aerials.

The aerial arrangements must be the simplest possible, and it is suggested that one light bamboo pole be utilised at each end of the dory to support a single wire "L" shaped aerial. Insulators can be of the light broadcast "egg" type.

Earth.

The Operator must provide that a reasonable earth connection is made from the earth terminal to a piece of heavy flex, which can either be taken through an earthing bolt on the side of the dory on to an earth plate, or if this is not feasible the heavy flex may be carried over the side of the dory and immersed at least 3 or 4 ft. in the water.

Power.

The power for the transmitter is drawn from a 6-volt 30 ampere hour accumulator, using jelly electrolyte. Under normal conditions there is sufficient power in these accumulators for at least ten hours continuous working.

R 612

THE WARSAW BROADCASTING TRANSMITTER

The new Polish broadcasting station at Rasin, near Warsaw, will be equipped with a Marconi Transmitter Type P.B.3 which possesses several features of more than usual interest.

We may state with confidence that this transmitter presents an outstanding example of super-power broadcasting development in its most modern form, and is one more indication, if such indeed is called for, that British enterprise and industry is not easily to be outpaced by that of any other nation.

THE power of the transmitter to be described below is considerably greater than that of any broadcasting station previously erected, the aerial carrier energy being 120 kw. when adjusted for 80 per cent. modulation, resulting in a C.C.I.R. rating of very nearly 160 kw.

$$(120 \times 1 + \frac{0.8^2}{2} = 158.4).$$

The main power stage of the set employs valves of a new type, capable of greater power input and higher voltage working than has previously been possible with valves of European manufacture.

In general circuit design and in external appearance the Warsaw transmitter closely resembles the installations already operating at Brookman's Park, London, and Stockholm, modified, of course, to suit the increased power rating and the longer wave length, which in this case is adjustable from 1,000 to 1,600 metres, the present wave length allocated to Warsaw being 1,411 metres (212.5 kilocycles).

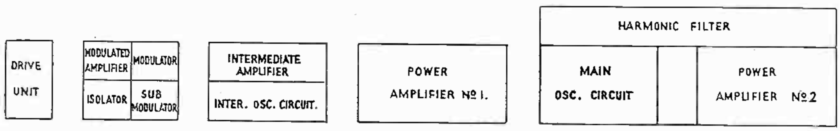
For purposes of description the transmitter may be conveniently separated into the following component units :—

(1) The Constant Frequency Drive.

This consists of a small receiving type valve in conjunction with a special oscillatory circuit, constructed of particularly rigid components, enclosed in a thermostatically controlled temperature chamber. The precautions taken are such that the frequency of the oscillator is kept constant to about one part in fifty thousand for long periods of time. A precision vernier adjustment of a variable condenser, forming part only of the total oscillatory circuit capacity, enables the frequency to be adjusted within very fine limits, and the circuit being maintained at a constant temperature and calibrated serves as a station wavemeter of a high order of accuracy. The drive itself oscillates at twice the working wave length required and is coupled to a screen grid valve, which acts as a frequency doubler. Three stages of amplification including an isolator raise the power level to a suitable value for driving the modulated amplifier.

(2) The Modulated Amplifier and Modulators.

In this unit an amplifier taking an input of 250 to 300 watts is arranged for anode voltage modulation by means of an anode impedance and the operation of a modulator and sub-modulator stage. The design is such that full modulation of the oscillatory output is possible with a grid input to the sub-modulator of approximately 10 milliwatts.



SCHEMATIC LAY-OUT OF BROADCASTING TRANSMITTER TYPE PB3

(3) The Intermediate Amplifier.

Comprised in this unit are eight water-cooled valves (Type CAM.3) of which six are normally in use, the other two being available as spare. Automatic switches connect the grid and filament of these spares into the circuit as soon as the filaments are brought to correct temperature by means of wheel operated rheostats.

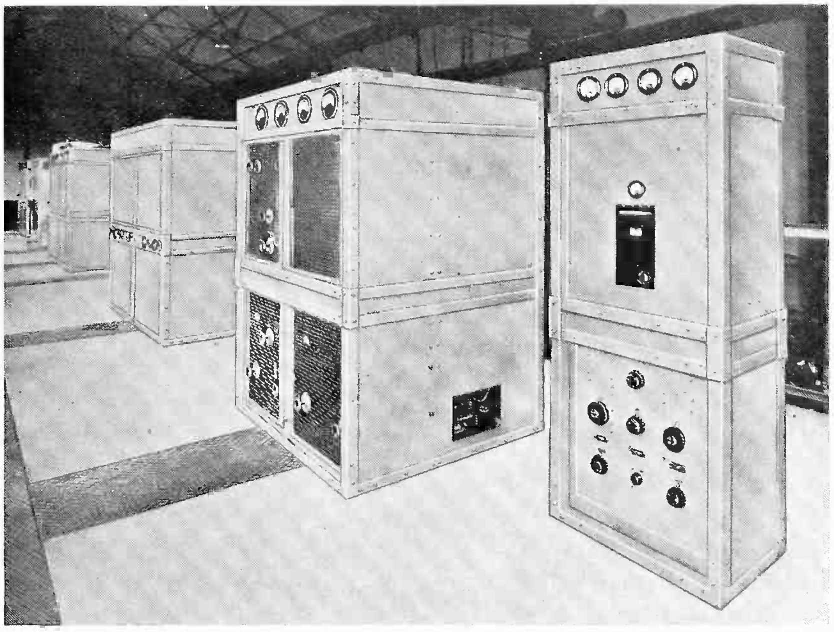
This unit is complete with its oscillatory circuit in the one shielded case.

The characteristic of these valves and the negative bias adjustment is such that they operate without grid current even at the maximum voltage swing of the grid input oscillations. The efficiency of the stage is low under such conditions, but on the other hand only a comparatively small power is required to drive it.

The anode input to this stage is approximately 40 kw. and the coupling to the final power stage is accomplished by means of condensers.

(4) The Power Amplifier.

Particular interest centres round the valves in this stage. These are eight in number mounted in sets of four in two frameworks, which are disposed one on each side of a central screened case holding the inductances and condensers forming the main oscillatory circuit. Normally six valves will be in operation at one time, leaving the other two for use as spares. The valves, known as Type CAT.10, are manufactured by the Marconi-Osram Valve Co., and represent a marked advance on previous types. The dead loss rating is set at 50 kw., and the valves are suitable for operating at voltages up to eighteen thousand. The filament current is approximately 225 amperes at about 30 volts, say 6·75 kilowatts, and the emission at this input is of the order of 40 amperes. Each valve is mounted on a wheeled truck or carriage, which facilitates and makes safer insertion or removal from the valve framework.



General View of Set.

At Warsaw it is intended to supply these valves at between fifteen and sixteen thousand volts. The total power input to the anodes required is about 450 kilowatts, which gives an aerial power of 120 kilowatts, and under these conditions a linear response is obtained to applied modulation up to 80 per cent.

