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REVIEW OF COMMERCIAL WIRELESS DEVELOPMENT

2090-05

By C. E. RICKARD, O.B.E.

By the courtesy of the Institution of Electrical Engineers, we are able to reproduce below the address given on November 5th, 1930, *by Mr. C. E. Rickard, O.B.E., M.I.Mech.E., M.I.E.E., Deputy Engineer in Chief of the Marconi Company, on his election as Chairman of the Wireless Section of the Institution for the year* 1930-31.

I FEEL that my first duty this evening is to express my great appreciation of the honour the Wireless Section has done me in electing me to serve as its Chairman for the present Session.

When I look back on the line of distinguished men who have preceded me, and on the splendid work that has been accomplished under their guidance, I feel that the high standard set by them will be very difficult for me to emulate.

A few years ago one of our past Chairmen remarked that the Wireless Section had not been in existence long enough to have a tradition, but since then we have built up a tradition in which we may take pride. We are now entering our second decade of existence full of vigour, with a membership of 529, backed by a splendid record of interesting papers and discussion in the past, and well-attended meetings.

During the past Session the Council has approved the extension of the activities of the Section to include under-water sound signalling and depth-sounding, communication by infra-red or light rays, and electrical recording and reproduction of sound as subjects appertaining to the Wireless Section. This additional scope should add further interest to our activities, and we hope that very interesting discussions and exchange of information will develop in due course.

Coming now to the subject of my Address this evening, I think I may safely assume that when inviting me to take this chair you had in mind my association with the development of commercial wireless telegraph communication and the manufacture of wireless transmitting and receiving gear for commercial services, and it is accordingly that part of the wireless art with which I propose to deal.

Speaking of wireless as it strikes the popular imagination, I noticed a few weeks ago that one of our leading daily papers, referring to the recent very interesting and successful public exhibition at Olympia, spoke of wireless as though it had been in existence for only 10 years, which made me wonder what we had been doing during some 20 odd " pre-wireless " years.

There is no doubt that the advent of broadcasting, to which the newspaper referred, gave a great impetus to the study of radio engineering, and the development of this science in all its branches is proceeding by leaps and bounds. Not all of the inventions or improvements relating to broadcasting are applicable to wireless telegraphy, but there is no doubt that the great advances made in broadcasting as a public service have placed at the disposition of the wireless telegraph and telephone engineer a vast selection of valves and circuits, and a variety of technique which would not otherwise have been developed.

Marine Communication.

Marine communication was the first form of wireless telegraphy to be developed on a commercial basis and, in spite of its powerful rivals in the public imagination, I am still of the opinion that it is the most important application of wireless, for the simple physical reason that wireless supplies a means of communication with moving objects, particularly with ships and aircraft, which can be achieved in no other manner. The contribution of wireless to the safety of life and property, and its assistance to navigation are so obvious and so well demonstrated that should there arrive, at some future time, any danger to mobile communication, due to ether congestion, in so far as the essential safety of life at sea or in the air is concerned, I feel certain that international opinion would continue to give marine communication the first consideration, and other forms of wireless communication would be called upon to give way.

These ideas are of course ever present in the minds of the international legislators who frame the rules and regulations of radio-electric communication, and who also demand that marine wireless telegraphy shall progressively improve and keep in step, so far as is economically possible, with modern progress.

Commenting upon the progress of marine communication we may say that about half (approximately 14,000) of the world's ships are fitted with wireless apparatus. Of these about 10 per cent. are fitted with valve transmitters and the remainder with spark only. Spark transmitters of 100 watts input power are considered to provide the best form of emergency apparatus, probably on the principle that the most strident and hoarse cry for help is likely to attract the most attention. Since the 1st January, 1930, in accordance with the Washington Regulations, no new spark transmitters of greater power than 300 watts input power are permitted to be installed, and from now onwards the percentage of high-power spark stations on board ship must of necessity decrease steadily.

The use of short waves for very long-distance communication between ship and shore is being recognised, and the number of ships fitted with short-wave apparatus is steadily increasing, the present-day estimate being about 150 ships fitted with transmitters and three times that number with receivers only.

The fitting of automatic alarm devices on board certain ships where a permanent watch is not kept has been carried out in accordance with the Safety of Life at Sea Convention, and there are now approximately 1,200 ships fitted with this apparatus which enables a ship's operator to be called to his post, when he is not on watch, by the ringing of a bell actuated by the reception of the alarm signal which nowadays precedes the S O S call.

There were also some 450 to 500 ships' lifeboats fitted with wireless up to the end of last year.

Apart from the large number of vessels which are compulsorily fitted, in accordance with the regulations of the Safety of Life at Sea Convention, or of the laws of the countries with which, or under whose flag, they trade, there is an increasing number of vessels which carry wireless apparatus although under no legal obligation to do so. In particular I refer to vessels which do not carry passengers, and are of less than 1,600 tons gross tonnage. It is obvious in these cases that wireless is carried solely for its utility in the navigation and exploitation of the ship. Among these are a large number of trawlers, whalers and other vessels engaged in the fishing industry who find that wireless apparatus for communication or for direction finding purposes is a valuable aid to their industry, and the equipment of vessels of this kind is rapidly on the increase.

So far as marine direction finding is concerned, the wireless direction finder is now recognised as a navigational instrument of such importance that at the International Conference for the Safety of Life at Sea, held in London last year, an agreement that all passenger vessels of 5,000 tons or over must be fitted with direction finders was signed by 18 nations, and is to come into force as from the 1st July, 1931.

According to the best estimates available there are at present well over 3,000 vessels equipped with direction finders, or over one-fifth of the total number of vessels carrying wireless.

Side by side with the ship direction finder, the installation of automatic wireless beacons around the coasts of the leading maritime countries of the world has made rapid progress. The function of the wireless beacon is to send out a recognised signal at convenient intervals, purely for the purpose of enabling ships fitted with direction finders to take their bearings and thereby to find their exact position when approaching the coast. Such stations work on wavelengths between 950 and 1,050 metres, and are distinguished by their call signals, the form of signal emitted, and by their musical notes.

At present there are in operation around the coasts of Great Britain and Ireland 15 automatic wireless beacons. Five more are in course of construction, and the number spread over the world is estimated to be about 200.

Rotating Beacons.

As a further aid to navigation an important development has been that of the rotating beacon, to which the Radio Research Board has devoted a good deal of attention.

The results of systematic tests showed that ships and aircraft fitted with ordinary receiving apparatus could obtain their bearings from rotating beacons with sufficient accuracy for navigational purposes, subject to the usual night effects. For small coasting and fishing vessels and for aircraft purposes the rotating beacon has important advantages, in the former case because it avoids for the small shipowner the cost of the ship direction finding apparatus, and in the latter because the aircraft direction finder solution is not entirely complete or satisfactory, and there are still some difficulties and limitations to be overcome in certain cases ; moreover, every ounce of extra weight carried is an important consideration.

Adcock Direction Finder.

Shore direction finding stations as an alternative to rotating beacons or direction indicators have a considerable importance in the field of mobile communications, and there are a number of stations in service both for marine and for aircraft services.

Most of such stations have up to the present been equipped with apparatus of the Bellini-Tosi type, but recently a very notable advance has been made by the development of the Adcock principle, which enables night errors to be eliminated. In this field important investigations have been made by the Radio Research Board.

Parallel work on somewhat different lines had been carried out by the Research Department of the Marconi Co. on the directional characteristics of incoming radiation, on *short* wavelengths. Following their achievements in this field, they decided to carry the technique of their short wave Adcock direction finder into the field of medium wavelengths on which radio navigation is carried out. Certain modifications to the method of screening the horizontal leads from the vertical aerials became necessary, as for an accurate navigational instrument the condition of non-radiating screens had to be allied with close electrical symmetry. This was successfully accomplished, and prolonged tests with the new direction finder showed the possibility, on wavelengths of the order of 1,000 metres, of obtaining a night accuracy of 2° to 3°. This result is of the highest importance, when it is realised that hitherto it has not been possible, with practical commercial instruments, to give an absolute guarantee of their accuracy on continuous waves during the night period. This has an important bearing on aircraft navigation.

Comparative tests recently made with aircraft after sunset, during night effect conditions, over a distance of more than 50 miles, showed that the limit of error was $\pm$ 3° with the Adcock arrangement, whereas with the Bellini-Tosi method only one-third of the observations made gave bearings of an accuracy within $\pm$ 3°, and errors were shown up to approximately 90°. In other words, two-thirds of the Bellini-Tosi bearings had errors of $\pm$ 5° or more.

The very convincing results obtained by the development of the Adcock principle into an instrument of a practical form, which on medium wavelengths can be guaranteed to be free from night effect errors, is considered to be so important and so definite an advance that it is thought unlikely that future coast or aerodrome stations will be fitted with Bellini-Tosi aerials.

On the other hand, the rigging and top hamper of sea-going vessels is a definite obstacle to the application of the Adcock principle on board ship, and it is considered very unlikely that the Adcock aerial will supersede the rotating-loop or Bellini-Tosi aerials for marine direction finding purposes.

Equi-Signal Radio Beacon.

Another direction finding problem peculiar to aircraft is that of "homing," or flying to and approaching an aerodrome. In this case a pilot does not so much desire to know his position as defined by bearings on two fixed stations, which may perhaps involve reference to a map, as to know in particular whether he is flying direct to his destination. Since 1920 the American Bureau of Standards has been developing a method of directional transmission which would serve this particular purpose.

The underlying principle of the American radio beacon system may be briefly stated as follows: Two directive aerials are placed at an angle with each other. Along the line bisecting this angle the radiation from each aerial is equal. At any other point radiation is stronger from one than from the other. If, therefore, the separate radiations of the two directional aerials can be clearly designated, it becomes possible by observing the combined radiation of the system to follow the course along the bi-sector referred to.

A very practical form of such a beacon was produced, known as an aural equi-signal radio beacon. It consisted of a Bellini-Tosi aerial system excited through two separate radiogoniometers set at 90° or less to each other. The radiation via the two radiogoniometers was distinguished by the letters "N" and "A," and the keying was interlocked in such a manner that equal reception of the two radiations combined to form a continuous dash. This dash indicated to the receiver that he was placed exactly on the line bisecting the angle between the two figure-of-eight diagrams of radiation. Displacement to the left or right of this line was indicated by reception of either the letter "N" or "A." Several such beacons are now in operation in the United States for point-to-point navigation of aircraft.

