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Contents

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Comment

THIS YEAR BRINGS, IN MAY, THE HUNDRED AND fiftieth anniversary of the birth of a pioneer in telecommunications, CHARLES WHEATSTONE.

At the age of 21 he set up as a musical instrument maker, which led him into experimental acoustics. About 1834 he was impressed with the great velocity of electric transmission in conductors, which he himself had evaluated with some accuracy. From 1837 onwards, he worked in partnership with W. A. Cooke, who had designed a telegraph instrument, towards adopting electric transmission for telegraphy.

Wheatstone's genius was many-sided. He was a skilled cryptographer: he deciphered hieroglyphic MSS for the British Museum. He invented the kaleidophone, for demonstrating the movements of sounding bodies; he discovered the principle of the stereoscope; he read papers on the physiology of vision and devised a means of analysing metals by examining the spectra of electric sparks thrown off from them. Part of his work in telecommunications is dealt with in an article in this issue.

Of a shy disposition, he yet became Professor of Experimental Philosophy at King's College, London. Governments, universities and learned societies showered no fewer than 34 distinctions upon him and ultimately he received a knighthood.

No one man can claim to have invented the electric telegraph, but we may honour Wheatstone as one who may be regarded as the founder of modern telegraphy.

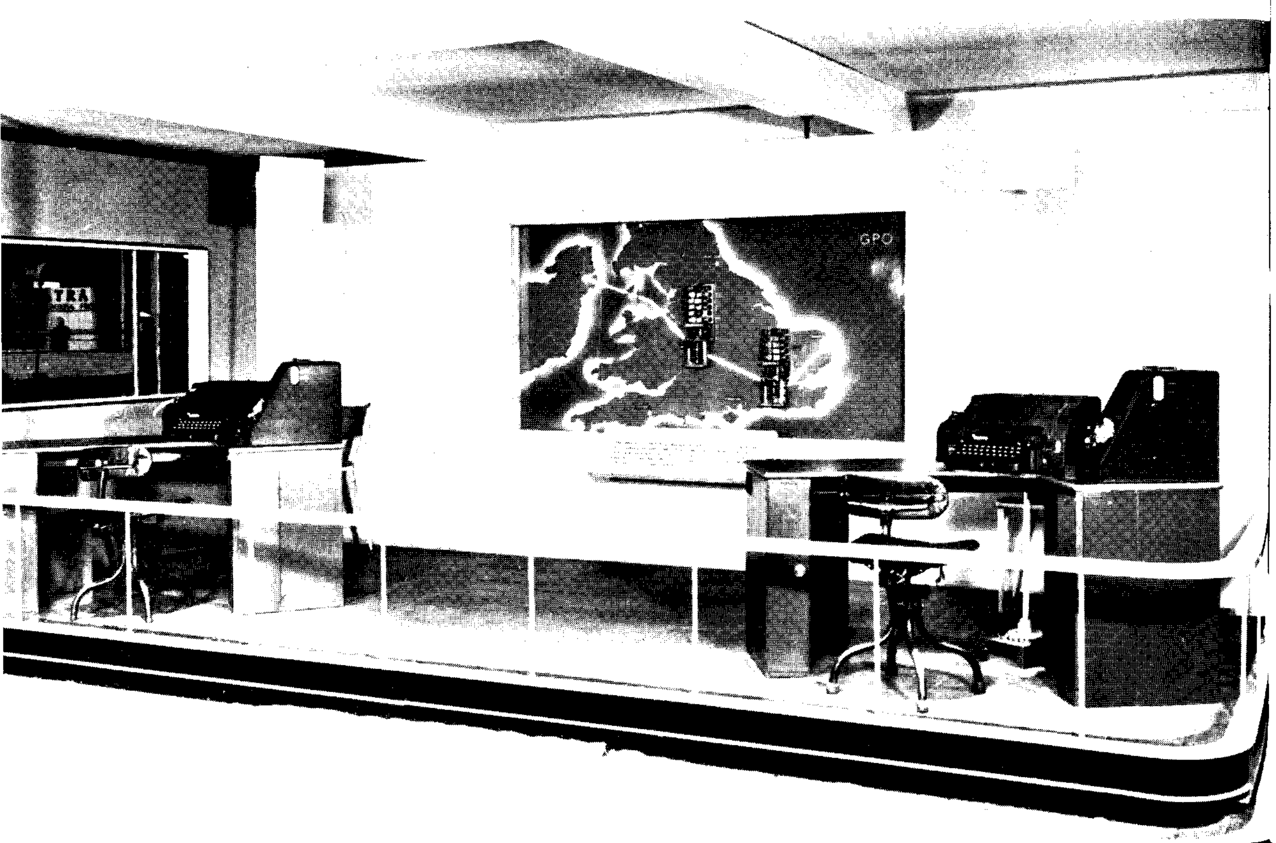
Telecommunications Technique in Exhibition Design

by A. H. Endecott, A.M.I.E.E.
Public Relations Officer, Midland Region

AN EXHIBITION AS A MEANS OF PUBLICISING Post Office services is something easily appreciated, but any connection between telecommunications technique and design in exhibition showmanship is not quite so obvious. The telephonist or the engineer in an exchange, for example, will not see at first any possible relationship between switchboard lamps or uniselectors and relays, which form so great a part of their everyday work, and exhibition displays. The connection exists, however, and is to be found in the use of telecommunications apparatus in this particular field.

When the telecommunications or circuit design technique in display work was used for the exhibits on the Post Office stand at the National Radio Exhibition at Earls Court, London, S.W.5, the displays showed, in pictorial form, the working of the automatic telegraph switching scheme (Fig. 1) and how television signals can be transmitted from London to the Midlands either by coaxial cable or over a series of radio links (Fig. 2). The lamps illuminating the paths of both the television and telegraph signals on these displays were ordinary switchboard-type lamps and they were controlled almost entirely by means of apparatus of the automatic telephone exchange type. A more detailed description follows.