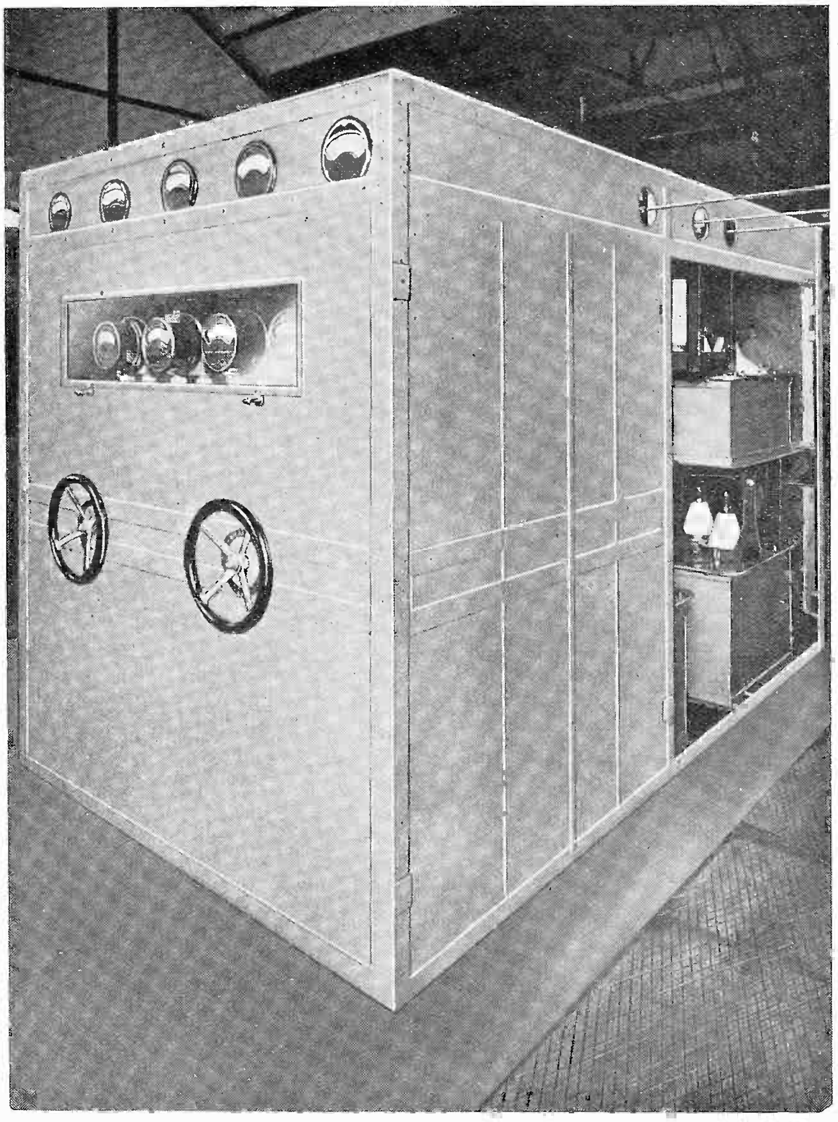
Using all the eight valves in this stage it will be possible to generate an aerial carrier power of 160 kilowatts, giving a C.C.I.R. rating of well over 200 kilowatts.

$$(160 \times 1 + \frac{0.8^2}{2} = 211).$$

Every water-cooled valve in the transmitter, both in this stage and the intermediate amplifier, is fitted with a Thermostatic relay which operates a buzzer and a red lamp should the cooling water temperature exceed a certain predetermined limit.

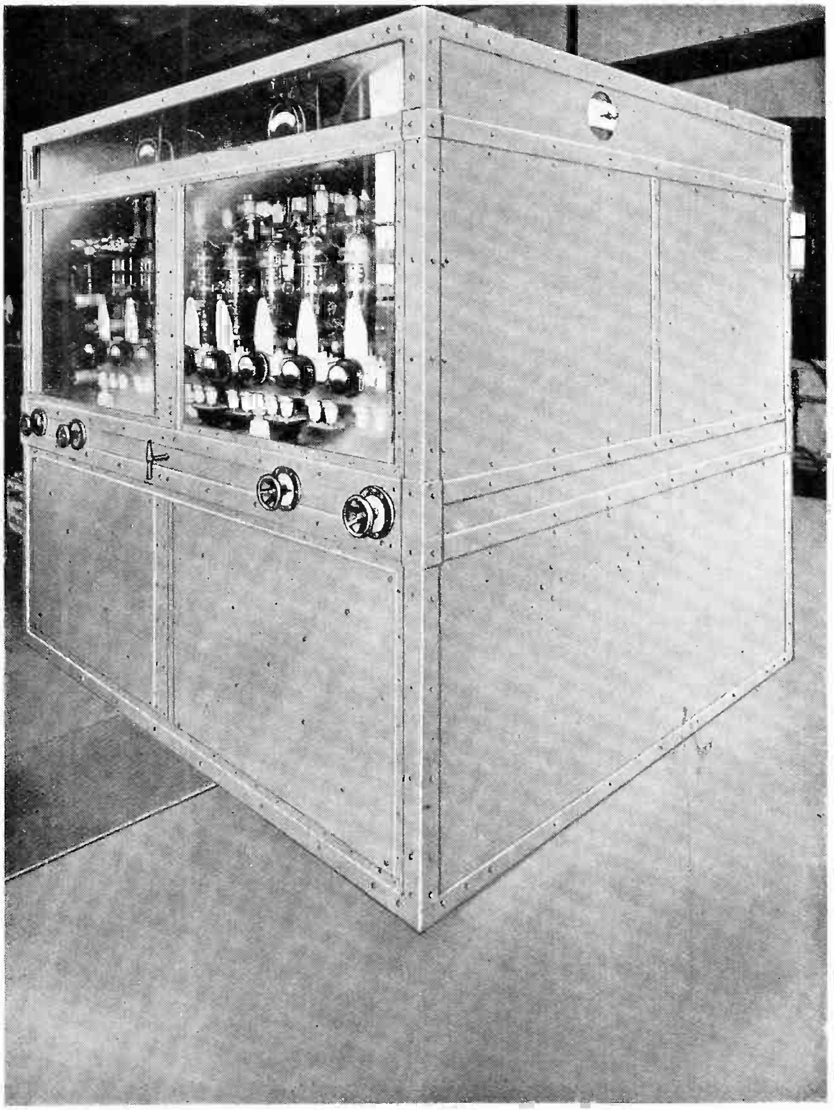
(5) The Harmonic Filter and Aerial Coupling Unit.

On account of the high power of the station, and particularly bearing in mind the working wave length, great care has been taken to reduce harmonic radiation to the lowest possible limits. One of the principal factors in securing the necessary attenua-



Main Oscillatory Circuit.

tion is a low-pass filter, which is inserted between the output circuit of the transmitter and the aerial feeder. The filter comprises three sections, and is, of course, completely enclosed in a metal screening case. It is designed to work into a terminal impedance of 500 ohms, and the twin wire feeder which conveys the power to the remote aerial is consequently designed to have a surge impedance of the same value.