The Bureau of Standards of America have also made experiments with beacons in which the separate directional radiations are designated by different modulated frequencies. The output circuit of the receiver developed to work in conjunction with such beacons is fed to two reed indicators, the first of which is resonant to one frequency of modulation, and the second to the other. If, therefore, the receiver is placed on the line bisecting two such radiations, both reeds vibrate equally, whilst a displacement to the right or left of the line coincides with a reduction in amplitude of vibration of one reed and an augmentation of the other, and vice versa.

Ship Telephony.

Ship-to-ship telephony is in common use between trawlers and whalers and other types of vessels, and ship-to-shore telephony has been successfully carried out on many occasions previously, but perhaps the most interesting development in marine communication during the past twelve months has been the combined effort made by the British Post Office on this side of the Atlantic, the American Telephone and Telegraph Co. in the United States, and the Marine Communication Companies and their associated manufacturing Companies to try out a public ship-to-shore radiophone service. So excellent and comprehensive an address was given a few months ago by Sir Thomas Purves to the London Students' Section that there is little I can add on this subject.

Compared with transatlantic telephony, the obvious transmission handicaps of telephony from shore to shipboard in the Atlantic are (1) the economic limit to the power of the ship's transmitter; (2) the lack of the multiplying factor of beam aerials both for the transmitter and the receiver on board; and (3) the continually changing distances over which it is required to work. The small space available for the installation not only limits the power of the transmitter but has a bearing in some cases on the number of wavelengths it is practicable to employ to meet the changing conditions of distance, of night and day working, and of the seasons of the year.

Another drawback is the fact that, owing to the changing direction of the ships from the shore stations, the fullest advantage of directional beam working cannot be taken at the shore end. There are further difficulties due to the fact that those ships with which a ship-to-shore telephony service is most desirable are those with which it is also necessary to maintain the best telegraph service, which entails simultaneous working on short wave telegraph sets for arbitrage or Stock Exchange services, medium long wave working on 1,875 to 3,000 metres for long distances ; 600 to 800 metres working on interrupted continuous waves for normal ship communication purposes, and reception of news on long waves from Rugby and other news-disseminating stations. All of these things are desirable and are accomplished to a certain extent, but the problem of interference to the short wave telephony service from the long wave ship transmitter on continuous or interrupted continuous waves is serious.

The type of continuous wave transmitter that it is economically possible, or even practicable, to install on shipboard is a generator of numerous harmonics, and it requires co-operation between telephonist and telegraphist on board to avoid interference, and a certain amount of juggling with wavelengths to prevent a harmonic of the long wave set interfering with telephony. Perhaps the most difficult problem which has arisen is the fact that the powerful radiation from the short wave transmitting aerial generates oscillations in all loose conductors about the ship. These conductors re-radiate and, given the vast number of possible modes of vibration, there is practically certain to be interference with the incoming telephony wave. Bonding of stays and conductors has been resorted to, but this is a difficult job and it is usually impossible to trace the particular conductor or combination of conductors causing the interference. Some ships are worse than others in this respect. These parasitic re-radiations behave somewhat similarly to atmospherics, and the best solution appears to be to suppress the cause, that is to say to suppress, or rather to reduce greatly, the carrier of the transmitted wave during reception.

Reviewing the situation, I think we must look upon the work done up to the present with regard to ship-to-shore telephony as a series of successful experiments which have shown the direction in which we must proceed. I believe it can be said to be established that 4-wire working at the ship end is merely a stepping stone and that we must face the expense of 2-wire working, and the use of a telephone terminal equipment on board, if a satisfactory service is to be attained. With regard to the number of wavelengths required—a problem which affects the manufacturer and legislator concerned with the repartition of the ether—it is at present considered that 5 wavelengths are advisable if a continuous service is to be obtained, day and night, winter and summer, and at the varying distances from land over which communication has to be made. Such wavelengths as are being catered for at the moment by the Rugby and American shore stations are 17, 23, 34, 63 and 90 metres approximately. Experience is not sufficient to establish these definitely, and it may be that 26½ metres as a compromise between 23 and 34 and 75 metres as a compromise between 63 and 90, will be found sufficient for commercial purposes when further experience is gained, or some other compromise may be found sufficient for ordinary purposes, thus reducing the wavelength requirements to three.

Slightly separated wavelengths are required for the shore stations in America and Europe to allow simultaneous conversations to be carried on from either side of the Atlantic, and ship stations require to be able to make slight adjustments to each of their waves to enable them to call either Rugby or New York.

The selection of wavelengths for the ship telephony service is complicated by the presence on board ship of short wave installations working telegraphy ; and in fact the selection of wavelengths and the organisation of all short wave services is becoming so delicate a matter that it is to-day a specialist's job.

It seems certain that the study of ship-to-shore telephony organisation, and frequency allocations, will provide an interesting and, at the same time, arduous task for the experts of the International Technical Consulting Committee, who meet again next year at Copenhagen.

Design and Development of Portable and Semi-Portable Apparatus for Mobile Services.

Transmitters.

In the field of wireless engineering concerned with small and medium-power general purpose transmitters, activity has centred chiefly in the last few years in the development of circuits to make possible the application of short waves. Naval, military and aviation authorities, as well as civil authorities responsible for the maintenance of communication between small isolated centres, have been quick to appreciate the great saving in power and cost of transmitters made possible by the use of short waves, and, further, the possibility of communicating over distances quite outside the range of medium-wave transmitters of a practicable power, size and economic cost.

In the class of transmitter under consideration, the types vary from pack sets employing hand-generators to fixed or mobile stations of the order of 3 kw. aerial power, but in every case the prime requirements are a large choice of transmitting wavelengths and simplicity of operation, the latter being of the utmost importance, since this class of transmitter has frequently to be operated by entirely unskilled personnel.

Arising out of these requirements the problem most difficult of simple solution, from about 75 metres downwards, is the tuning of the aerial circuit.

Two methods are in general use :—

(A) To employ a variable length of aerial, using an insulated winch, and so to adjust its length that the wavelength of aerial plus loading and coupling coils is one-quarter or three-quarters of the transmitted wavelength.

(B) To use a fixed length of aerial and to provide at its base a variable impedance capable of terminating correctly the aerial for any distribution of standing waves along its length.

Method (A) gives better average radiation but is impracticable in many cases, *e.g.*, a submarine ; while method (B) lends itself to extreme simplicity of adjustment, and for this reason, and also because it is simpler to rig, it is more frequently employed, in spite of poorer average radiation.

One important aspect of the introduction of short waves into this class of transmitter is that whereas previously, on medium wavelengths, reliable telephonic communication has been possible with simple self-oscillators, this is not the case on short wavelengths, due to distortion during propagation resulting from variations in the carrier frequency caused by modulation.

Most short wave transmitters of this class, therefore, employ only C.W.* and I.C.W.† telegraphy, but for some services a demand exists for telephonic communication, and thus the difficulties of design have been greatly increased by having to provide a master oscillator the frequency of which will be unaffected by modulation of a subsequent amplifying stage. Also, international regulations as to constancy of frequency now make it necessary to employ master oscillators having a high degree of constancy for certain services catered for by this class of transmitters.

A modern example of a transmitter designed to cover all these varied requirements is a crystal-controlled set, the main data of which are as follows :—

Wave range. 16 to 75 metres.

Master oscillator. Choice, by external switch, of a valve oscillator giving continuous wave range, or three short waves by crystals. Valve oscillator and crystals enclosed in thermostatically controlled box. By suitable doubling and trebling in subsequent stages valve oscillator covers wave range in one sweep of variable condenser.

Aerial power. C.W. 350 watts ; I.C.W. and telephony, 120 watts.

Instantaneous selection of C.W., I.C.W. or telephony by 3-position switch.

Keying. By self-absorber method, up to 150 words per minute.

75 per cent. modulation on telephony—sensibly linear.

Aerials. A single length of aerial can be employed for whole wave range, but, naturally, when working wavelengths have been decided upon, aerials would be used having good radiation at those wavelengths.

Carrier frequency. Constant to 1 in 10,000.

Time to change from one frequency to another. Five minutes in worst cases.

Size. 5 ft. × 5 ft. × 18 in. deep.

At the other end of the scale is a portable set for C.W. and I.C.W. telegraphy only, employing a self-oscillator, wave range 20 to 60 metres, using a hand generator as a source of power, and capable of operation by semi-skilled personnel.

Modern aerodrome ground station transmitters present special problems, the chief of which is the selection by remote control of any one of six spot wavelengths in the waveband 400 to 1,600 metres.

Still another tendency in all transmitters of this class is the elimination of batteries for auxiliary supplies, as for keying, grid bias, etc. Small rectifiers—of the metal type where possible—are used to provide these supplies from the filament alternator.

Screen-grid transmitting valves have opened up new possibilities in the simplification of circuits, since they dispense with the necessity for balancing interelectrode capacitances in multi-stage transmitters. Against this advantage must be set their lower efficiency and the requirement of a screen-grid voltage supply. In small

* Continuous wave. † Interrupted continuous wave.

and medium power transmitters, up to say, $\frac{1}{2}$ kw. aerial power, the latter is important, since it involves either a separate H.T. supply or a potentiometer across the main H.T. supply taking an amount of power which is uneconomical in proportion to the total power of the transmitter. In many cases, however, the resultant circuit simplification more than justifies the use of such valves in general purpose transmitters.

Receivers.

Coming now to general purpose receivers, the two most important influences in recent years in their progressive development have been the introduction of short waves and the arrival of the screen-grid valve. For receivers in this class the prime requirements are a wide wave range and simplicity of operation.

Development has been along two main lines :—

(A) Receivers with low damping input circuits, followed by high-gain multi-stage screen-grid valve amplifiers, with reaction definitely excluded. Separate oscillators for C.W. reception, tuned or untuned low frequency magnification at will ; or

(B) Receivers with one stage of screen-grid valve amplification, having the aerial directly coupled to the grid circuit, followed by a detector with reaction capable of self-oscillation for C.W. reception. Low frequency amplification as for (A), *i.e.*, tuned or untuned.