Fig. 1. Representation of the automatic telegraph switching scheme



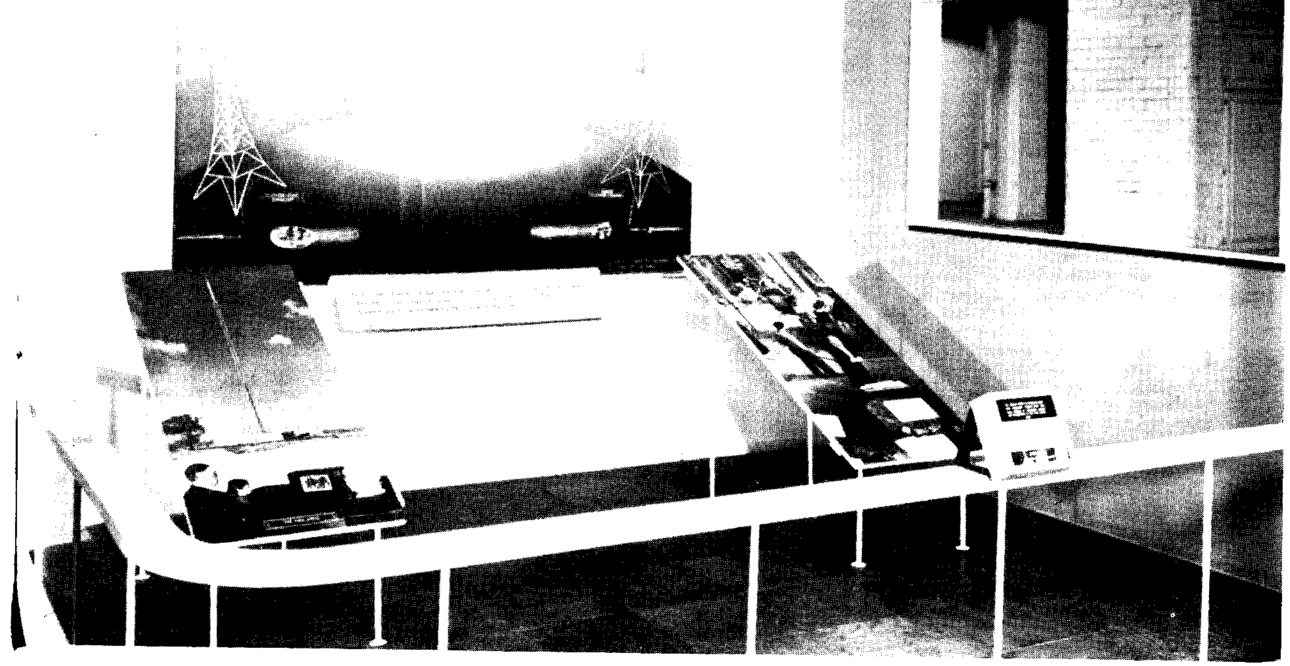


Fig. 2. Stand showing the transmission of television signals from London to Birmingham

Automatic Telegraph Switching Display

As will be seen from the photograph (Fig. 1), the display consisted broadly of two standard single table teleprinter installations, each ostensibly identified with a particular town by means of illuminated panels, situated on either side of the stand. A map of the greater part of the United Kingdom formed the centrepiece. The demonstration centred mainly round the teleprinter on the right. The demonstrator was able, by operating one of six keys, to light up any one of the six place-names, Belfast, Glasgow, Newcastle, Exeter, Portsmouth and Norwich, on the illuminated panel, thus identifying her teleprinter with the selected town. On the map, the association between the teleprinter installation and its normal geographical location was shown by an illuminated spot.

The main switching centres for the automatic telegraph system are situated in London and Birmingham and these centres were each symbolically represented on the map by a 2,000-type selector.

To demonstrate to the public how the system worked, the demonstrator followed the standard operating procedure. First the dial key on the control panel by the side of the teleprinter was pressed. Immediately the dial lamp glowed, indicating that dialling could proceed. The audience were shown that the connection had been put through to the switching centre, by a line of lights sweeping rapidly and progressively along from the source of the message (say Belfast) to the selector representing the switching centre. As the operator followed the standard procedure of dialling the required code, so the selector on the map stepped, rotated and became connected to the next switching centre.

Circuit Established

Further digits were dialled and a final line of lamps extended to show the route of the call from one end of the country to the other. As the last connection was made, so the name panel over the left-hand teleprinter indicated the destination of the telegraph message, a lamp on the map showed its location and the glowing of the green lights on both teleprinter positions and the starting of the distant-end teleprinter motor indicated the establishment of the circuit. In this position, standard working between the two machines was demonstrated and the transmission of the message across the country shown on the map by the flashing on and off of the whole train of lamps in synchronism with the tapping of the teleprinter keyboard.

The measure of the success of a display piece can perhaps best be judged by the simplicity with which it tells its story. If no explanation is necessary, then it can be reasonably assumed to have achieved its object. In the case of the television display (Fig. 2), the object was in the first place to demonstrate, in a simple way, and without the help of a demonstrator, how television signals generated by the cameras in the B.B.C. studios in London are transmitted as radio waves round the curved surface of the earth between London and Birmingham in five steps. The photograph mounted on the right of the display in Fig. 2 shows the inside of a television studio. In the foreground is the orchestra with the camera, lights and other properties forming a circle round the actors. The photograph on the left is a composite one, showing the mast at Sutton Coldfield and superimposed upon it a family group watching the television programme. The picture on the screen is a reproduction of the groups of actors to be seen in the studio scene. The centre panel shows symbolically a section of the curved surface of the earth standing against the sky. On this surface are mounted outlines of the