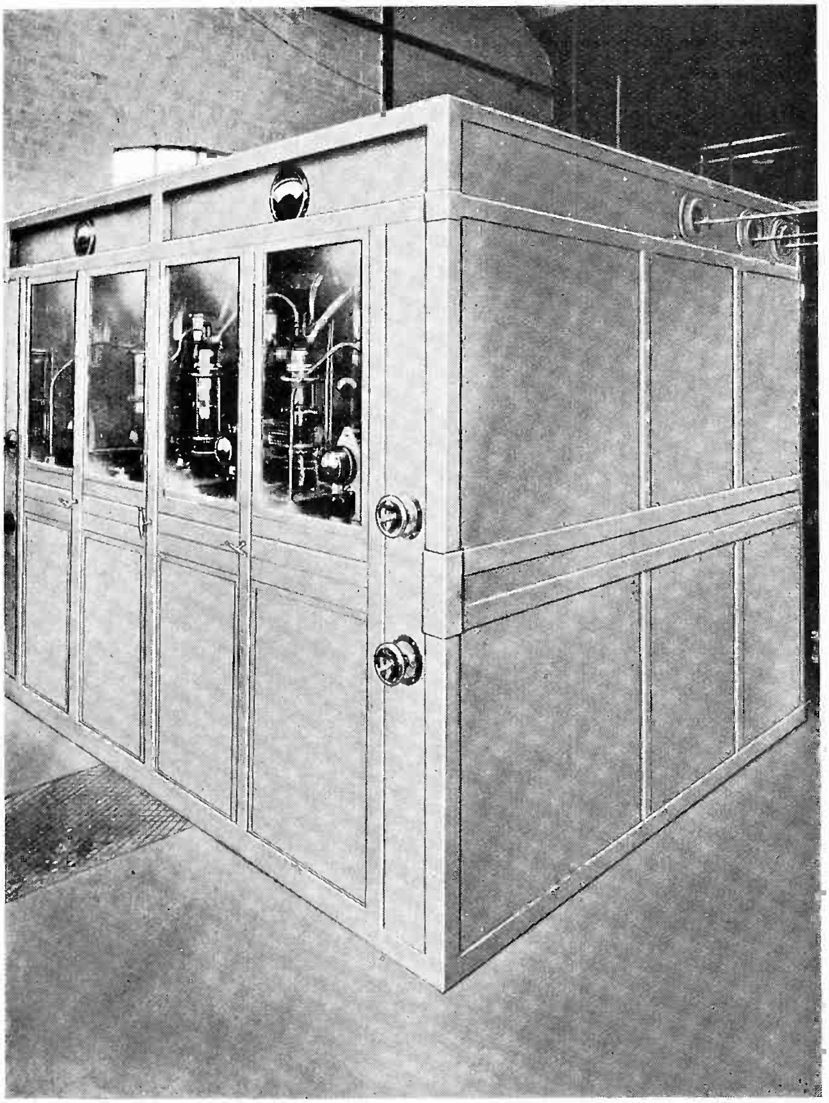


Intermediate Amplifier.

The feeder terminates across a condenser, forming a capacity coupling to a tuned closed circuit, to which in turn is coupled the aerial. The aerial will be supported by two towers of 200 m in height, and aerial heating arrangements will be provided for melting ice or snow from the wires.

(6) The Rectifier and other Power Plant.

Power for operating the station will be taken from an outside three-phase supply. The main high tension direct current required for the intermediate and power ampli-



One of the Last Stage Power Amplifiers.

fier valves is to be provided by Brown-Boveri mercury-steel arc rectifiers. Two of these are being installed, each rated at 500 kilowatts at various voltages between 10,000 and 15,000. The first of these high voltage arcs to be employed for radio work was erected by the British Brown-Boveri Company in the Marconi Research Laboratories at Chelmsford, the particular unit being rated for 400 kw. at 12,000 volts, and has proved very satisfactory in service. The high efficiency, ruggedness and negligible maintenance costs, enable this type of rectifier to compare very favourably with any alternative method of generating high tension direct current. The Warsaw arc rectifiers have actually been tested up to 800 kilowatts at 28,000 volts, so there is obviously a large factor of safety in hand.

The rectifier is arranged to produce hexaphase currents, and the ripple is filtered by the usual arrangement of iron core chokes and condensers. The greater part of the capacity is grouped at the end of the smoothing circuit, and this will prevent any undue attenuation of the low note register during modulation.

The various valve filaments will be heated by a direct current dynamo capable of delivering 2,200 amperes at 20 to 40 volts.

A separate rectifying plant using glass envelope thermionic valves will provide the D.C. supply at 3,000 volts, required for the low power stages of the set.

Grid bias voltages are taken from D.C. dynamos varying from 50 to about 2,000 volts, as necessary for the different types of valves employed.

General.

Rather elaborate arrangements have been incorporated in the transmitter for ensuring the safety of the staff, and the valves. The various units of the set are all fitted with doors which cannot be opened without automatically cutting off the power and manually earthing all high voltage "bus-bars." The power switch is also interlocked with safety relay operated by the filament and grid bias voltages and the water flow indicator.

A control unit, on which are grouped voltage regulating apparatus and important indicating instruments, enables the transmitter to be operated and kept under observation from a central point.

A very complete range of measuring instruments is attached to each unit of the set so that the adjustment and operation of each stage can be correctly made and instantaneously checked.

The full power tests of the set, which were carried out at the Marconi Works, Chelmsford, have been extremely satisfactory.

The CAT.10 valves have worked with great ease and stability, and have shown not the slightest indication of internal discharges.

W. T. DITCHAM.

R5.26

WIRELESS DIRECTION FINDING AS AN AID TO AERIAL NAVIGATION

The following description of directional transmission and reception systems as applied to aircraft, indicates that each of the available systems possesses certain advantages and also certain disadvantages. There is no one system which can be said to be the "best," as the most satisfactory system to be employed depends entirely upon the local conditions of the route which is under consideration.

It has accordingly been the aim of the author to outline the pros and cons of the various systems with a view to assisting Air Operating Companies and others to understand the problems concerned, and to enable them to select that form of directional assistance which is most suited to their particular needs.

General.

THE art of navigating any mobile craft depends essentially on being able to determine the position of that craft with relation to a fixed point or points; the position may either be obtained in the form of a bearing on, and a distance from, any known fixed point, or of simultaneous bearings from two or more fixed points, which bearings are laid off on a chart and denote, by their intersection, the position of the craft at the time.