Type (A) is confined to medium and long waves, and development has resulted in the use of at least three stages of high frequency amplification with small gain per stage, for the reasons that such an arrangement does not depend on special care in design or testing to ensure stability, and also that the resultant high damping of this circuit enables the condensers to be ganged.

Type (B) fulfils the requirements of a great many services, and is used on short, medium and long waves. Below about 150 m. such receivers usually employ plug-in coils, to avoid stray capacitances as far as possible, but above this wavelength all coils are contained in the receiver, and the range required is selected by a switch.

A modern example of a receiver in category (B) has a wave range of 150 to 3,000 metres. Circuit development has made possible the complete ganging of the two tuning circuits, in spite of the fact that an aerial is coupled to one and reaction applied to the other, and that both are low-loss circuits, so that the tuning controls comprise a 4-position range switch, one tuning handle—calibrated directly in wavelength—and a reaction control. A drastic volume control is required on this class of receiver, because mobile service conditions frequently imply working at short ranges from powerful transmitters. Such a volume control should increase high-frequency selectivity whilst reducing high frequency gain.

Aircraft Picture Transmission.

The problem of transmitting military intelligence by means of picture telegraph apparatus between moving aircraft and a distant ground station has been investigated, and the results obtained show that the methods available are quite practical. One such apparatus recently developed possesses the following features :—

(A) Independent synchronising means at the transmitter and receiver.

(B) No photo-electric pick-up system at the transmitter.

(C) Messages to be transmitted are written in conducting ink or very soft pencil.

(D) Messages at the transmitter and receiver remain stationary.

Actual flying experience has shown that it is possible to convey military intelligence between an aircraft and its base over distances up to 150 miles. The normal aircraft wave, using a 160-watt transmitter, is employed, and the speed of transmission is approximately 8/9 square inches per minute. With the adverse signal-to-noise ratio available on such a circuit it has been found essential to utilise separate synchronising means at the transmitter and receiver.

Let us turn now from the mobile to the fixed services.

Point-to-Point Communication.

The commercial development of point-to-point services has been continuous during the past year. On the telegraph side new circuits are being opened up for communication and the number of competitors against our national services is steadily increasing. Since the war the tendency for each nation to control its own communications becomes continuously stronger, and whereas wireless communication on long waves did *not* constitute a really serious competitor to cable companies, short wave working goes strongly ahead, and each new commercial wireless station in foreign countries takes traffic and revenue from the older methods of communication.

During the present year, however, the short wave services have not quite lived up to their reputations of the previous years, and there has been a falling off in the number of hours of recordability, due to an excessive number of magnetic storms. The year 1930 has been peculiarly severe in this respect, but it is probable that the disturbances to the short wave services will become less and less during the next 5 or 6 years, increasing again until the period of intense magnetic disturbance occurs 10 or 11 years hence, by which time we hope that some method will have been found of eliminating their effects.

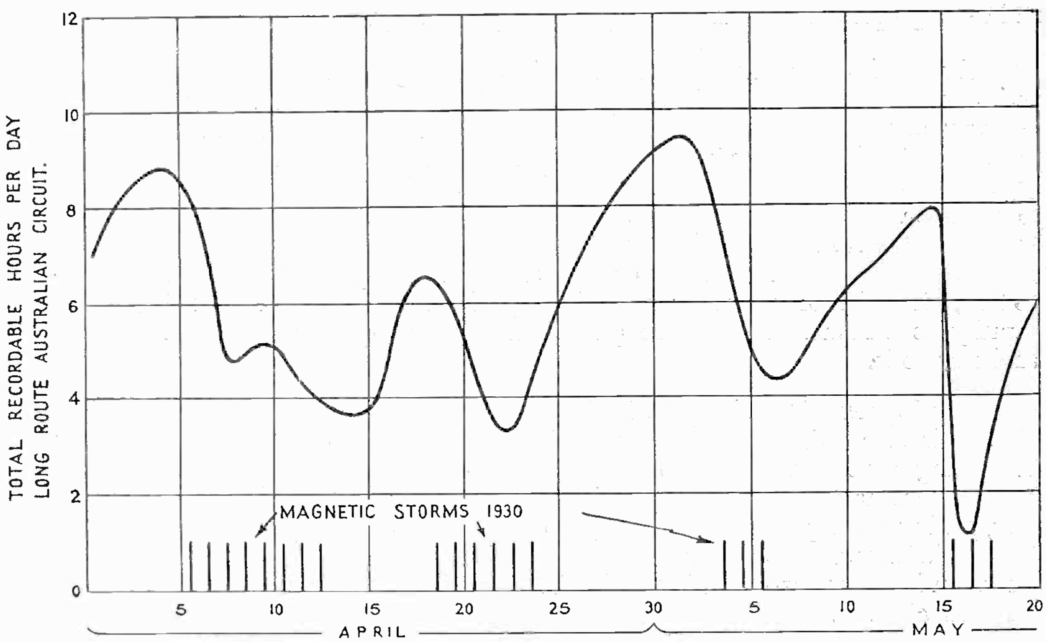
As an illustration of the effects of magnetic storms on long distance short wave communication, I have selected from a series of curves an example for the months of April and May of this year (see Fig. 1). Traffic between England and Australia is sent on 26 m. waves, part of the day over the "long route" across the Atlantic and South Pacific Oceans, and part over the "short route" across Asia and the East Indies.

The rounded curve refers to the "long" route, which is the *worst* and *least used*, and shows the reduction of hours of high speed and recordable working, as compared with the incidence of magnetic storms.

Fortunately the "short" route is not so badly affected. The Indian and South African wireless circuits are hardly affected at all. It is those circuits of which the great circle between terminals passes near or over the polar regions which suffer most during magnetic storm periods.

These facts point to a solution, *i.e.*, the use of relay stations during fade-out periods in such a way that the great circle paths between terminal stations and relay stations do not approach the polar regions.

There is some reason to believe that the most suitable wavelength for communication between distant points is considerably shorter during the periods when magnetic storms are prevalent than in the periods of solar quiescence. Investigations are being carried on in many parts of the world in the hope of finding a solution in the use of very short waves. Also it may be stated that during the early days of experimental short wave working before the beam stations were constructed, wavelengths of 30 and 60 m. were found quite suitable for transatlantic day and night working respectively. The beam stations were originally designed for such wavelengths, which were found at a later date to be quite unsuitable.



1930.
FIG. I.

There is, therefore, a possibility that as time proceeds along the magnetic storm cycle it may be found necessary to modify the present beam station wavelengths. There is not much evidence to support this theory, but it is worthy of careful observation.

During the periods of magnetic storms it has been found on repeated occasions that while communication on short waves has failed completely during periods of 12 hours or more, communication on long waves has remained unaffected. Therefore, in spite of the higher initial cost and higher maintenance charges of high power long wave stations they still have their uses, particularly for distances up to 3,000 miles, and both the Post Office and the Imperial and International Communications Co. contemplate additional long wave stations for their communications with America, the Post Office for telephony and the Imperial and International Communications Co. for telegraphy.

Point-to-Point Telephony.

The Post Office telephony services from Rugby continue to extend rapidly, and the dream of telephonic inter-communication between the Dominions, Colonies, and the Mother Country is in course of becoming an accomplished fact. I do not think I can add anything to the excellent papers and information which have been read and published on radio-telephone services, in particular the lecture given by Mr. G. H. Nash, C.B.E., at the Royal Society of Arts in April last, but perhaps the following remarks will be appropriate from one whose experience was confined to radio-telegraph services until comparatively recently.

Until radio-telephony was developed to the stage of entering into public service, radio communication could hardly be called an exact science. It was, of course, as exact as we could make it, but there is no doubt that the influence of telephone practice on radio practice has been very beneficial. In particular the adoption of the transmission unit (néper or decibel) and of methods of measuring amplification and losses in our apparatus has led to a great advance in technique in all directions ; for example, it is now standard practice to specify the gain in the individual parts of a receiver, the shape of the filter curves, and even the gain of beam aerials. Added to this, the habit of measurement and study of transmission phenomena has extended rapidly as a result of the more general use and progress of measuring apparatus and methods.

Development in radio practice both in measurement and in theoretical studies has made it possible to prophesy the behaviour of a proposed radio channel with increasing accuracy. The propagation phenomena in connection with waves from 15 to 40 m. have been investigated so that for a given period of the year, time of day, and wavelength employed, it is possible to prophesy with reasonable precision the conditions which will prevail at either end of a radio channel between given points. Such studies have proved of considerable value in the setting up of intercontinental wireless circuits.

Reverting to the influence of telephone practice, its value was exemplified in planning, for example, the Rugby-New York radio-telephone circuit. In operation such a circuit is treated, from the point of view of a telephonist, as if it were a metallic circuit, and in the main the circuit is treated as though it were a repeatered line.

Methods of design employed in telephone practice are now used to an increasing extent on wireless receivers and transmitters, such as rack-mounted equipment, as in repeater stations, and alarm indicating devices to show the existence and whereabouts of faults and to provide facilities for testing circuits at any point throughout the equipment, etc. It may be said that the influence of telephone practice on wireless practice, particularly as regards telephony, is due to the conditions under which telephony must work. Since a subscriber has no technical interest or appreciation of any difficulties which may arise, it is essential that there be no discontinuity in his conversation. Under these circumstances faults must be cleared with the minimum possible delay, and all levels throughout the system correctly adjusted and supervised. In pursuit of the telephonist's ideal of uniform signal intensity, a great deal of money has been spent in the effort to perfect a method of automatic volume control which will maintain a uniform level during extremes of fading without causing distortion.

Facsimile Working.

The attainment of facsimile transmission, that is to say the transmission of a message in the form in which it is handed in at the telegraph office, has been the goal of endeavour of administrations and companies exploiting telegraph communication for a number of years, and public services have been open for a considerable time for the transmission of facsimile pictures and messages.