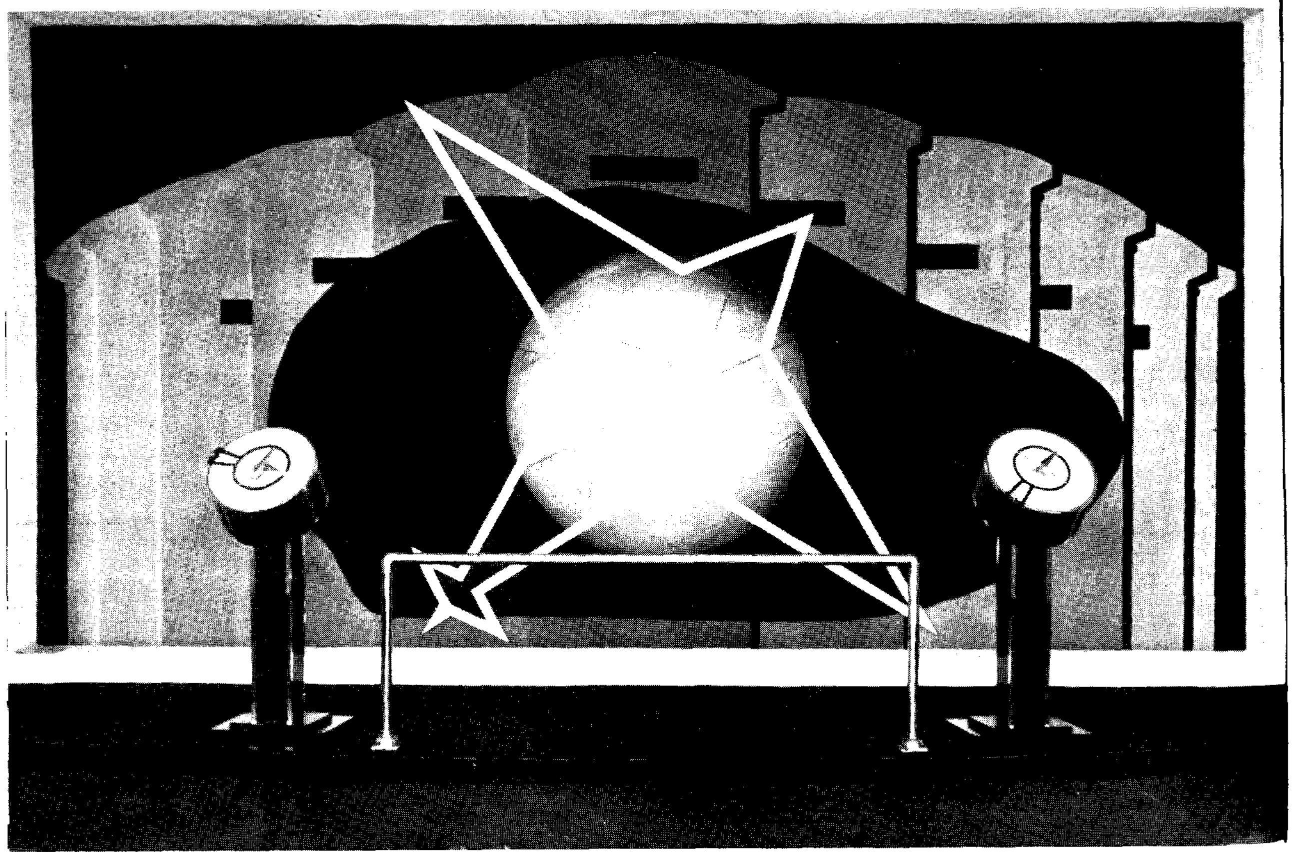


Fig. 3. A demonstration of air mail routes

masts used at the various relaying points between London and Birmingham. As the panel is made of translucent Perspex, the switchboard lamps are not normally seen. They are set out on the back of the panel in the shape of a wave form of decreasing amplitude between stations and are controlled and illuminated in such a way as to give the impression of continuous flowing movement from the studio, over a coaxial tube, up the mast, through the ether, down the distant mast and again by coaxial tube to the transmitter. Projecting apparently out of the earth, at either end of the panel, are two sections of the London-Birmingham coaxial cable. These represent the alternative path for the transmission of television signals. The operation by the public of a key mounted on the rail in front of the stand transfers the line of flowing lights from the masts, to connect studio and transmitter together via the underground cable.

An Earlier Example

Perhaps the most ambitious and potentially effective display of this kind ever to be designed was that installed at the Radio Exhibition staged at Olympia during September, 1939. The outbreak of war caused the premature closing of the exhibition and most unfortunately the elaborate display, which was designed to publicise the South African and Australian Air Mail Services, was lost when the Central Telegraph Office and adjoining buildings were destroyed by fire following enemy action on the 29th December, 1940.

The centrepiece of the display portrayed in Fig. 3 was a 6 ft. diameter sphere, representative of the world, with the routes of the air mail services shown by means of switchboard lamps. The sphere itself was rotated slowly and was suspended in such a way as to appear unsupported in space. The devices on either side and in front of the proscenium, rather like ships' telegraphs, were used by the public to select one of the twenty or so stopping places on each of the two air mail routes concerned. The arm was rotated, and as soon as it was brought to rest, a line of lights would sweep out from England, round the surface of the globe, coming to rest at the destination sought. At the same time a lamp lighting inside the selection box indicated the relative times taken by air and surface mail. It is not proposed to describe the circuit details: indeed, they now remain only in the mind of the designer, since all the records were destroyed along with the display in 1940. It is sufficient to say that almost any series of some 400 separate switchboard lamps could be illuminated at choice, and all this with only six electrical connections between the inside and outside of the sphere.

Although it is not appropriate to the telecommunications aspect of this article, it is worth recording that the rotating sphere was treated with fluorescent paint and illuminated by ultra-violet light, to heighten the impression of mysterious suspension in space.

An idea can often be conveyed to the average exhibition visitor by a symbolic display, but it must be simple if it is to make an impression and it must be dramatic if it is to attract attention in the first place. People with long experience in the exhibition business know that, although for the majority of its applications it has become hackneyed, the flashing light or a movement of some sort is the most positive way of attracting attention. Despite the commonplace usage of this medium, it can be attractively staged. With some thought on the subject it is possible to combine the tasteful with the dramatic and the use of modern telecommunications apparatus as a contribution to this end can be highly successful.

It would be wrong to conclude this brief description without referring to a series of displays that have been seen by many tens of thousands in nearly all parts of the country. These show the working of the 999 service and have been seen at Post Office exhibitions and at many put on by police and fire authorities. Here the technique descibed above has been used fully. On panels, an emergency call is traced by flashing lamps to the public exchange and thence to any of the services required. The exchange and each of the public services are shown photographically and the appropriate sound effects—exchange alarm, fire siren and police and ambulance bells—are introduced automatically at each stage. The original display was designed as a spare-time hobby by two officers on the staff of the Telephone Manager, Nottingham, and later modified in the Engineer-in-Chief's Office.

Acknowledgments

The displays described were constructed during two periods—before the war and in the past two years. Much of the construction work for the earlier display was carried out by the Engineer-in-Chief's Circuit Laboratory. The recent displays were constructed by the Post Office Factory at Fordrough Lane, Birmingham, with help and advice from the Birmingham Telephone Manager's Office.

Bulk Supply Agreements

by G. H. Arnold,
Post Office Contracts Department

FOR MANY YEARS PAST THE MAIN ITEMS of telephone plant have been purchased under "bulk agreements"; that is, agreements with groups of contractors under which the latter undertake, for a period of years, to supply, and in some cases to instal, specified types of equipment to the Post Office, and the Post Office in turn agrees with certain reservations to purchase only from the contractors in each group. Each agreement includes a schedule of prices and details the general conditions governing transactions between the parties.

The Post Office, which requires a high degree of standardisation for the efficient running of the telephone and telegraph services, was itself originally responsible for initiating bulk-agreement procedure and has undoubtedly derived great advantages therefrom. Under this procedure, competitive tendering for certain selected requirements is dispensed with and all orders are placed with the agreed group of contractors as supplies are required. The types of products purchased in this way are those that involve specialised manufacturing technique and for which the spreading of orders for the limited demand over too wide a field would be uneconomic to buyer and seller alike. These are: telephone exchange equipment; dry-core paper-insulated cables, and latterly coaxial cables; loading coils; batteries for telephone exchanges and repeater stations; telephone cords and cordage; telephone subscribers' apparatus.