In practice, the former method of obtaining the position of the craft is seldom employed owing to the difficulty of gauging distance in a direct line; the latter method is, therefore almost universally used, whether the mobile craft be on land, at sea, or in the air, and different means are employed for ascertaining the bearings of the fixed points. For example, light waves, sound waves, wireless waves and infra-red waves are all used for this purpose, according to their suitability to the particular conditions.

The aircraft is, without doubt, one of the most difficult craft to navigate by the traditional visual methods; for one thing it is often not large enough to carry a specialist navigator on board, all navigation having to be undertaken by the pilot himself, who is usually fully occupied with flying the aircraft, etc.; even if serious navigational work can be undertaken on board the aircraft, such work has usually to be carried out under most uncomfortable and inconvenient conditions; and lastly, those conditions of visibility which render visual methods either entirely or to a large extent useless are just those which call for the greatest amount of navigational assistance being obtained by the pilot of the aircraft, and which most jeopardise the safety of the aircraft which (except in the case of an airship) cannot like other craft, reduce its speed to a safe figure under these conditions.

Under normal conditions of visibility, aircraft are navigated by the simplest of "visual" means, *i.e.*, by the pilot keeping continual track of the position of his aircraft by reference to landmarks on the ground which are either known to him or else verified from a map; should, however, conditions of poor visibility obtain, this method becomes useless, and the pilot is forced to fall back upon one or other of the more scientific methods of navigation. Of these, there is no doubt that the most useful and the most usually employed are those methods which are provided by wireless.

Wireless direction finding systems can be divided into two basic types, which are as follows:—

(A) Those which employ directional transmission from a fixed point and non-directional reception in the mobile craft.

(B) Those which employ non-directional transmission from a fixed point and directional reception in the mobile craft, or *vice versa*.

It is not proposed in this article to give a detailed technical description of the various systems of directional transmission and reception which are available at the present time, since the reader who is interested in this matter can refer to the numerous text books on the subject, but it is felt that a brief description of the various systems is essential for a proper understanding of the problems involved in the navigation of aircraft by wireless methods.

Directional Transmission Systems.

The systems of directional transmission which are at present available for use, are provided by the "equisignal" beacon and the "rotating" beacon transmitters; each of these comprises a fairly powerful and costly transmitter, which is obviously only suitable for ground installation.

Equisignal Beacon.

The equisignal beacon transmitter provides a number of "zones" of equal signal strength, which radiate in straight lines from the transmitting aerial system and which can be oriented in any desired direction; the presence of the "zones" is indicated to the pilot of an aircraft either by means of a characteristic signal received in the telephones of his receiver, or by means of a visual indicator installed on the dash-board of his aircraft and operated by his receiver.

By means of either indicator, the pilot is continuously notified whether he is on his correct course or not, and if not, whether he is to port or to starboard of the course. Such indication does not, in itself, give the pilot any information as to his actual position, *i.e.*, how far along the particular course he has flown; this information is supplied by what are known as "marker" beacons, which are erected at periodic intervals along each course of the route, and which comprise low-power non-directional transmitters, each of which transmits a characteristic signal which is received by the pilot in the form of either an aural or a visual indication. The ground-to-air range of such marker beacons is small, being of the order of 5 miles, and their purpose is simply to "mark off" each course and give the pilot an automatic indication of position as well as of his course. Arrangements can also be made whereby telephone transmission from either main or marker beacons can be temporarily provided in place of the normal beacon transmissions; by this means, information as to route, weather conditions, etc., may be broadcast to pilots flying along the route.

The results obtained with this system under conditions of daylight are very satisfactory, ranges of up to 120 miles or so having been obtained on numerous occasions, the width of the equisignal zone being of the order of 3 miles at a distance of 60 miles from the transmitter, *i.e.*, the angular width of the zone being of the order of 3°.

In this connection it is of interest to note that the use of a vertical rod antenna in the aircraft for reception purposes is claimed in certain quarters to be an essential factor in securing freedom from "night affects," *i.e.*, in permitting of the system giving as accurate results by night as by day; a considerable body of technical opinion is, however, doubtful if this is the case, since, from a purely scientific study of the matter, it would appear that "night effect" is bound to be present with this system, although the magnitude of such effect may be so small as not seriously to impair the practical efficiency of such a system at night. Prolonged and extensive tests during darkness have not at present been carried out in the country, and the results of such tests when they are made, will doubtless be of the greatest interest both to technicians and to aircraft operating companies and their pilots.

A further criticism of the use of a vertical rod antenna is that it is difficult to construct such an antenna which, while being airworthy, will not seriously detract from the performance of the aircraft. Furthermore the use of such an antenna necessitates the complete screening of the engine ignition system, on account of the small pick-up obtained and the consequent need for extremely high amplification in the receiver; this latter requirement involves additional cost and weight and maintenance difficulties, and is not welcomed, at the present time, by aircraft operating companies in this country.

The "equisignal" type of beacon is obviously only applicable where each of the routes to be followed consists of a number of straight line courses, each course being of some considerable length (for example, 50 to 100 miles), as otherwise the cost of the numerous beacon transmitters which would have to be installed to cover the route would be prohibitive; furthermore, it has the disadvantage of concentrating aircraft flying in a given area along one or more sharply defined courses, with the resultant increased risk of collision during conditions of poor visibility.

Rotating Beacon.

The "rotating" beacon provides a means whereby transmissions are continuously revolved at a regular and pre-determined speed through space, the intensity of the transmission at any point at a given distance from the beacon depending entirely upon the bearing of the beacon from the point in question ; the intensities of the transmissions revolved comprise, per revolution, two broadly defined maxima 180° apart and two extremely sharply defined minima also at 180° from each other, the maxima and minima being 90° apart. The transmission from the beacon is continuous, except when the plane of the minima is in either the N—S or the E—W direction, in each of which cases the transmission is interrupted for the sending of a characteristic signal. The rotary beacon accordingly corresponds very closely in its functioning to a luminous beacon of the revolving type which produces two very broadly defined beams of light 180° apart and two extremely sharply defined eclipses also 180° apart, but 90° apart from the axis of the light beams, and which in addition flashes a characteristic signal when the plane of the eclipse is in either the N—S or the E—W direction.

Hence, in the case of either the luminous or the radio beacon, an observer knowing the rate of revolution of the beacon, and provided with (A) a stop watch, and (B) a means of observing both the "starting" signal and the "eclipse" or minima as it passes him, will be in a position by simple computation, to calculate the time interval between these two observations, and hence the angle through which the eclipse (or the minimum intensity, in the case of the radio beacon) has swept between the true N—S plane and the plane formed by a line joining his position to that of the beacon, *i.e.*, he will know the true bearing of the beacon from his position.

The radio beacon is usually arranged so that one complete revolution per minute is made, *i.e.*, 360° per 60 seconds or 6° per second ; furthermore, the "starting" signal and the passing of the minima is observed in the form of a varying strength of signal on the telephones of a normal receiver and, finally, a specially calibrated stop-watch is provided, in which the seconds hand "boxes the compass" in one complete revolution, *i.e.*, in one minute. An observer accordingly starts his stop-watch when he hears, say, the characteristic N—S signal, and stops it when he hears the first of the two minima—which, as stated above, are extremely sharply defined and which can, with practice, be gauged to less than one half of a second ; the position of the seconds hand then gives him a direct indication of the bearing of the beacon from him.