By *wire* telegraphy the problem of picture and facsimile working can be said to be solved to a large extent, but the problem of providing high speed facsimile services on long distance short wave circuits has not yet been solved. Modern facsimile transmitting or receiving apparatus does not impose an upper speed limit on such a circuit, but the intervening space between the transmitter and receiver does impose a very definite limit on the speed at which facsimile messages can be faithfully reproduced. In other words, high modulation frequencies are not possible on such circuits. This limitation is due to the fact that although one pulse or dot may be signalled, the waves so radiated will be reflected from the Heaviside layer a number of times, and the distances traversed by the various rays will be unequal. At the receiver end a number of overlapping pulses or dots will be received, and the delay between the first and last dot may be more than 0·01 sec.

For example, during tests on 60 metre waves between Somerton and Chelmsford, a distance of about 144 miles, the maximum time interval observed between the first and last echo was about 0·005 sec. during the day and 0·0143 sec. during the night. On transatlantic circuits using waves of about 22 metres, the interval between the first and last impulse varies from about 0·001 sec., to 0·01 sec.

In short-wave radio-telegraphy the ear and brain do not take notice of the relatively short intervals between these echoes, and as a result telephony, that is to say high modulation frequencies, can be employed without apparent distortion (assuming the terminal apparatus to be free from distortion). The facsimile machine is, however, really a photographic oscillograph, and a very clear record of the mutilation is shown by a series of multiple images of a single transmitted impulse. Therefore, in order to achieve successful transmission of facsimile, the speed of working has to be adjusted to the prevailing circuit conditions, *i.e.*, it has to be reduced to such a value that the overlapping impulses merge into a single line and the apparent distortion is thus made negligible.

The following table gives some figures of the speeds of working found to be commercially practicable under transatlantic conditions using beam aerials. The wavelength employed was 22 metres, and the distance 3,000 miles :—

Linear velocity of exploring spot.	Period.	Typewriting in 5-letter words per minute.
In. per sec.		
3·61	Twilight and night	20
7·22	Daytime	40
10 83	Abnormal daytime conditions	60

For those not familiar with the subject, it may be mentioned that 10 typewritten words occupy, with the standard lettering, a space of approximately 1 sq. in.

Actually the facsimile terminal equipment is capable of reproducing messages at linear exploring spot velocities as high as 120 in. per sec., corresponding to a speed of $66\frac{1}{2}$ sq. in. per min., or a typewriting speed of approximately 665 words per min.

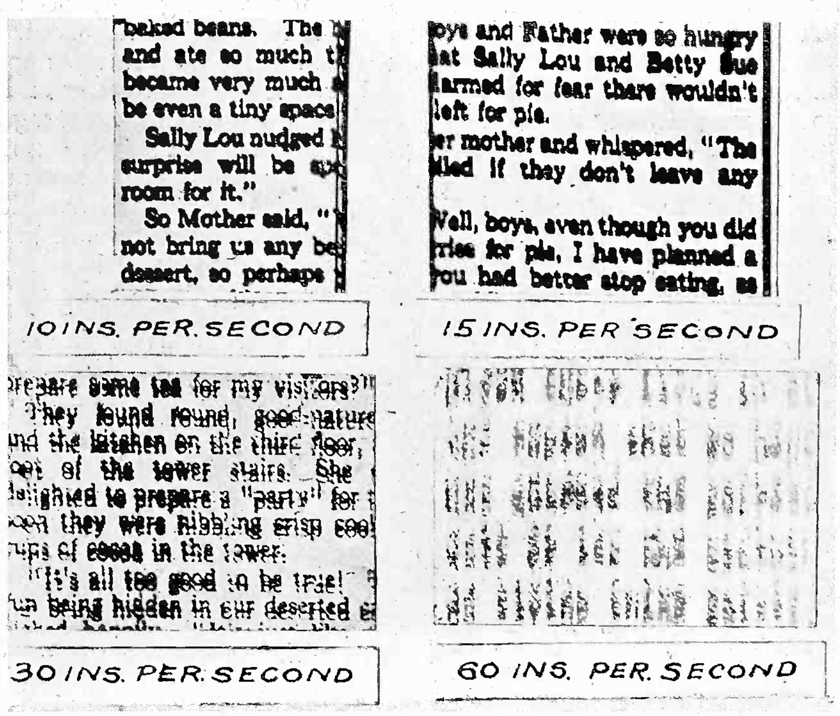


FIG. 2.

Fig. 2 shows the effect of attempting to transmit facsimile at high speeds. A linear spot velocity of 10 or 11 in. per sec. is the speed I have cited as being the maximum on 22 metre waves on the transatlantic circuit, under abnormally favourable conditions. At higher speeds, say 15 in. per sec., distortion begins to show up, at 30 in. per sec. it is very bad, and at 60 in. per sec., or the equivalent telegraph speed of 330 words per min., the script is unreadable.

The problem of increasing the speed of facsimile transmission is being attacked by increasing the directivity of the aerial polar diagram in the vertical plane, so as to limit the solid angle of radiation of aerial systems. Thus it is hoped to limit as much as possible the number of rays passing between transmitting and receiving aerials. Furthermore, present theories suggest that on shorter waves, for example 16 metres, better results are to be expected than heretofore, and that the maximum echo lag on a 16 metre transmission to New York is likely to be only one-fifth of that on 22 metres. Results of tests to be carried out on 16 metres between England and Montreal were therefore awaited with keen interest. They have just come to hand and, happily, confirm the accuracy of the prognostication.

Reverting to an earlier remark, that the facsimile machine is really a sort of photographic oscillograph, it is interesting to observe that experiments with this apparatus have given unexpected impetus to the study of short wave propagation phenomena. From the results of tests, accurate data have been supplied upon which scientists have been able to build up their theories.

Developments in Point-to-Point Services and Practice.

The use of directive aerial systems both for transmission and reception on short waves has now become an accepted principle and established practice, and a number of different shapes and forms have emerged. Endeavours are now being made to improve their directive efficiency and to control their polar diagrams both in the horizontal and vertical planes, either by varying the form and disposition of the aerial wires and reflectors, or by inclining them from the vertical or horizontal, as the case may be.

In the interests of economy, the design of a directive aerial becomes a compromise based on the probable earning capacity of the proposed circuit. Economy has been sought in feeder and distribution system costs by using twin open-wire feeders, as opposed to concentric copper tubes. So far as the transmitting station is concerned, radio engineers are perhaps not yet agreed. On the one hand concentric tube feeders are reliable in service and certain in behaviour and efficiency, but their cost is high. On the other hand, open-wire feeders are cheap, but their behaviour as non-radiators is more difficult to control, and consequently their efficiency is more variable.

At the receiving station the concentric-tube feeder has the valuable advantage of perfect screening, or absence of pick-up from local sources of interference.

With competing services arising in all directions, the natural tendency is to reduce initial costs and maintenance charges wherever possible, and recent practice has been to group a large number of transmitters or receivers, as the case may be, on the same site, and to locate such sites at a moderate distance from a central office situated at a traffic centre.

A further development is to situate both transmitter and receiver on the same site where possible, of course without sacrificing the advantages of duplex working. This has been done at a number of stations, and is contemplated in a number of cases where new stations are to be erected. The principle employed in this achievement is quite simple, *i.e.*, the receiving aerial is placed in the direction of zero radiation from a beam transmitting aerial or vice versa. In either case a small difference of frequency is quite sufficient to avoid interference between transmitter and receiver.

The type of cyclic fading known to radio receiving engineers as selective fading is being attacked both at the transmitting and receiving ends of the circuit by the so-called diversity methods. Modulating the transmitter output at a tone frequency yields a diverse frequency effect which has been found to improve considerably the general level of signal strength, with the result that since modulation has been introduced there has been a very noticeable increase in the average effective speed of communication on short waves, accompanied by an increase in the average daily number of hours of recordable signals. At the receiving end diversity reception, or simultaneous reception of signals on separate or spaced receiving aerials, is also found to be very effective. Large area directional aerials, both for transmitting and receiving, have a similar effect.

Modulation is not favoured in some quarters on the ground that it occupies a wider band of frequencies than C.W., but it has the advantage that it improves the reception of distant stations where for economical reasons or lack of space, as on board ship, it is not practicable to employ beam or diversity aerials.

Diversity, *i.e.*, spaced aerials, are practicable for large receiving stations where a number of circuits and, therefore, receivers are concentrated at one place and can be jointly connected to the same aerials. Generally it may be said that each method has its advantages according to circumstances.

In order to cope with the high signalling speeds required for facsimile keying, for example, and to effect economy in land-line charges between the central radio office and the transmitter, improvements are continually being made in keying methods, and it is becoming the established practice to employ tone sending over the intervening land lines and cables.

As regards installation design, the present tendency is to take 3-phase power from the supply mains and to eliminate all running machinery and batteries by using static transformers and rectifiers to generate all plate, grid and filament supplies.

Much work is also being done on the design of reliable frequency meters for station use, and also in the design of commercial apparatus for the rapid and accurate measurement of incoming waves, based on multivibrator or other fundamental methods.

Anyone acquainted with short wave working or even with the Berne list of frequencies must have observed that the separation between station allocations is becoming smaller and smaller and that the need for frequency constancy is becoming more evident every day. The tendency is therefore not only for the controlling administrations and governments but also for the exploiting companies to set up monitoring stations whereat they can make rapid and accurate measurements of the outgoing frequencies of stations under their control or with which they are in communication, and also of interfering stations. In some quarters a further step has been made and field strength measuring sets are being used to advise or give warning as time progresses of a change of frequency on any particular channel.

(*To be Continued.*)

MARCONI UNDULATOR TYPE U.G.6a

The following article describes a type of undulator which has proved of great service on high speed, heavy traffic circuits. In this type a method of feeding the paper slip is arranged in such a manner that no cessation of signal recording takes place between the finish of one slip and the insertion of another.

WHEN using Undulators for recording morse signals, at very high speeds, on continuous or heavy traffic circuits and particularly when the marks have to be of considerable size for "running slip" transcription, the amount of slip used and, consequently, the frequency with which rolls of slip have to be inserted in the instrument become large.

The delay caused by this operation and the transmitter time involved by "breaks" are of serious consequence on important circuits; on simplex working, much more loss of capacity may occur.