Arrangements entered into under the various current agreements differ in detail, but the principal features are briefly as follows:

(*a*) The Department undertakes for the period of the agreement—usually five years—to place all its orders for the particular products with the group of contractors who are party to the agreement. Some reservations are made in respect of certain products for which the Post Office desires greater freedom of action.

(*b*) The contractors may allocate the orders among themselves as they think fit, subject to the satisfaction of the Department.

(*c*) Patents held by the contractors are pooled.

(*d*) All the contractors receive the same price rates for the goods supplied or services rendered.

(*e*) Basic prices are fixed for the term of the agreement, subject only to adjustment in respect of variations in rates of wages and the cost of materials.

Any financial advantages due to improvements achieved in manufacturing technique during the term of an agreement accrue to the contractors, but the Post Office benefits under follow-on agreements, other things being equal, in the form of reduced prices.

The bulk-agreement procedure operates to the mutual advantage of the contractors and the Department in several ways:

(i) The contractors are given reasonably long forward estimates of future requirements and can therefore plan ahead with some confidence. Delivery as required is reasonably assured and production costs are brought to a level which would be unattainable without the forward planning in the light of estimated requirements which is made possible by the bulk-agreement procedure.

(ii) Standardisation is best attained by the centralisation of production in a group of manufacturers, especially in connection with the complex apparatus required by modern automatic systems.

(iii) Research, development and design are co-ordinated and shared between the Department and contractors, overlapping effort or expense being thereby avoided.

(iv) The pooling of patents obviates a vast amount of negotiation and saves the Department considerable royalty charges.

(v) It often happens that requirements of a particular component are so small that it would not be manufactured economically if made by all the firms. Under agreement procedure, it is possible to arrange that such components are made by one or two firms only and distributed to others as required, with consequent saving in production cost.

(vi) Contract procedure is simplified and time is saved in putting work in hand.

While these advantages do not apply with equal force to all the agreements, they have proved particularly valuable in the case of exchange equipment. Two instances only need be mentioned here.

The first relates to the scope for planning for production which the agreement allows. This can be appreciated best by examining the position that would result if competition were resorted to on each occasion when supplies were needed. Under such conditions the Post Office might be in the position of requiring to place orders for half a dozen new exchanges within the space of less than a month. Under competitive tendering, no contractor could quote reliable delivery and completion dates, because he would be uncertain of the number of orders he would receive. Under the agreement, the works are allocated in advance, in accordance with the capacity of the contractors, and it has been practicable to estimate fairly closely what deliveries can be promised.

Standardisation

The second advantage is in connection with standardisation. Standardisation in telephone equipment is desirable not only because it reduces the amount of spare plant that must be held and simplifies the training of maintenance staff, but also because, in a nation-wide telephone system, it is essential that all exchanges shall work one with another. In large multi-office areas, such as London and Manchester, the interconnection is of a very much more closely knit nature and the use of plant of different types by different contractors would have involved the development of special apparatus and methods to enable this inter-working to take place. This, of course, would have increased the cost and the fault liability of the system as a whole.

After some years of experimenting with different systems, the Post Office decided, soon after World War I, to standardise the Strowger system and there were many differences resulting from the designs of relays and switches adopted by the several firms. After the agreement had been entered into, it was practicable to form a joint development committee, known as the British Telephone Technical Development Committee, on which all the participating contractors and the Post Office were represented. The purpose of this committee was to pool new ideas which any of the parties might develop and also to pass on to the contractors information about facilities needed by the Post Office, so that these could be provided by all the firms in a uniform manner. As a result of the work of this committee, not only have extensive changes been made in the system, but the automatic system of the Post Office has been standardised in all its essentials, so that plants of different makes work easily one with another.

It will be realised from the foregoing that the agreement policy has been of definite value to the Department, particularly when it is considered in its broader shape as a method of executing work rapidly and smoothly. During the last few years before the war, the value of orders placed with the exchange equipment contractors more than doubled and this entailed a tremendous amount of work, to both the Post Office and the contractors. In the same way, a drastic reduction in the output of subscribers' apparatus, made necessary by the financial limits imposed upon the capital expenditure of the Department in post-war years, has been rendered possible by the co-operation of the body of contractors participating in the agreements. It seems doubtful whether problems of this kind could have been handled so successfully under any other form of contracting.

As regards price, up to the period immediately preceding the war, the Department's knowledge of contractors' production costs was incomplete and prices were fixed on a combination of general knowledge and hard bargaining. The Department, however, was very conscious of the fact that it did not have access to the contractors' production costs, and this point was the subject of sustained enquiry by the Public Accounts Committee in the pre-war years. For some time the Department had urged the contractors to permit it to investigate their costs, and eventually they agreed to afford the necessary facilities at the works of one of the firms in the group in connection with the Telephone Exchange Equipment Agreement. This investigation was made in 1939, and since that date no agreement has been renewed without the granting of facilities for cost investigation. In addition, the scope of the investigations has been widened to the extent that for each agreement costs are now investigated at the works of at least two contractors, the selection of which is made by the Post Office. By these means the Department is able to satisfy itself that the prices paid are fair and reasonable.

The Bulk Agreement system came under review by the Select Committee on Estimates 1950, and after the hearing of evidence from the Post Office and the contractors, the Committee endorsed the continuance of the system.

"Flying Enterprise"

(By courtesy of the "Daily Graphic")

by W. Williamson,

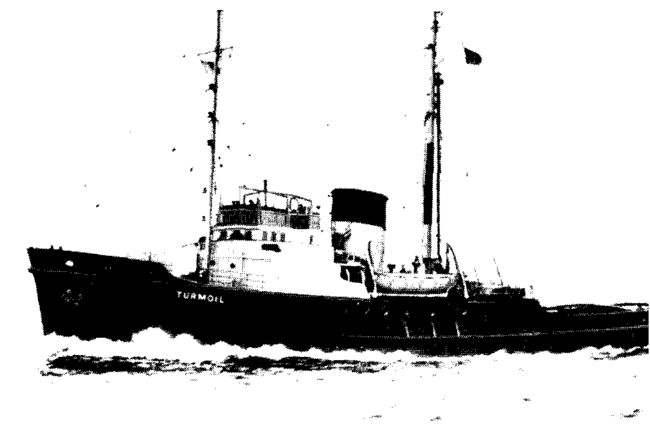
Overseas Telecommunications Department

OVER A PERIOD OF TWO WEEKS IN JANUARY, world-wide interest was focussed on the very courageous attempts to save an American vessel, the *Flying Enterprise*, which was lying helpless some 400 miles out in the Atlantic. The details of the heroic struggle of both her gallant captain and the tug *Turmoil* are now known to all the world. We in the Post Office take pride in the fact that by one of our services the Press and the B.B.C. were able to bring the hour-by-hour story to the public.