From the foregoing it will be seen that no extra equipment is required in the aircraft over and above the normal receiver—apart from the stop-watch—and what is more important, any number of aircraft can avail themselves simultaneously of the direction finding service ; furthermore, the service is not—as in the case of the equisignal beacon—confined to certain pre-determined straight line courses radiating from the beacon, but is available in any direction from the beacon up to the limit of range available. Unfortunately, by virtue of the fact that the radiating circuit of the transmitter is extremely inefficient, comprising a relatively small closed loop of wire (which is revolved, as explained earlier), the power of this type of beacon—and hence its cost—has, for a given range, to be greater than that of any other type of directive or non-directive ground beacon transmitter ; furthermore with this type of beacon freedom from night effects cannot be definitely guaranteed, *i.e.*, the accuracy of the system at night is liable to be of a lower order than that obtainable by day.

In practice, however, exceedingly successfuly results have been obtained, in daylight, with beacons of this type, an average accuracy of within a degree or two being possible when observations are made on the ground, and within three to five degrees when the observations are made in the air ; under certain conditions it is possible to foresee a great use for a chain of beacons of this type, especially where navigational aid is required over an area in which aircraft are not flying along a few pre-determined routes, but where the area is more or less completely covered by a network of routes.

Other Directional Transmission Systems.

In addition to the above systems of directional transmission which have definitely reached the stage in which practical use can be made of the navigational aid provided, experimental work is at present being carried out on several other forms of directional transmission. In one system, for example, a sharply-defined unidirectional "beam" (which is produced by means of a special aerial system comprising a number of vertical energised aerials having reflecting aerials—also vertical—behind them, the whole system being mounted on a rotatable frame) is continuously rotated through space at a predetermined angular speed ; distinctive Morse signals are transmitted when the "beam" is oriented in the various directions corresponding to each of the cardinal points of the compass, and ultra short wavelengths (of the order of 6 metres) are employed. When the receiver on the mobile craft is tuned to the correct wavelength, a series of three of four of these distinctive signals are heard at regular intervals of approximately two minutes : these signals occur in a definite order, which, by reference to the chart of distinctive signals transmitted indicates the orientation of the "beam" as it sweeps past the receiver, and hence the true bearing of the transmitter from the receiver. In a second system, a sharply defined unidirectional "beam" is projected in any desired (fixed) direction ; short wavelengths are employed and an indicator is provided on the aircraft to warn the pilot whether he is flying along the correct course or not. In another similar system, the "beam" can be oriented in any desired vertical as well as horizontal plane, with a view to providing assistance in landing during fog. In yet another system, a combination of two rotating beacons is utilised, short wavelengths being employed ; the total time per revolution of each beacon is identical (the beacons being synchronised for the purpose), but the speeds of revolution of the beacons are different, being governed in each case by a cam or similar mechanism. By so arranging the contours of the cams it is possible to arrange that the successive points of intersection of the zones of maximum intensity which are swept out by each of the beacons will trace out, in space, any desired path, which can be altered as required by altering the contours of the respective cams ; a continuous series of dashes is transmitted by one beacon and a series of dots from the other. Hence the pilot of an aircraft flying along the correct course will hear in the headphones of his wireless receiver, for each revolution of the beacons, a continuous signal formed by the "interlock" of the dots and dashes ; should, however, he be to one side of his correct course, he will hear, for each revolution of the beacons, a series of dots followed by the continuous signal, followed in turn by a series of dashes, or, if he is to the other side of his course, a series of dashes, followed by the continuous signal, followed in turn by a series of dots. It is claimed that, by careful mathematical study of the contour of the cams, it is possible so to arrange matters that the number of dashes (or of dots) heard by the pilot before the commencement of the continuous signal, will be an indication of the lateral distance by which the aircraft is off the correct course. Each of the above systems, it will be noted, employs short wavelengths ; owing to the well-known effects associated with short wave propagation, however, such as "skip," "scattering," etc. (which are phenomena inherent to propagation at these high frequencies), further experimental work on short wave directional transmission systems will be necessary before a decision as to their practical value can be given.

Directional Reception Systems.

The basic principle underlying the operation of all systems of directional reception is that the reception properties of an aerial consisting of a simple loop of wire are directive, being at a maximum in the plane containing the loop, and at a minimum at right angles to this plane ; the two maxima in the plane of the loop, which are of course 180° apart, are broadly defined, whereas the minima at right angles to this plane are extremely sharply defined. Hence, if the loop aerial be connected to a receiver, tuned to the wavelength of the transmitter whose direction it is desired to ascertain, and slowly rotated in the field produced by this transmitter, two positions of the loop will be found in which the strength of the received signal will rapidly decrease to zero and as rapidly increase again in audibility ; these two positions of the loop will, of course, be in the same plane (*i.e.*, will be 180° apart), and this plane will be at right angles to the plane joining the source of the transmitted signal and the directional receiver. From this it follows that the orientation of this latter plane can be ascertained with no small measure of accuracy, the only information which is lacking in this simple system being that the actual bearing of the transmitting station relative to the directional receiver is subject to an ambiguity of 180° ; in the various systems which have been developed from this simple system, devices are, in most cases, incorporated in order to overcome this ambiguity and to give the actual bearing of the transmitting station. Before describing the more important of these systems it is as well to point out that in most cases the directional receiver can either be installed on the ground (and take bearings of the aircraft transmissions), or can be installed in the aircraft (and take bearings on transmissions emanating from known points on the ground) ; there is, however, one exception to this rule, which occurs in the case of the Marconi-Adcock system, in which the aerial system necessary could only be installed on the ground, for both technical and practical reasons.

Marconi-Bellini-Tosi System.

In this system, the aerial system comprises two loops of wire rigidly supported at right angles to each other and to the horizontal ; each loop is split at the centre of its base, and a pair of leads run from there to the apparatus which is employed for taking bearings, *i.e.*, the radiogoniometer. This latter comprises a relatively small unit containing two coils of wire rigidly and accurately supported at right angles to each other (the field coils), within which coils lies a rotatable coil called the search coil ; this latter is mounted on a spindle, one end of which projects through to the outside of the case containing the field and search coils, where it is provided with a knob of convenient size for comfortable operation, and with a pointer, which, of course, rotates with and indicates the position at any moment, of the search coil. A carefully engraved scale from 0° to 360° is provided on the outside of the case, in such a manner that the orientation of the pointer can be read with great accuracy. From the search coil of the radiogoniometer two leads run to the tuning and amplifying circuits, the output of which latter is taken to a pair of telephones.