In Wheatstone Recorders this difficulty is eliminated by the use of double slip drawers but the same arrangement cannot be applied to Undulators by reason of the fact that the writing point never leaves the paper and it is impossible to enter a fresh slip directly under the syphon point as would be necessary every other time the change was made.

Various methods of gumming on the end of a new roll have precluded the use of drawers in the base of the instrument.

A method for overcoming the difficulty is described for application to Undulators but it also has advantages when used on Wheatstone Recorders.

Two drawers are arranged in the base of the instrument one immediately above the other in such a way that, when the lower one is pulled out, the upper one falls into the lower position. Means are provided to prevent the top drawer being pulled out also and to dropping suddenly.

The slip is normally used from the bottom drawer and, therefore, the fresh roll is inserted in the top position; the new end of slip will consequently always be on the same side of the running slip and can be arranged to go underneath it.

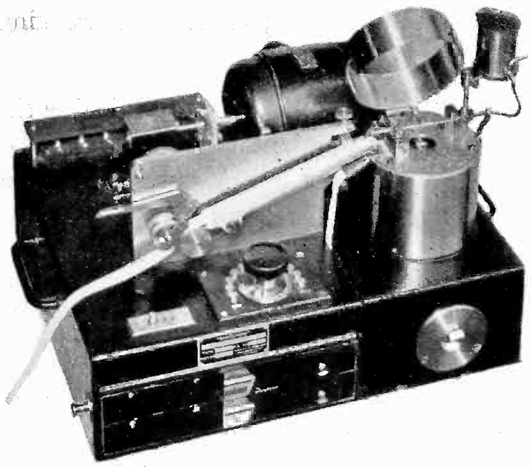
The writing platform is a roller and from there to the pulling roller extends a flat platform or guide. It is only necessary to insert the new end of slip under the writing roller whereupon it is carried round and along the guide by the pressure of the running slip until it reaches the pulling roller which then proceeds to pull both slips.

When the inside end of a roll of slip is gummed to a cardboard centre, it is necessary to break the old slip before it pulls up taut. This can be done by hand or, preferably, by a small guillotine in each drawer so arranged to exert no drag on the slip.

The loose end of the old roll having passed over the writing roller, the signals are continued, without interruption on the new slip. The bottom drawer is then withdrawn, reloaded and inserted in the top position ready for the next change.

Figs 1, 2, and 3, show how the idea has been incorporated in the U.G.6a Undulator.

Two cast metal drawers 1, mounted in the cast metal base 2, each carry a tape wheel 3, tape guard 4, pulleys 5 and 6 for guiding the tape and a guillotine 7 operated by a push-rod 8 and button 9.



The base is slotted at an angle to the vertical where the slip is led through so that the slip from the bottom drawer to the guide roller 10 is clear of the top drawer.

From the guide roller the slip passes through the guide chute 11 over the writing roller 12 and along the guide trough 13 to the pulling wheel 14.

The drawer, containing a new roll of slip, is inserted in the top position ; the spring catch 15 engages with the notch 16 in the drawer and prevents it being inadvertently withdrawn.

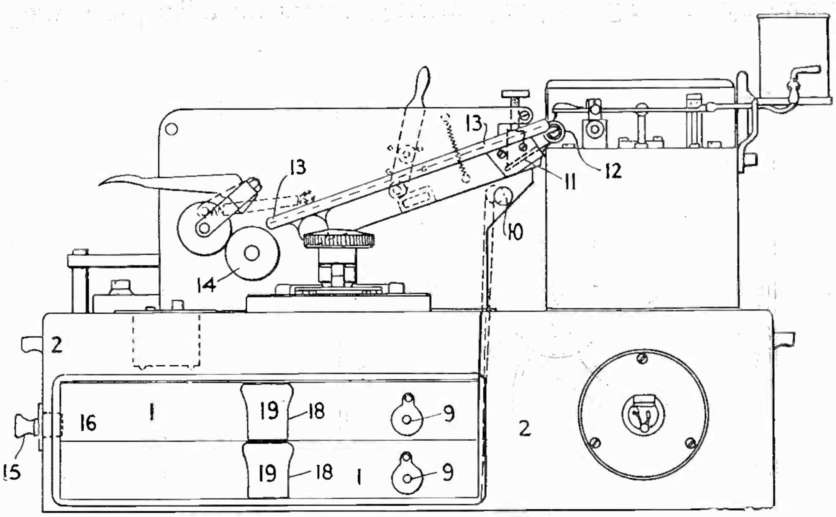
When the slip in the lower drawer is nearing exhaustion that from the top drawer is fed over the roller 10 through the chute 11 until it engages between the writing roller 12 and the running slip which being in tension pulls the new slip over and along to the guide trough 13 where it engages with the pulling roller 14.

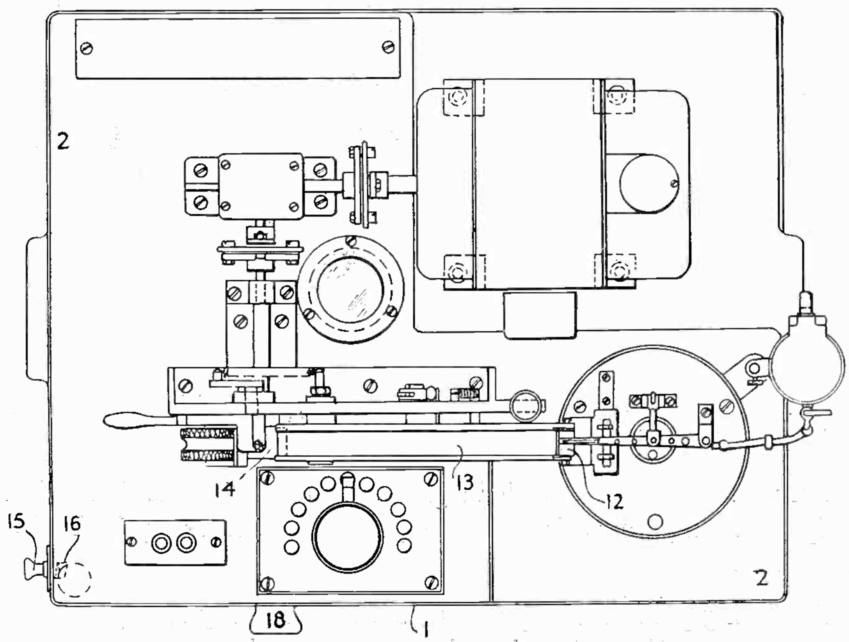
The slip in the lower drawer is now cut by pressing the button 9 which releases the trigger 17 of the guillotine 7. The action of the guillotine is so rapid that no drag is put on the slip and no distortion of the recorded signal occurs.

When the end of the old slip passes over the writing roller 12 recording continues without interruption on the new slip and no signal is lost whatever the speed of working.

Now, in order to replenish the roll in the lower drawer it is pulled out ; although the upper drawer rests on the lower it is prevented from being withdrawn also by the catch 15 engaging in the notch 16.

The top drawer falls into the lower position on the withdrawal of the empty drawer ; the handles 18 of the drawers are so shaped that the back of the lower drawer slides over the inclined underside 19 of the upper handle and so prevents the

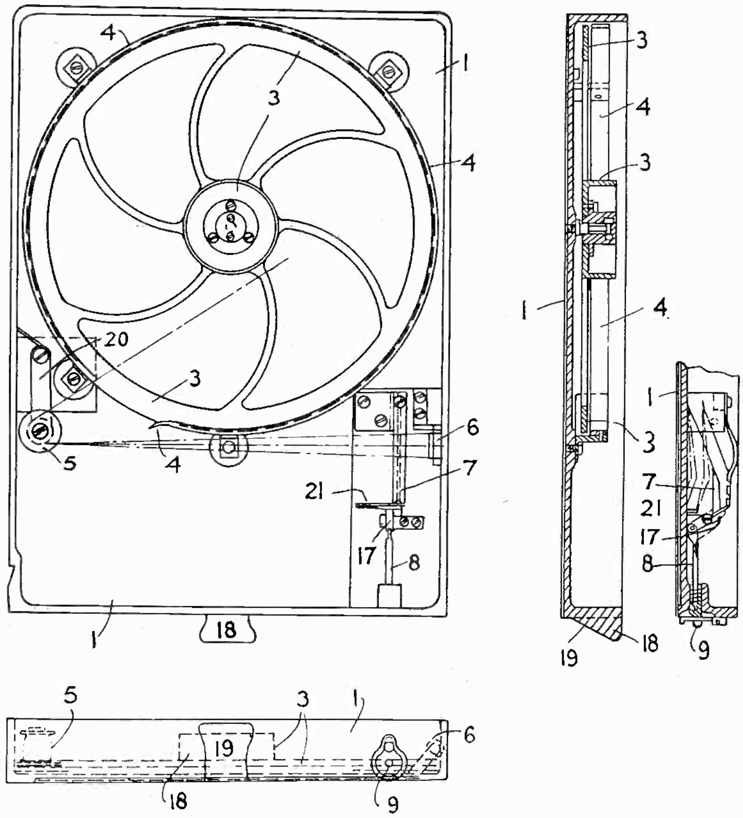




sudden fall of the drawer and any drag on the tape. A spring loaded arm 20 on the guide roller 5 in the drawer also militates against this.

After refilling the empty drawer the guillotine is reset by lifting the bar 21 and the drawer is inserted in the top position ready for the next change.

Should the guillotine in the top drawer be operated in error, the top drawer can be withdrawn, by releasing the spring catch 15, and the threading procedure performed again.



Experience may show that the guillotine action should be made dependent on the withdrawal of the drawer.

With different types of recorded signal it may also be found an advantage to cut the slip at an angle in which case the guillotine knives may be inclined in the horizontal plane.

The Recording part of the apparatus is of the moving coil type, development having been along the lines of a robust instrument capable of withstanding the wear and tear of heavy duty rather than that of extreme sensitivity ; while signals up to 320 w.p.m. can be recorded with the large amplitude required for "running slip".

transcription it is necessary in general to operate the recorder from a valve or mechanical relay.