The *Flying Enterprise*, a modern vessel of 6,700 tons, was on a voyage from Hamburg to New York. On the 28th December, 1951, when some 300 miles south-west of the Fastnet Rock, she encountered one of the worst gales known for many years. The ship suffered severe damage and, with a cracked deck, a flooded hold and a shifted cargo, she took on a permanent list of 60 degrees. Her bulkheads, dividing the ship into watertight compartments, held, and she remained buoyant with that perilous list for some fourteen days.

The first intimation that the *Flying Enterprise* was in difficulties reached Land's End Radio Station at 12.49 on the 28th December—"Encountering a severe hurricane, position 49.20 North, 17.20 West, situation grave. Have 30 degrees port list and ust drifting." Land's End was already dealing with everal other ships in distress, but immediately ook over control and advised ships in the vicinity hat the *Flying Enterprise* was in urgent need of ssistance. Several ships, themselves being badly attered by the gale, proceeded to her assistance nd took off the passengers and crew, but the naster, Captain Carlsen, insisted on remaining on oard.

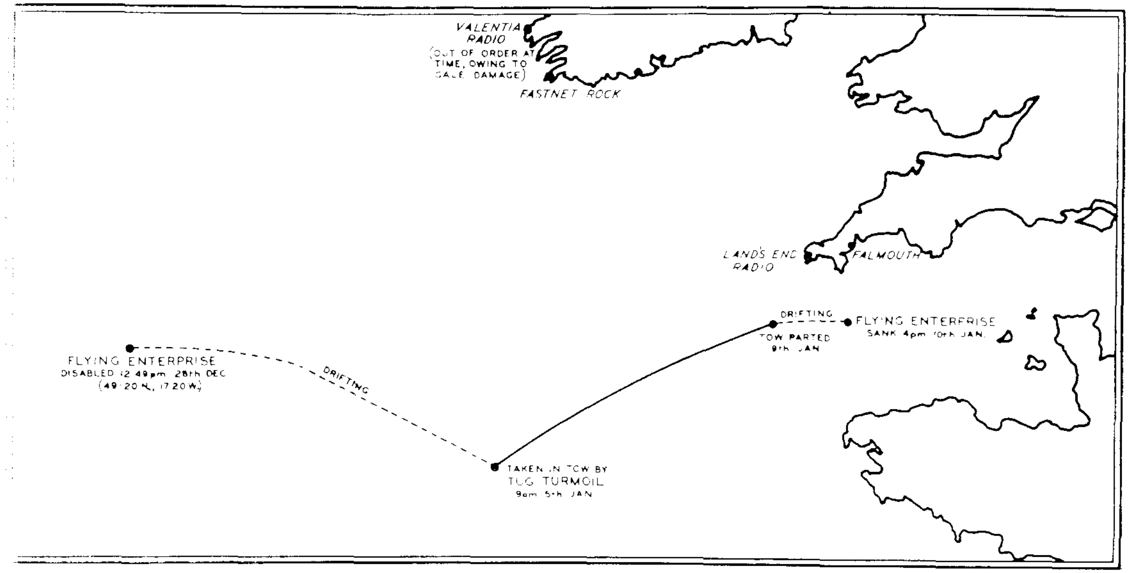
How the ship remained afloat under the terrific ounding of the mountainous seas is beyond undertanding. The details of the thrilling events of the ays that followed are well known and need not be escribed here. The lonely vigil of Captain Carlsen, ater to be joined by Mr. Dancy, the Mate of the *Turmoil*—the rigging up of a low-power radio ransmitter, which enabled him to keep in touch vith the attendant ships (Captain Carlsen was a een radio amateur)—the hazards of getting a tow ne on board with such a heavy list—the towing of he ship and the parting of the tow rope in a second torm, when the ship was almost within sight of arbour—the final rescue of the two men as the hip sank beneath them—it was not surprising that he whole world was stirred by this epic struggle gainst the elements and that the demands of the



(By courtesy of Overseas Towage & Salvage Co., Ltd.)

Press for communication facilities exceeded anything known in the past.

Normally the distress work of the Coast Radio Stations ceases when all lives have been saved. In this case, however, the more information that reached the public, the more was wanted and the greater the load on the radio circuits at the Land's End station. Direct radio communication with Captain Carlsen was not possible, so all information from the ship had to be relayed by the ships standing by—two United States destroyers and, later, the tug *Turmoil*. From the time the *Turmoil*



The course of "*Flying Enterprise*" after disablement.

left Falmouth until she returned with the heroic Captain Carlsen, communication hardly ceased, for not only had the needs of the Press to be met, but all up-to-date information about the progress of the rescue operations had to be passed to the Coast Guard Service, the Admiralty and Lloyd's, London. In addition, there was naturally much traffic between the *Turmoil* and her owners; this was handled by radio-telegraph and telephoned directly to their offices in London.

The Press, well aware of the facilities for communication available via Land's End, made heavy demands for radio-telephone calls with the ships on the spot. It was not possible for calls to the tug to be set up until after the tow had been connected, as she was too busy with other work to accept them, and over 30 calls were on hand when communication became possible; some of these had been waiting for 36 hours. Thereafter, it seemed that the only breaks in communication were those necessary for battery charging on board.

During the following days, over 75 calls with the *Turmoil* were handled, some of the conversations lasting for over an hour. In addition, other vessels, some specially chartered by the Press and carrying newsmen and photographers, had to be catered for, and these accounted for more than 100 calls.