Transmissions arriving from any particular direction induce high frequency voltages and currents in each loop and hence in each field coil, their magnitude depending on the angle formed by the plane of the loop and the line joining the transmitting and receiving stations ; the result is the formation of a "resultant field" within the field coils, the plane of this field being identical with that of the incoming transmission. By rotating the search coil within this field, therefore, an operation is performed which is identical with that which takes place when a simple loop aerial is rotated in the field of a transmitter, *i.e.*, two broadly defined positions will be found where signal strength is at a maximum, and two sharply defined positions where the signal strength is at a minimum. By calibrating the radiogoniometer, *i.e.*, by taking observations on a transmitter whose bearing relative to the receiver can be accurately obtained from a map or calculated by other means, and by then altering the position of the pointer relative to the spindle of the search coil until the position indicated by the pointer on the scale tallies exactly with the bearing as so determined, the bearing of any transmitted signals can be obtained by the simple process of tuning the associated circuits to the correct wavelength, rotating the search coil until a position of minimum signal is found, and reading the bearing off the radiogoniometer scale. As mentioned above, the bearing so obtained is subject to an ambiguity of 180°, but, by means of a special circuit which can be switched in or out at will, the "sense" of the bearing can be obtained, *i.e.*, the true bearing differentiated from that which is incorrect by 180°.

This system is obviously applicable to either ground or aircraft use. In the former case, the aerial system usually comprises two single turn loops of triangular shape supported on a central mast some 80 ft. in height and having a base of some 100 ft. or so. Such a station, if erected at an aerodrome, can ascertain the bearing of transmissions emanating from an aircraft, and hence of the aircraft itself; furthermore, by providing two or more such stations to cover a particular route, with a rapid means of intercommunication between them, it is possible to ascertain with great accuracy the position of an aircraft by taking simultaneous bearings on the aircraft's transmission at each station, laying off the bearings on a chart, and ascertaining the resultant position as given by the intersection of the bearings. This application of the Marconi-Bellini-Tosi method is extensively employed for civil air route work in Europe, and offers the advantages that: (A) the pilot is given an actual position without any necessity for calculations on his part; (B) the process of obtaining a position is effected in a very short time, a minute and a half sufficing so far as British D.F. stations are concerned; (C) the system is capable of great accuracy by day; (D) a network of such stations can serve a large area, not being confined to a few directions, as in the case of the equisignal beacon. On the other hand, there are certain disadvantages with the system, which are as follows:—(A) In order to obtain a bearing or a position, a transmission for the aircraft is necessary. In these days when air route traffic is becoming relatively dense, the wave allotted for aircraft communications is congested, and any extra transmissions on this wave should be eliminated; of course, this could to a certain extent be overcome by utilising a different wavelength for D.F. purposes than for normal communications, but this involves the provision of two receivers (and possibly two transmitters) on the ground—one for normal communication work and the second exclusively for D.F. purposes—in place of the one which is at present employed for both purposes, and also involves a rapid and simple wave-changing device being fitted to the aircraft set. Furthermore, while the D.F. work is going on, the aircraft is out of touch with the ground for normal communication purposes. (B) Only one aircraft can be served at a time, by any given D.F. station or stations; with dense traffic in any particular area, when conditions of visibility are bad, the delay in service which occurs is often a matter of some import.

Where the Marconi-Bellini-Tosi system is applied to aircraft, *i.e.*, where the directional receiver is installed on the aircraft, the aerial system comprises two single or multi-turn loops insulated from, but rigidly affixed to the structure of the aircraft, their planes being at 90° from each other ; operation of the direction finder is in all respects similar to when installed on the ground. Bearings can be taken on any known ground transmitter whose wavelength lies within the wave band of the receiver, and hence—by laying-off methods—the position of the aircraft can be calculated with great accuracy. This system has been extensively used on long distance flights oversea, as, for example, on Major Franco's transatlantic flight in 1926, and Captain Courtney's attempted transatlantic flight in 1928 ; in the latter case, the prompt rescue of the crew after the accident which forced the aircraft down in mid-ocean can be truly ascribed to the presence of a Marconi-Bellini-Tosi direction finder and an aircraft transmitter on board the aircraft.

This application of the Marconi-Bellini-Tosi system has—like all aircraft D.F. systems—numerous advantages and certain disadvantages. On the one hand, it permits of an aircraft so equipped obtaining D.F. navigational aid in any quarter of the globe where ground wireless transmitting stations exist, even where no ground D.F. facilities are available ; furthermore, bearings can be taken and D.F. navigational aid obtained without the necessity for any transmission from the aircraft and—in many cases—without any additional transmission from the ground. On the other hand, however, the operation of taking bearings and of laying them off for calculation of position, necessitate the carriage of a trained operator and/or navigator on board the aircraft, in addition to the pilot and mechanic ; furthermore, the small pick-up of the loops used for reception necessitates the use of a highly sensitive receiver, which, in the case of most types of aircraft, in turn necessitates the screening of the engine ignition system for satisfactory reception, with the consequent addition of weight and maintenance difficulties.

This disadvantage can, however, be to a great extent overcome by the use of statically-screened loops in place of the normal large-area loops ; these loops are approximately 4 ft. in diameter and are enclosed in a static screen of streamline section, with the result that they can be mounted on the exterior of the aircraft well towards the tail assembly, *i.e.*, well away from the engines, and screened leads run forward up to the receiver which is installed in the normal position. Owing to the smaller area turns of these loops as compared with the normal type, the pick-up is appreciably less, but the interference received from the ignition system is reduced to an even greater extent, with the result that the range obtainable is greater than with the normal loops and an unscreened engine, and nearly as great as if the engine ignition system had been completely screened.

One grave defect is, however, present in the Marconi-Bellini-Tosi system in common with all other systems except the Marconi-Adcock system (which will be described later) ; this is that at any time between sunset and sunrise, it may be impossible to obtain satisfactory bearings owing to what is termed "night effect." At certain times while "night effect" is present, the minimum on which the bearing is taken, is so badly defined as to make it impossible to take an observation; at others the minima are sharply defined but anything up to 30° or 40° inaccurate, and at others again they are normal. The result is that no D.F. service can be guaranteed at night, which, in these days of incipient night services, is a matter of great import. Hence, the evolution of the Marconi-Adcock system is one of the greatest advances in the art of wireless direction finding that has been made for many years.

Marconi-Adcock System.

This system has been developed within the last few months, in order to provide a service having all the advantages provided by the Marconi-Bellini-Tosi system, but lacking its chief disadvantage, *i.e.*, the susceptibility to "night effect." In this it has been remarkably successful, as searching tests have shown, and it is anticipated that this system will be in extensive use in the very near future all over the world, as it is the only system at present in existence which will permit of an accurate D.F. navigational service being given at night.