The desirability of obtaining "square topped" recorder signals has led to the use of limit stops instead of springs for balancing the power driving the moving parts. It is found, however, that as the driving power is increased in order to obtain greater acceleration of the moving parts there is an increasing tendency for "bounce" to develop when solid stops are used, an effect which is obviously detrimental. Moreover, since it is desired to obtain as high an acceleration of the moving parts as possible, the employment of damping means to reduce the effect of this bounce, is inadvisable and it is found that stops of self restoring material, such as rubber, or even of felt, are not satisfactory.

Accordingly a limit stop device is fitted which is called a friction or inertia stop. The adjustable stops are mounted in a U-shaped carrier which is also capable of an adjustable amount of lateral movement between secondary stops; this movement is frictionally restricted by an adjustable flat spring pressing the U-shaped carrier against the base member.

For any given power driving the moving parts the deceleration can be arranged so that there is no "bounce" and this is accomplished without reducing the acceleration when the moving parts are starting from rest. In practice it is found that the amount of movement required between the secondary stops is very small, about one-tenth of that between the main stops.

The moving coils are provided with two windings of 1,000 turns and 1,000 ohms each suitable for operation in the anode circuits of mark and space valves of a double cut-off bridge. The current required for high speed under these conditions is 30 m.a.'s mark and space.

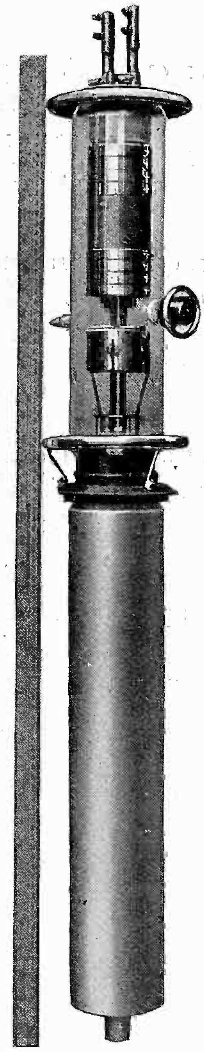
When connected in the local circuit of a relay it is an advantage to connect a shunted condenser in series with the Undulator coils, suitable values being 2 mfds. shunted by such a resistance as will give a standing current of 15 m.a's.

J. A. SMALE.

100 K.W. VALVE

TYPE C.A.T.10

The introduction of the super-power type of broadcast transmitter such as that erected at Rasin, near Warsaw, and described in the last issue of THE MARCONI REVIEW, *has provided the opportunity needed to introduce into service the* 100 *k.w. type of water-cooled valve which is described below.*



A PHOTOGRAPH of the Type C.A.T.10 Valve is shown in Fig. 1, with a meter rule beside it to give some idea of its dimensions. The valve is more or less orthodox in design, having a glass envelope at the top, to which are mounted the filament and grid structures and a cylindrical metal anode at the bottom. Water cooling is used on this anode; the valve filament leads also are cooled by contact with a flow of water.

The overall dimensions of the valve are 1080 × 170 millimeters approximately, and the weight of the valve alone is 18 lbs., the water jacket and water weighing another 14 lbs.

The electrical data are approximately as follows :—

Filament volts, 30.

Filament current, 225 amps.

Amplification factor, 45 } Taken about

Impedance, 3,500 ohms. } E_A 12000 and E_G 0.

Anode volts, 10,000—15,000.

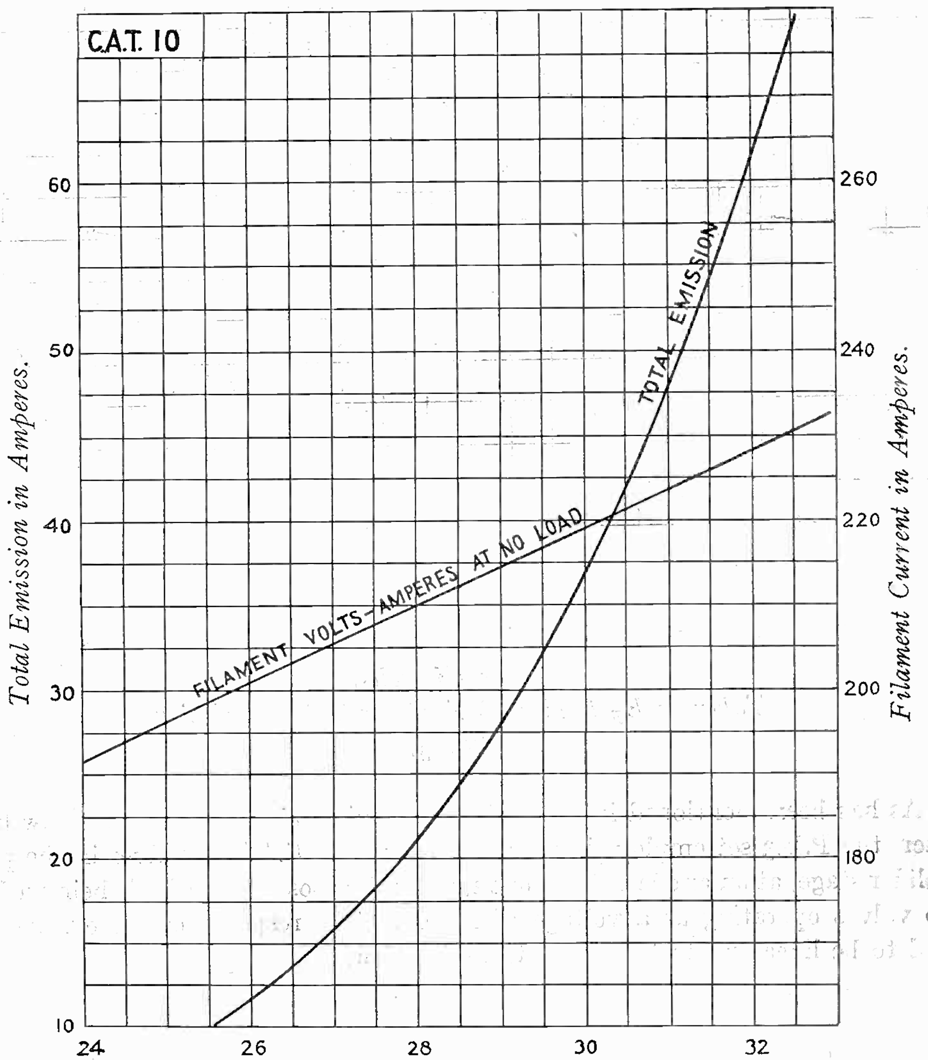
Continuous anode dissipation, 50 k.w.

The normal operating conditions are given below :—

Telegraphy: Input, 8 amperes mean anode current at 10,000/15,000 anode volts D.C.

Telephony : High Power modulation—Input, 5 amperes mean anode current at 12,000 anode volts D.C.

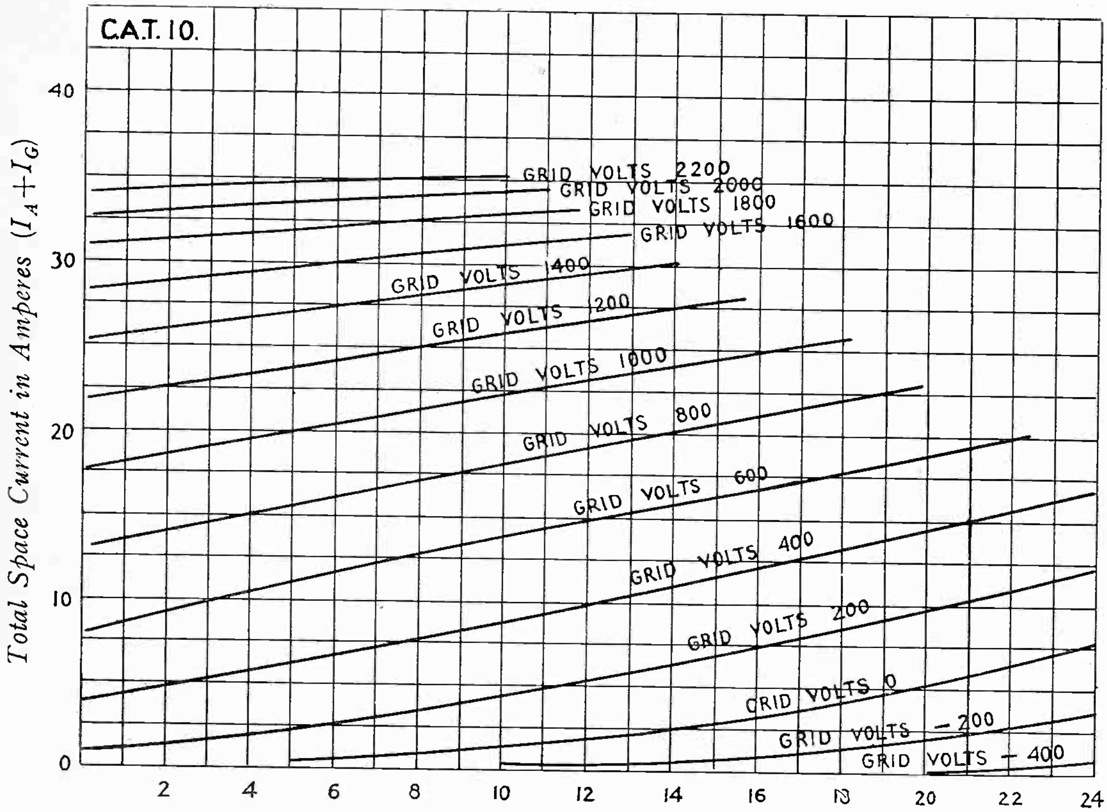
Low Power modulation—Input, 5 amperes mean anode current at 12,000/15,000 anode volts D.C.



Filament Volts.

FIG. 2.

Two curves are given in Figs. 2 and 3, the first giving the relation between the filament potential and filament current, and the filament potential and total emission; and the second giving the relation between the plate voltage and the total space current.



Anode Kilovolts.
Taken at E_F to give 38 *Amperes Total Emission.*
FIG. 3.