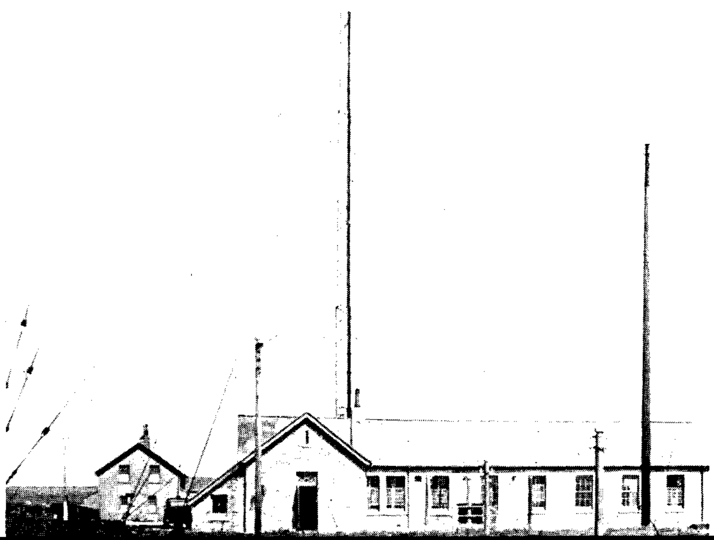
The B.B.C. included first-hand stories in their own news features. Special recording equipment was despatched to Land's End Radio Station and calls from ships on the scene were recorded for inclusion in the Home and Overseas services. One recording of particular interest was that of Captain Carlsen's voice from the *Flying Enterprise* relayed by the American destroyer, *Willard Keith*. This ship fortunately had the necessary magnetic-tape recording apparatus on board and a very interesting story, involving double recording and transmission, was obtained by questions and answers relayed by the destroyer. The records were not only used by the B.B.C., but were also flown to the United States and Denmark and broadcast over their nation-wide networks.

During the last moments of the *Flying Enterprise*, on the 10th January, the minute-by-minute reports from the tug and destroyer, and also from R.N.L.I. lifeboats, which had joined the company of ships in the final stages, were passed to Lloyd's in London by teleprinter manual switching to the Burnham station and thence by direct teleprinter. These messages were received at Lloyd's and posted in the Underwriters' Room within ten minutes of leaving the ship.

All the messages and calls that have been referred to were, of course, additional to the normal work of the Land's End station; this work continued without interruption throughout the period of stress and strain due to the *Flying Enterprise* incident.

As the tug *Turmoil*, with the *Flying Enterprise* in tow, neared Falmouth, this small old-world port became the centre of operations of newsmen of many nationalities. The Falmouth Head Post Office provided a news room overnight, with special facilities for the transmission of photographs and for handling the heavy load on the trunk telephone system for calls not only to London but to places on the Continent and in the United States of America. Many tributes were later paid to the Post Office for the splendid co-operation given to the Press by the telephone and coast radio service.

Land's End Radio Station



A typical scene in the Shetlands—Weisdale (*Photo. by courtesy of Scottish Tourist Board*)

V.H.F. Radio-Telephone Links in the Inland Trunk Network

by J. H. H. Merriman, M.Sc., A.Inst.P., A.M.I.E.E., *and*
D. E. Watt-Carter, A.M.I.E.E., *Engineer-in-Chief's Office*

COMMUNICATION WITH ISLAND COMmunities has always presented a challenge to man's ingenuity and initiative. In the United Kingdom there is a special interest in this matter, since there are over 100 inhabited islands off our coasts, ranging from the large islands like the Isle of Man, with a population of some 100,000, to islets that bear the full force of the Northern Atlantic storms, such as Foula, the far outpost of the Shetlands, which has about 150 inhabitants, or Pabbay in the Hebrides, with its population of three. The larger islands and island groups have maintained their communication by regular boat services, and during the past twenty years or so the use of aircraft has become more common.

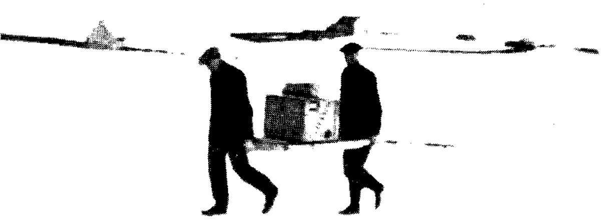
Communication with the smaller islands, however, is infrequent and dependent upon the whim of tide, wind and ocean swell, being usually achieved by open boat; yet it is in conditions of extreme weather, when transportation fails, that communications are so often most urgently required, to deal with such emergencies as critical illness, shipwreck or shortage of fuel or food. The provision of a telecommunication service to island communities has therefore engaged the attention of the Post Office for some time past.

In the middle and towards the end of the nineteenth century, undersea telegraph cables to the larger islands were laid and the basis of a telecommunications service provided. The routes such cables had to follow, however, were generally either routes lying across much-frequented shipping lanes or across channels where there were unusually high variations in tidal flow and an associated rocky bottom. The life of the cable was found to be relatively short, on the one hand owing to fouling by ships' anchors, and on the other to abrasive movement of cable on rock.

It was not accidental, therefore, that the first recorded uses of " wireless " in the G.P.O. were intimately associated with attempts to establish communications between mainland and island. For example, there is the record of experiments carried out in May, 1897, by the "young Italian electrician", Marconi, between Brean Down, an island in the Bristol Channel, off Weston-super-Mare, and Lavernock in Glamorgan, under the active encouragement of Sir William Preece, then Engineer-in-Chief of the G.P.O. Then, around 1900–1904, there were many attempts to provide wireless telephony circuits to lighthouses. In one of these experiments, during which Oliver Lodge co-operated with the Post Office, successful attempts were made to establish communication between Cemlyn, in Anglesey, and the Skerries lighthouse, off Holyhead. We find, in a letter dated 19th July, 1900, that Lodge suggested: "*. . . what we want is a magnifying microphone . . . another vibrating arrangement or dancer . . . and a sluggish relay . . . by this means spurious signals can be avoided . . .*".

These experiments were carried out under the general superintendence of the Engineer-in-Chief's Office of the Post Office. In his report on the performance of this link, the Engineer-in-Chief's technical officer wrote, on the 5th January, 1903, that "*. . . when the tide is low . . . the speaker has a strong voice, the listener has good hearing and is used to the accent of the speaker, it is possible to follow a conversation with the telephone receiver almost half an inch from the ear . . . but as the operators speak with a strong Welsh accent, it will be readily understood that a stranger . . . would have some difficulty in following a conversation . . .*". As an indication of the unchanging characteristics of human nature, present officers of the Department may fine a ring of familiarity in the minute of the Superintending Engineer, North Wales District, dated 22nd January, 1903, to the Engineer-in-Chief, stating: "*It is desired to close the Skerries Works Order as soon as possible, and in order to do this I shall be glad to learn whether the Engineer-in-Chief's technical officer has yet concluded his experiments*".