"Night effect," in so far as it effects wireless direction finding systems, is due to the effect on a normal directive aerial system of vertically polarized waves, which have been reflected from the Heaviside layer and which, in combination with the non-polarised waves which have travelled along the earth's surface from the transmitting aerial, produce an effect which results in the normal directive properties of the receiving aerial system being distorted—and, in some cases rendered non-existent. These effects are unfortunately completely variable, and may vary from second to second, minute to minute, and hour to hour; hence, any D.F. system which is affected by such reflected waves is practically useless during darkness.

The principle of the Marconi-Adcock system is to provide an aerial system which is unaffected by these reflected waves, and which is only affected by the direct waves. The aerial system is suspended from four self-supporting wooden masts on lattice steel towers some 70 ft. in height, and arranged at the four corners of a square whose diagonal length is approximately 300 ft. from a cross arm at the top of each of the masts or towers is suspended a single vertical wire, which, at its base (approximately 5 ft. above the ground) is connected to a junction box from which runs Franklin feeder tube along the diagonals of the square to the building housing the radiogoniometer and amplifier, which is placed at the geometrical centre of the square formed by the four masts or towers. This feeder tube comprises two concentric copper tubes, the inner or conducting tube being insulated from the outer tube by means of annular porcelain insulators spaced at regular intervals; the feeder tube is supported at a height of some 2 ft. off the ground, and is earthed at several points. Before entering the building, each of the four tubes is taken underground and led up through the floor of the building direct to a special radiogoniometer which is provided with a complete metallic screen, to which each of the outer tubes is very carefully connected ; the inner tubes are connected to the radiogoniometer from which screened leads are taken to the associated tuning and amplifying circuits in the same manner as with the Marconi-Bellini-Tosi system.

In so far as the basic principle underlying this system is concerned, *i.e.*, the use of a radiogoniometer, there is no difference from the Marconi-Bellini-Tosi system, furthermore, the method of operation is identical, but as stated above, the fundamental advantage of this system is that " night effect " is eliminated and a satisfactory service can be offered when it is most required, *i.e.*, during conditions of fog or low cloud at night.

Marconi-Robinson System.

This system is a development from the simple loop method of obtaining directional reception, and is only applicable for installation on aircraft, where it forms a useful method of " homing " the aircraft on a known transmitting station. The aerial system comprises two single or multi-turn loops insulated from the structure of the aircraft but rigidly fixed thereto at right angles with one another, one loop being in the fore and aft plane, and the other in the athwartships plane of the aircraft ; the connections from these loops are taken to a tuner box containing tuning and switching arrangements, which in turn is connected to an amplifier, the output of which comprises a pair of telephones worn by the pilot. The tuner box, which is mounted in a convenient position in the pilot's cockpit, contains an automatic switching and indicating device which is driven by means of a small windmill mounted on the outside of the fuselage ; the effect of this switching device is to connect the output of the athwartships loop alternatively in phase and in opposing sense with that of the fore and aft loop which is tuned to the signal transmitted from the ground station. Assuming, therefore, that the head of the aircraft is pointing directly at this station, a signal of a certain steady strength will be heard by the pilot, such signal being entirely due to pick-up on the fore and aft loop, since the athwartships loop will be exactly at right angles to the direction of the incoming wave and so will have a zero pick-up ; hence connecting the output of the athwartships loop in alternate sense will have no effect on the signal received. Assume that the head of the aircraft is now no longer pointing towards the transmitting station ; a certain signal is received from the fore and aft loop, but as the athwartships loop is now no longer at right angles to the direction of the incoming signal, the alternate " addition " and " subtraction " of the output from this loop to that of the fore and aft loop will cause the formation of a resultant signal of greater intensity in one case than in the other. As explained above, the tuner box contains an automatic indicating device which comprises a circular disc divided into three equal segments which are coloured red, green and white respectively, and which are rotated behind a small "window" in the case of the box by means of the windmill drive; should the pilot hear a series of signals of equal magnitude when the red portion of the indicating disc is exposed, then it indicates to him that he must turn to port to "head" his aircraft on the transmitting station in question; should the equal magnitude signals be heard while the green portion of the disc is exposed, he will have to turn to starboard in order to "head" his aircraft on the transmitting station; and should the signals be heard while the white portion is exposed, it will indicate that he is on the correct course, which need not, therefore, be altered.

The advantages of such a system are numerous; for one thing the pilot is guided to a fixed destination by a means which is entirely automatic in action, *i.e.*, in which he has no operation to undertake; this enables this system to be employed for aircraft in which no observer or navigator is carried, and in which the pilot is too occupied with actual pilotage to devote any of his time to the operation of wireless navigational instruments.

There are, however, certain disadvantages which are inseparable from this system; the chief of these is that the system is definitely not free from "night effect"; the extent to which such effect will prevent the successful operation of the system has not been ascertained, but it is thought that, in practice, the results at night will be sufficiently accurate to enable a pilot eventually to arrive at a predetermined destination.

Other disadvantages of this system are that, should a wind be blowing across the direct line joining the aircraft and its destination, the aircraft, while eventually reaching its destination, will not do so by the shortest route, *i.e.*, its path will be a curve, constant corrections to the course being necessary by the pilot; furthermore, since the pick-up of this system (like any other which relies on the reception of signals in the air on a loop aerial) will be small and will hence necessitate the use of a high amplification receiver if practical ranges are to be obtained, reception will be more subject to interference from the engine ignition system than if reception were carried out on the normal trailing aerial; this will, in many cases, necessitate screening the ignition system which may introduce complications owing to additional weight and maintenance difficulties.

This system, however, notwithstanding the above disadvantages, provides a method which is extremely simple and reliable by day for bringing an aircraft to a desired destination; it has been in use for many years and has given excellent results.

Other Directional Reception Systems.

Other systems have been developed either from the simple loop reception system or from one of these described above; these include the fuselage coil system, in which the fixed loops normally employed in the Marconi-Robinson system are replaced by two coils fixed at right angles to one another and mounted in the fuselage in such a manner as to be rotatable, a scale and pointer being provided to indicate the angular position of the coils at any time relative to the fore and aft line of the aircraft ; by employing a hand or automatic switching device for connecting the output from the athwartships loops alternately in phase and in opposition with that of the fore and aft loop—as is done in the case of the Marconi-Robinson system—and at the same time by rotating the coils relative to the fore and aft line of the aircraft until no change in signal strength is noted when the reversing switch is operated, it is possible to ascertain the direction of any particular station. This method has not proved very practicable since, in addition to the disadvantages specified in the case of the Marconi-Bellini-Tosi system, it involves the use of a relatively bulky coil assembly (which takes up valuable space in the aircraft), and, in addition, is liable to an ambiguity of 180°. Yet another system which has been tried out necessitates the use of a loop of wire rigidly fixed to, and insulated from, the structure of the aircraft and installed in a plane at right angles to the fore and aft line of the aircraft, and of a normal trailing aerial ; by suitably combining the pick-up from these two antennae, it is possible to provide a means of determining the bearing of a particular transmitting station, without the ambiguity of 180° which is present in the case of the Marconi-Robinson or fuselage coil methods. The required result can, however, only be obtained by turning the head of the aircraft until the indication of a correct course is obtained, *i.e.*, this system is primarily intended for "homing" purposes and gives results comparable to those provided by the Marconi-Robinson system.