As has been mentioned in the article referred to above, on the Warsaw transmitter the P.B.3 set employed at this station uses 8 C.A.T.10 valves in the power amplifier stage, at an anode voltage of 12,000 with a possibility of this being reduced to 6 valves operating at a voltage of 15,000. The response of these valves was found to be linear up to 80 per cent. modulation.

W. J. PICKEN.

MARCONI NEWS AND NOTES

WIRELESS DEVELOPMENT IN 1930

IMPORTANT advances have been made during 1930 in the development of each of the three main sections of modern wireless : (1) broadcasting ; (2) telegraphy and telephony, and (3) special services, such as marine, aeronautical, and military.

In broadcasting, considerable improvements have been made in technique, necessitating in some cases radical departures from previous designs.

One of the most notable changes is the tendency to replace small relay stations working from the main broadcasting transmitters by high-power regional stations which are capable of producing substantially constant field intensities over large areas. Stations of this kind supplied by the Marconi Company during the year include Spanga (Sweden), Iceland and Warsaw.

On account of the high power of these stations considerable precautions are required to prevent unnecessary mutual interference. This avoidable interference may be divided into two types ;

(A) Interference caused by the departure of the station from its intended wavelength ;

(B) Interference caused by the radiation of harmonics of the fundamental wavelength.

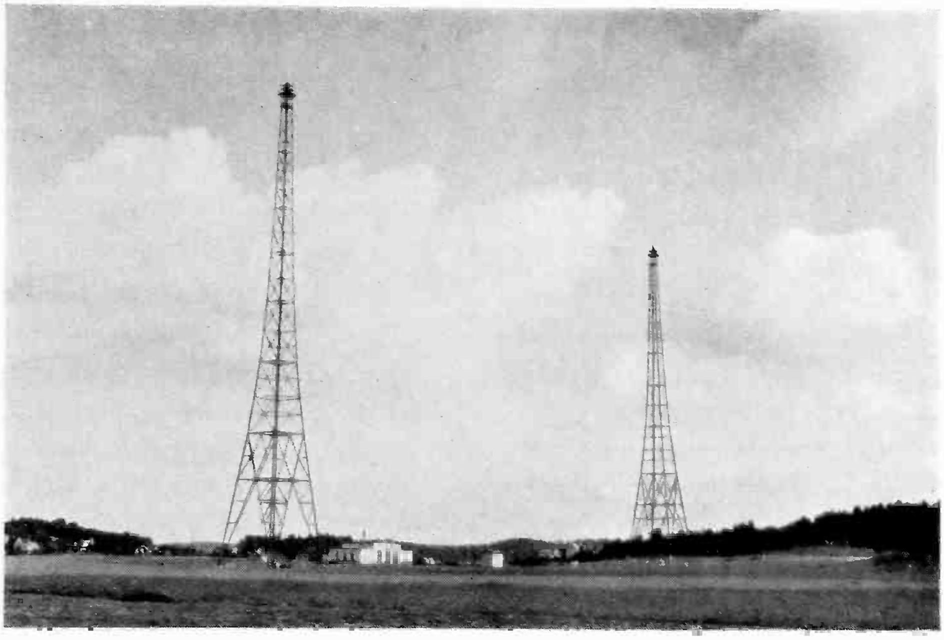
Interference due to the first of these causes has been minimised by the provision of suitable constant frequency drives for the broadcast transmitters. These drives may be either of the valve, tuning fork, or quartz crystal type according to the conditions under which they work, but all are capable of keeping the main transmitter on its allotted wavelength to a high degree of accuracy.

The provision of harmonic attenuating filters has done much to eliminate the radiation of unwanted harmonics.

Modern Transmitter Design.

A good example of modern transmitter design is to be found in the equipment of the new broadcasting station which has been erected by the Marconi Company at Rasin, near Warsaw. The transmitter is of the power amplifier type, and possesses an aerial carrier energy of approximately 120 kilowatts with 80 per cent. modulation.

Broadcast receivers are necessarily becoming more selective, and nearly all high-class receivers incorporate some form of band selection. Other advances are the development of " power grid detection," and improved methods of low frequency



Marconi high-power broadcasting station at Spanga, Sweden.

amplification rendered possible by the advance in A.C. and D.C. valve construction, and extensive research work on the design of audio frequency transformers.

The development of broadcast transmitters has created inevitably a demand for studio equipment and landline linking apparatus of a higher degree of perfection. A growing proportion of the total programme material is transmitted from cultural centres by landline and radiated from comparatively distant transmitters, and it is necessary to ensure that these programmes can be given with a fidelity of transmission comparable to that obtained on local circuits. Studio equipment and landline linking apparatus have therefore been developed to meet this demand.

Facsimile Transmission.

The art of signal transmission by facsimile methods is less advanced than the transmission of messages by telephony or telegraphy, but in the past year considerable progress has been made in increasing the speed of long distance facsimile transmission and reception. Marconi apparatus for this purpose is being installed for communication between England and Canada, and England and South Africa.

The most serious obstacles in the way of an efficient world wide system of facsimile communication lie in the fact that the conditioning factors of short wave propagation involve echo and other effects which are deleterious to such transmission. Research is being carried out on the subject in order to improve conditions of transmission and reception not only of facsimile work but of all short wave traffic.

A recent development is the production of a practical portable facsimile apparatus which can be used for the transmission and reception of simple diagrams, charts, and so on, between aircraft and other mobile stations and their bases.

Changes in Wireless at Sea.

Notable changes have taken place in marine wireless communication. Spark transmitters are quickly disappearing and their place is being taken by continuous wave and interrupted continuous wave sets. At the present time the installation of spark sets of greater power than 300 watts is forbidden. New types of valve transmitters have therefore been designed to meet the changed conditions. Much greater use is being made of short waves for marine communications both in the case of inter-ship and ship-to-shore telegraphy and a new development is the initiation of a commercial system of ship-to-shore telephony using short wave channels.

Apparatus for use in this connection has been installed on some of the largest transatlantic liners and is giving every satisfaction.

Wireless Stations for Arabia.

The King of Hedjaz and Nejd has signed a contract with the Marconi Company for the supply of 15 wireless stations, which will provide Arabia with a complete system of telegraphic communication.

Within the next 18 months every important centre in the joint kingdom will be linked for the first time in history by the most rapid means of communication that the world can provide—a striking development in a country where the camel messenger, travelling on the ancient caravan routes, may still be seen side by side with the modern motor car.

In addition to the fixed wireless stations which will be erected in the towns, four Marconi sets fitted in lorries are to be supplied as general mobile telegraph stations, and to enable the King to keep in constant touch with his two capitals, Mecca and Riyadh, during his many journeys into the desert.

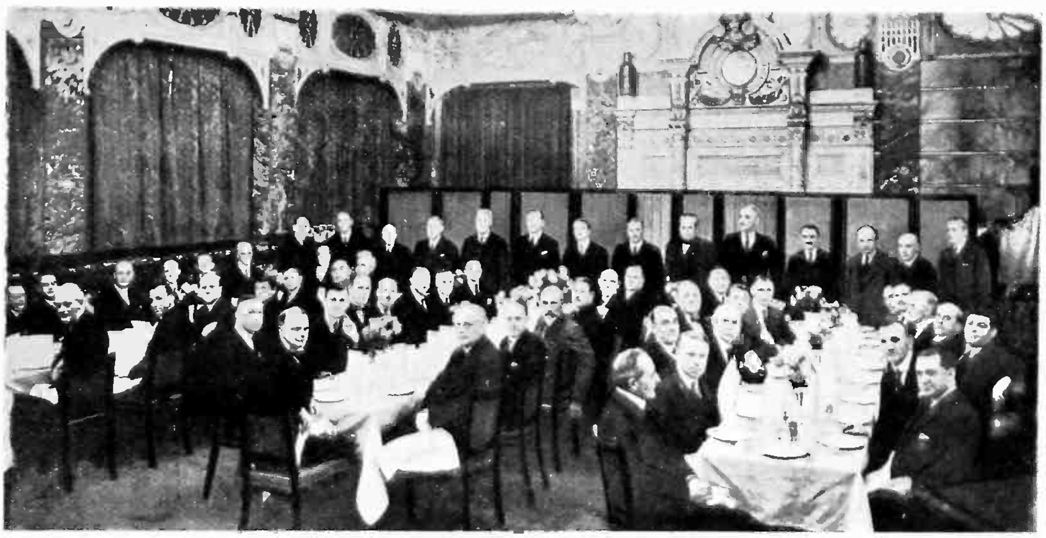
In Mecca a powerful telephone and telegraph transmitter of the Marconi 6 kilowatt " U" Type, with a modern type receiver (Marconi R.G.19) will be installed within the sacred precincts, and as persons who are not of the Mahommedan faith are forbidden to enter the Holy City the resources of the Marconi Company are being called upon to supply a Mahommedan engineer to instal the transmitting and receiving equipment in Mecca.

Similar stations are to be erected at Riyadh, the capital of Nejd, about 400 miles from Mecca, so that King Ibn Saud, who has palaces in both towns, will be able to talk from one to the other by means of special microphones which will be installed in the palaces.

The stations in the smaller towns will be of the Marconi X.M.C.2 Type, the transmitters having a power of 500 watts. These also will be capable of working by telephone, if required, though only telegraph services are to be inaugurated at first. They will be worked by Arab operators, and in order to facilitate working between the different stations the controls are adjusted to fixed wavelengths and interlocked, so that once the stations are erected further adjustments for wavelength will be unnecessary. By merely moving a handle into the position of " transmit " or " receive " the operator will automatically switch on the set at the correct wavelength for the service required.

This type of installation was originally developed for use by unskilled operators on whalers operating in the Antarctic, and is now in use in many parts of the world as the simplest means of providing efficient wireless telephone and telegraph services.