Man-handling test equipment for radio link in Orkney



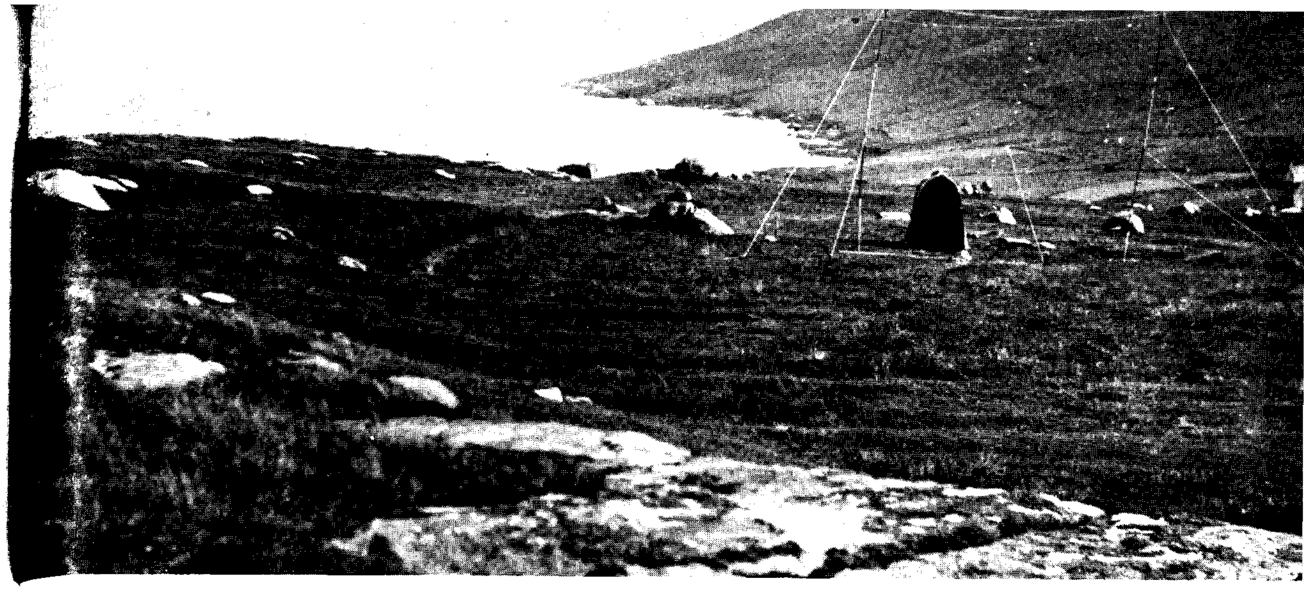
In the years that followed, methods of cable armouring and transmission techniques progressed steadily, to such a degree that telegraph and in many cases telephone facilities could often be provided. It became apparent, however, that there would remain certain cases where the handling of cable ships would be so difficult, or the maintenance of the cable so costly, that radio communication would be the only alternative. In some cases, too, the provision of a radio system as an alternative routing, to avoid complete loss of contact during cable fault conditions, was considered desirable. The provision of radio systems for telephone communication over short distances did not become economically practicable, however, until the period 1930–1935, when valves and techniques exploiting wavelengths much shorter than those in general use were developed. These shorter wavelengths allowed designers relative freedom to plan V.H.F. (very high frequency) systems without fear of interference from other stations, and also permitted the use of much lower powers than would have had to be used at longer wavelengths. It was also possible, at these wavelengths, to erect aerials on relatively small telephone poles, which would "beam" the signals towards the distant station in the manner of a searchlight beam, only some few per cent. of the power "spilling over" outside the beam angle of eight or ten degrees. To have achieved this same beam width at longer wavelengths would have required aerial systems supported by more complicated and costly steel lattice masts some 150 ft. or more in height.

Let us now consider in greater detail the setting up of a V.H.F. link. The need for telecommunication services to a particular island having been established, consideration has to be given to the most appropriate method of provision. If by radio, then the system chosen will be of one of the two standard types, either:

(i) providing up to 24 speech channels and capable of being fully integrated with the trunk network; or

(ii) capable of providing one speech channel and having certain restrictions on its connection to the trunk network.

The first type has been developed to take the place of one or more complete repeater sections on 12 or 24 channel cable systems and will give a performance complying with the requirements of the C.C.I.F. (Comité Consultatif International Téléphonique)* over links of up to 100 miles in length. Any one or more of the telephone channels so provided may be used for the transmission of multi-channel V.F. telegraph systems. In order to make the radio system as proof as possible against interruption due to faults, duplicate equipment is installed, with a remotely controlled change-over system.



Transportable field testing equipment in action in the Hebrides

The second type of equipment has been developed to provide a subscribers' telephone service in remote localities where no public electric power supply exists and where the calling rate is low. The equipment enables a subscriber or possibly a small manual exchange to be connected to any type of manual or Strowger-type automatic exchange over links of up to about 20 miles in length. It has been designed to have an endurance of about 4–6 months without replacement of its battery power supplies and, being necessarily as simple as possible, has no reserve equipment.

In both types of equipment, the principal aim in design has been reliability, since both types have to operate on an "unattended" basis. The importance of this is obvious when it is remembered that a maintenance visit to, for example, the island of N. Ronaldshay requires an open-boat crossing of an exposed channel. The boat operates only two days a week and there is always a risk of inability to return because of mounting seas. In fact, for the sake of a few hours' work, the maintenance officer was once marooned on the island for a fortnight.

The first step in setting up a radio link of either form is to select the sites of the two terminal stations. A number of factors have to be taken into account, if a reliable and satisfactory link is to result. One inescapable requirement arises from the quasi-optical characteristics of radio wave propagation at the wavelengths used for these links. That is to say, the radio signals travel in straight or nearly straight paths, so that the presence of obstacles in their path, such as the spur of some local hill or even high trees, gives rise to radio "shadows", or areas where the received signals are relatively weak. Although it is possible to forecast and allow for some of the effects of path obstructions, the radio engineer endeavours to locate his sites so that they can "see" each other, in the radio sense. It is a tribute to the accuracy of the Ordnance Survey of the United Kingdom that the various alternatives to meet this requirement can nearly always be selected to within quite narrow limits and frequently pinpointed with confidence from map inspection and contour plotting. This, of course, narrows down the field search and saves much time. Incidentally, the lack of such accurate maps is one of the factors that increase the difficulties of planning such links in relatively undeveloped areas overseas.