Various other systems have been tried out with more or less success, but, for various reasons, have not been found to be practicable ; in general, the only systems which have entered into general use, are those which have been described above.

MARCONI NEWS AND NOTES

SHORT WAVE BROADCASTING STATIONS.

THE reception of the programmes radiated by short-wave broadcasting stations over very great distances, under favourable conditions, has now become a commonplace, and in its modern designs for stations of this type the Marconi Company has concentrated not only on ensuring a wide range but also a high quality of reception.

Up to the present the novelty of receiving from distant stations has perhaps compensated the enthusiasts for any lack of quality, but with the erection of standard short-wave broadcasting stations intended to give a regular service to ordinary listeners in distant areas, the factor of quality assumes great importance, as in the case of ordinary medium-wave broadcasting stations.

That the new Marconi short-wave broadcasting station which has been erected near Rome for the Italian Broadcasting Company, and which was described in the Marconi Review No. 20, fulfils this requirement, is indicated by the number of reports received placing emphasis on the clarity of reproduction.

The South African Broadcasting Company state that they have received the Rome Station on 80 metres and rebroadcast its programmes with excellent results. Their report adds " The clarity of reproduction and the steadiness of the wave were of a considerably higher order than has been obtained from any previous relay of an overseas short-wave station."

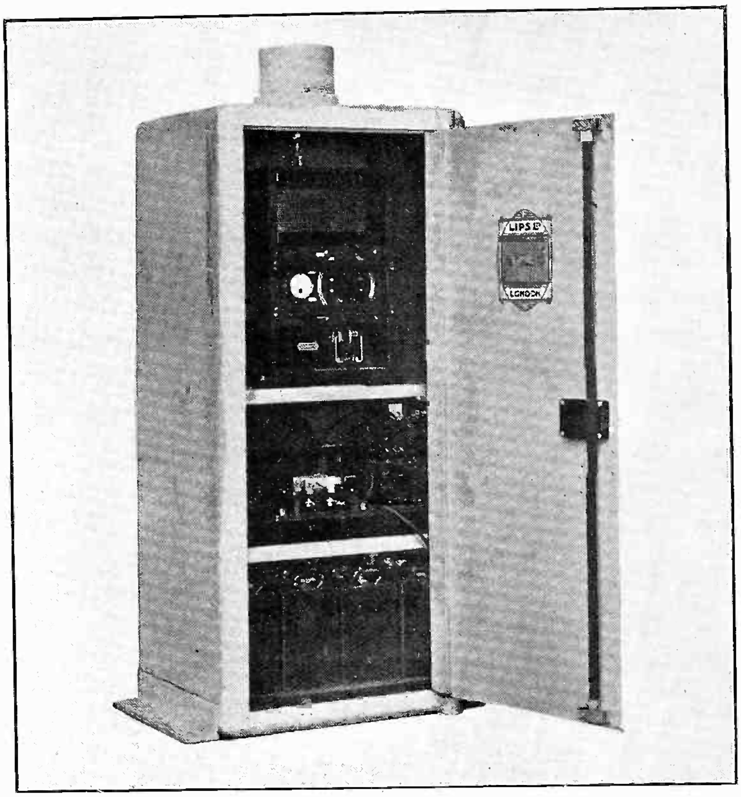
Russian technicians have also informed the Marconi Company that the Rome short-wave station is very well received in Russia and is of exceptional strength and quality.

Public Telephone Service at Sea.

Another report concerning the value of Marconi wireless telephone installations comes from Holland.

The Dutch passenger steamship " Princess Juliana," of the Zeeland Steamship Company, plying between Flushing and Harwich, has been fitted with a Marconi Type X.M.C. wireless telephone set of 500 watts power modified for duplex working.

With this equipment, good communication was established as soon as the ship put to sea, with the receiving and transmitting stations of the Dutch Post Office at Noordwyk and Scheveningen Radio, and throughout each journey it is possible for the Captain and passengers of the ship to communicate by telephony with any subscriber in Holland. Several hundreds of conversations with persons all over Holland have taken place, and a large number of enthusiastic reports have been received by Radio Holland on the success of these conversations.



Marconi "anti-piracy" equipment installed in a safe.

All these reports emphasise the excellent quality of the service, especially the clearness of speech and the absence of background noises.

A striking demonstration of future possibilities was also given when communication was established from the ship, through the Dutch Post Office wireless telephone service, to Bandoeng, Java, in the Dutch East Indies.

Wireless Guard Against Piracy.

The danger of an attack by pirates on ships is one which has to be ever in the mind of those responsible for ships sailing in Chinese waters, as many experiences during the last few years have shown. Armed military guards are now carried on those ships most likely to be raided. The presence of this guard is, undoubtedly, in many cases a deterrent to pirates who may be concealed among the passengers, but cases have occurred where the pirates have believed they could outwit or overcome the guard, and desperate and, sometimes, successful attempts have been made to do so.

To obtain further assistance when such an attack takes place, reliance must be placed on wireless communication, and, in order to do this, adequate protection must be forthcoming for the operator and the wireless installation. An effective and practical solution to this problem has been supplied by the Marconi Company by the development of an automatic transmitter fitted in a fireproof safe, and equipped with the necessary power supply for immediate use. This was first brought out by them in 1924. By the mere closing of a switch the wireless transmitter is set in operation, and the safe is then locked, leaving the transmitter secure from attack while it radiates automatically the ship's call sign and the request for assistance. This transmission continues uninterruptedly until either the necessary assistance arrives or until, after some hours of continuous working, the batteries lose their charge.

How Help is Summoned.

It has been found in practice that pirates only attack the coastal and river steamers, and not deep sea ships, and, as the position of these ships is known practically from hour to hour, it is unnecessary to transmit the position of the ship in any wireless message sent out when the vessel is attacked. The simple transmission of the ship's call sign and the distress call is sufficient information for the local coast stations, and a telephone call to the owners will soon determine the position of the ship. The coast station can then inform all ships within range, of the details and the estimated position, so that assistance can be rushed to the spot. As direction finders are now carried by an ever-increasing number of ships, the continuous radiation from the ship in trouble provides an excellent signal from which wireless directional bearings can be taken to facilitate the rescue work.

The great advantage of this installation is that it only requires the safe to house the wireless equipment, which consists of a standard ¼ kilowatt quenched spark transmitter fitted with an automatic key in place of the ordinary operator's hand key, and no elaborate safety devices are necessary to protect it. The operator, having received orders to call for assistance, can abandon the cabin once the safe has been locked, and join the ship's company in defending the ship, knowing that the wireless equipment needs no further attention, and will continue to operate.