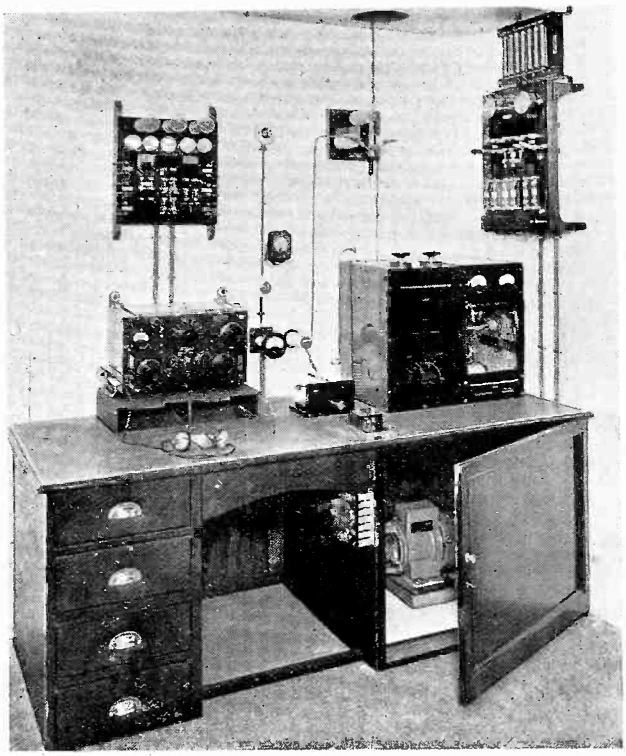
A British engineer will supervise the installation of the Arabian stations outside Mecca, and to provide for the maintenance of the stations after they have been erected King Ibn Saud has sent four of his subjects to England for a course of instruction in the Marconi School at Chelmsford.



The Marconi Veterans' Reunion Dinner—referred to in the last issue of the " Marconi Review."

Arabia is one of the few remaining countries of the world which still retains many of the manners and customs of biblical times, and King Ibn Saud's introduction of wireless as a means of internal communication involves many striking contrasts between ancient and modern methods. All the apparatus for the stations will be transported by car or camel caravan over the desert tracks which have been in existence from time immemorial, for roads are few and the only railway in the country, that running from Transjordania to Medina, was destroyed during the war.

Wireless for Trawlers.



A modern Marconi trawler equipment.

More than forty Marconi telegraph installations have recently been ordered for trawlers in the Humber district of England. This remarkable development is due to the fact that those who are engaged in the arduous labours of the fishing industry fully appreciate the difference which a wireless installation can make to the working of the ships and to the lives of the men employed in them. It is an effective link connecting the owner, the market, and the skipper for the exchange of information to their mutual benefit. The men on the trawlers also appreciate the increased sense of security it brings to them in times of storm, and the opportunity it gives them to keep in touch with what is happening not only in the fleet to which they are attached but also in the world at large.

The specially designed Marconi trawler installations comprise a telegraph transmitter, receiver, and, usually, a Direction Finder.

The transmitter is tuned to a special wavelength for communicating with other trawlers in addition to the normal maritime wavelength for working with ships and coastal stations. The receiver has a comprehensive waverange which makes it possible to tune in broadcasting stations for weather reports, news bulletins, and also the high powered stations which transmit time signals, navigation and meteorological reports and other useful information. The Direction Finder has proved itself to be of great assistance in locating the exact bearing and position of other ships and land stations and thereby saving time and money on innumerable occasions.

How Radio came to America.

News comes from New York that what has been regarded for a great many years as an ordinary and somewhat homely little shack in a field near Babylon, Long Island, has been identified as the first commercial wireless station built by Marconi in the United States, and consequently as a structure of unusual interest and significance, and that it is to be preserved as an historical exhibit.

As far as it is possible to determine the facts, Marconi erected this station late in 1900 or early in 1901. This gives it a date in radio history prior to the inventor's experiments in trans-oceanic radio communications, and previous to the achievement, by which he amazed the world, of flashing the letter " S " through space across the Atlantic.

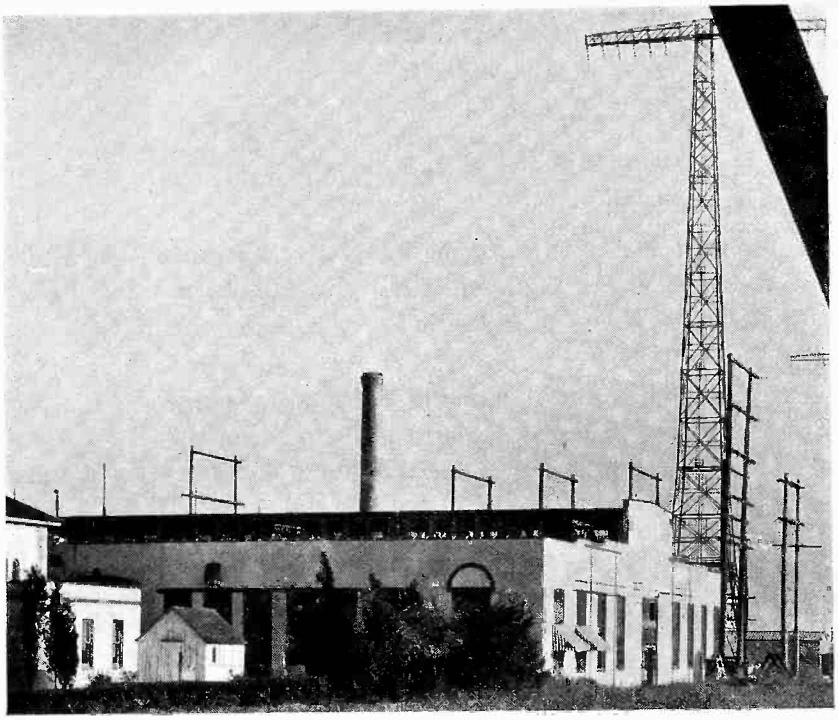
Marconi located his Long Island sending post at a point on the outskirts of Babylon, near the coast, where he could reach incoming ships while they were yet some distance from New York. He erected the tall, wooden pole, which was the mainmast of early radio ; sunk into the earth the great zinc ring that was used for a ground connection, and began on favourable days a communication with vessels as far as sixty miles at sea, at a rate of approximately ten words a minute. The station was operated by the Marconi Wireless Telegraph Company of America, which Marconi had just organised.

Discovery of the Earliest Station.

Discovery of the existence of the station and verification of the part it had played in early American radio came about partly by coincidence. The coincidence was that Captain H. J. Round, of Marconi's Wireless Telegraph Company and an early associate with Marconi, happened to mention the Babylon station while he was visiting Major E. H. Armstrong at Bayport, Long Island, last year, and expressed curiosity as to what had happened to it.

Captain Round and Major Armstrong drove over to the town. They found that it had extended towards the coast and that many houses had been built in what was open country thirty years before. A new street had been cut through from the old road, but Captain Round soon oriented himself, left the car, and glanced into the field where the shed stood.

The shed measures approximately 12 ft. by 14 ft., and in the days of its use as a radio station merely provided room for one or two operators, who lived in a



The first Marconi station in America—the hut in left foreground—contrasted with a modern wireless station.

house which no longer exists. The shed stood less than half a mile from Great South Bay, and from it on clear days a view could be obtained over the bay and Fire Island of the ocean and steamships moving down the Long Island coast toward New York.

The first experimental employment of radio in the United States was a year earlier, when Marconi supervised the installation of a temporary station on the "Forward," a tug of the Yankee Salvage Association, to report the international yacht races off Sandy Hook. A land station was built at Sea Gate, at the entrance of New York harbour, for a relay of the messages by land wire to New York. This experimental work ante-dated the Babylon station, but the latter was the first commercial post of permanent character constructed by the inventor in that country.

It was of much value to shipping companies in the days when radio was first disclosing its service to obtain reports on the probable hour of arrival of transatlantic vessels at New York.

Historic Equipment.

Very probably the mast was used for kindling wood. It was a well-known and accepted scientific fact in the early days of radio that an iron pole could not be

employed as the support for an antenna (iron or steel masts are used exclusively to-day) and as a height of approximately 170 ft. was desired, the pole was spliced. The antenna was a single wire of the vertical type, reaching at only a slight angle to the ground. About the mast was laid the large zinc ring buried in the earth. The zinc circle about the pole was approximately 40 ft. in diameter. Thus the ground connection was provided.

The equipment inside the station included the transmitter, which was an induction coil that produced high voltage electrical discharges from battery current or from a dynamo. The output terminals of the induction coil were connected to a spark gap.

There was also the more elaborate receiving apparatus. In the latter, in addition to the vertically suspended antenna wire, were the coherer, a telegraphic relay, a tapper, and a Morse ink recorder. The coherer was a crude device compared with modern radio apparatus. It consisted of a glass tube with metal plugs on each end, with a quantity of loose nickel and silver filings between these plugs. When the radio wave from a transmitting station reached the antenna or receiving wire, the filings "stuck together," or cohered. This gave the device its name of "coherer." Thus the circuit of the relay was closed, and this actuated a recorder. Simultaneously, the tapper struck the coherer so as to disassociate the filings and make the coherer ready to receive the next signal. So slow a process was thus involved in the action of this apparatus that it may readily be perceived that ten words a minute was good speed, and often a slower rate was regarded as satisfactory.

Arrangements for Preservation.

After Major Armstrong had established that the shack actually was the starting place of the present-day American system of wireless communications, he purchased it and offered it to the Radio Corporation of America, the successor to the American Marconi Company.

Formal acceptance of the gift was made by David Sarnoff, President of the Radio Corporation of America. Mr. Sarnoff described the early station as one of the most valuable exhibits that could be obtained to picture the extent of radio progress. It is now erected at Rocky Point, where it offers an unusual contrast with the transmitting station that reaches all parts of the world at a rate of 150 words a minute. Engineers there pointed out that this contrast justifies the great expenditure made over the period of three decades for research and experiment in radio communications, evidencing so clearly what has been accomplished in a comparatively brief period of time.

The Babylon site was abandoned by the Marconi Company after other stations with greater range and newer equipment had been constructed on Long Island and after the American Marconi system, which had grown in size and resources, had begun conducting an extensive radio service along the coast.

employed as the support for an antenna (iron or steel masts are used exclusively to-day) and as a height of approximately 170 ft. was desired, the pole was spliced. The antenna was a single wire of the vertical type, reaching at only a slight angle to the ground. About the mast was laid the large zinc ring buried in the earth. The zinc circle about the pole was approximately 40 ft. in diameter. Thus the ground connection was provided.

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