The surfaces of both sea and earth act as very efficient reflectors of radio waves at the frequencies employed, and this has a fundamental influence on

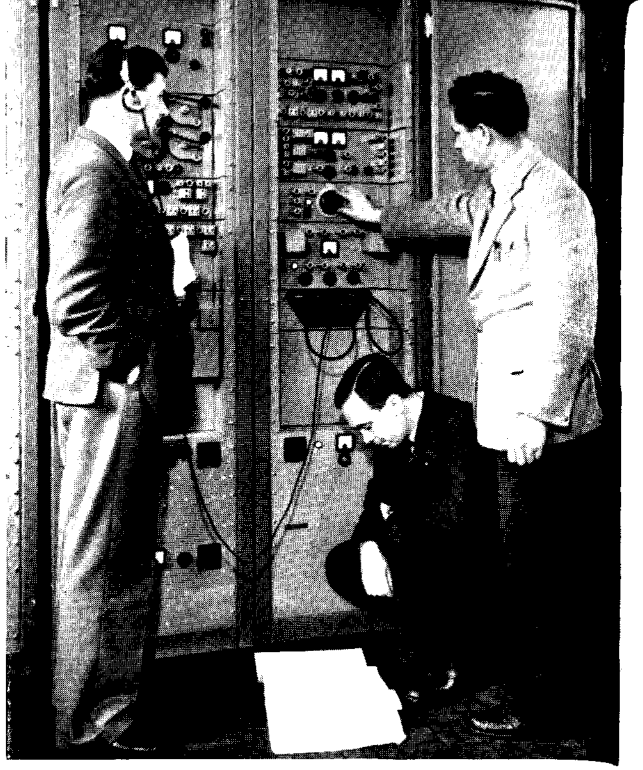
* C.C.I.F. is used to denote the International Telephone Consultative Committee, to avoid confusion with the existing abbreviation C.C.I.T., denoting the International Telegraph Consultative Committee.

the choice of both the position and the topographical features of a desirable site.

If properly exploited, the reflecting properties of the earth can be used to advantage in securing the best results from the aerial systems. The radio-frequency energy leaves the transmitting aerial or arrives at the receiving aerial, in general, in two useful directions: one is in a direct and more or less horizontal line joining the two aerials, and the other is via the reflecting ground plane in the immediate foreground of the aerial. The radio engineer tries, therefore, to find sites that have as nearly as possible a uniform gradual downward slope in the direction of propagation for at least 300 feet in front of the aerials. With aerials properly designed to take advantage of the slope characteristics, it would be possible, under ideal conditions, to obtain a resultant signal at the receiver four times as large as that in the absence of reflection from the ground plane. Such figures are rarely achieved in practice, since changes in slope or unevenness of surface scatters the reflected waves, but it is nevertheless possible to get really worthwhile improvement by attention to this aspect of site selection.

Site inspection and consideration of these technical factors usually reduce the number of possibilities to two or three sites for each station. They will almost certainly be on high ground and hence relatively inaccessible and so placed as to sample the worst degrees of wind, storms and snow that the district has to offer. If called upon to verify all this during the depths of winter, as is usually the case, the engineer bears his lot with fortitude, comforted no doubt by the knowledge that whatever money may be required for access roads, adequately weatherproof buildings, power and telephone cables, at least he has no charges to bear for the use of his communication medium, the ether.

At this stage, the technical, economic and operational pros and cons of each site are weighed and the choice narrowed still further. The next step is to carry out field-strength measurements between the two or more most promising sites. The purpose of these tests is to verify that the theoretically predicted propagation path is in fact satisfactory and to gather sufficient evidence about the disposition of field strength over the sites to enable the permanent aerials to be correctly designed and positioned. The equipment for these tests includes a mobile transmitter, complete with local power supply, and a means of measuring the transmitted



Part of the internal equipment of a multi-channel V.H.F. radio station

radio-frequency power, high-sensitivity receivers with linear characteristics and a signal generator for receiver calibration. An additional transmitter and receiver is also required for two-way communication between the sites. The test aerials take the form of half-wave dipoles of robust construction, connected to the equipment by flexible feeder cable to enable them to be moved about easily over the site. The aerials are mounted on light tubular masts some 30 to 40 feet high, which are easily and speedily erected by the testing staff. Needless to say, getting all this equipment to a remote site, often without any roads, sometimes presents difficulty, and transport of more than ordinary robustness and agility is essential.

The testing procedure is, briefly, to erect the test aerials at a number of selected points in turn on both transmitting and receiving sites and to measure the received signal as the height of each aerial above ground level is varied. By this means, a series of "height gain" curves is obtained, which, when interpreted in conjunction with a careful survey of the ground in front of the site, in most cases provides adequate information from which to choose

the best position and design for the permanent aerials.

A variety of different types of permanent aerial systems could be used to give the desired performance, but for some years the Post Office has favoured the rhombic aerial, on account of its extreme simplicity and mechanical strength—very necessary on exposed sites subject to very high winds—ease of adjustment and economy in its use of supporting structures and materials generally. It has now almost entirely superseded the older and mechanically more complicated "broadside" arrays of dipoles known as Koomans arrays. The method of feeding the aerials has also undergone some change with the use of higher frequencies. Open-wire lines are quite efficient and satisfactory up to about 60 Mc. s., but above this frequency irregularities in them due to such unavoidable imperfections as bends, insulators and even imperfect regulation of the wires begin to cause trouble, and it is now the practice to use coaxial feeder cables for operation over 100 Mc. s. A matching transformer is necessary to convert the balanced impedance of the aerial to the unbalanced 75-ohm impedance of the cable, and this is mounted in a hermetically sealed cast aluminium box as close as possible to the feedpoint of the aerial. It is also most desirable that the lengths of all feeder cables should be kept as low as possible, as otherwise some of the advantages of the high-gain aerial system would be forfeited in increased cable attenuation.

The installation of the internal equipment at a typical multi-channel radio system is shown in the accompanying illustration. The equipment is designed to operate on a wavelength of about 2 metres—more specifically, on frequencies in the range 156 to 184 Mc. s. The 24 channels are modulated as a group on to the radio-frequency carrier, the assembly of individual channels into this group being carried out at the appropriate terminal station in the associated line network. In some cases, however, at the island end of the link, this line terminal equipment is located at the radio station for ease in maintenance. The modulation of the group of 24 channels on to the radio-frequency carrier is by frequency modulation (F.M.). This enables significant advantages to be obtained in comparison with earlier systems using amplitude modulation (A.M.), by reduction of sender power to 10 watts and a consequential increase in reliability. The reduction in sender power is ten to one, without loss of performance, and the necessary high circuit stability can be achieved much more readily; so much so that over a range of incoming signal strengths of up to 1,000 to 1, the output level from the radio system will depart by less than one tenth from its nominal value. In order that the operating frequency allocated to a particular link may be rigidly adhered to, the mean radiated frequency is compared with that of a signal of stable frequency derived from a quartz crystal controlled oscillator. Should there tend to be any divergence between the mean radiated frequency of the sender and this local sub-standard, then automatic compensating and correcting circuits come into action to reduce that error, so that the mean radiated frequency is plus or minus one part in ten thousand of its

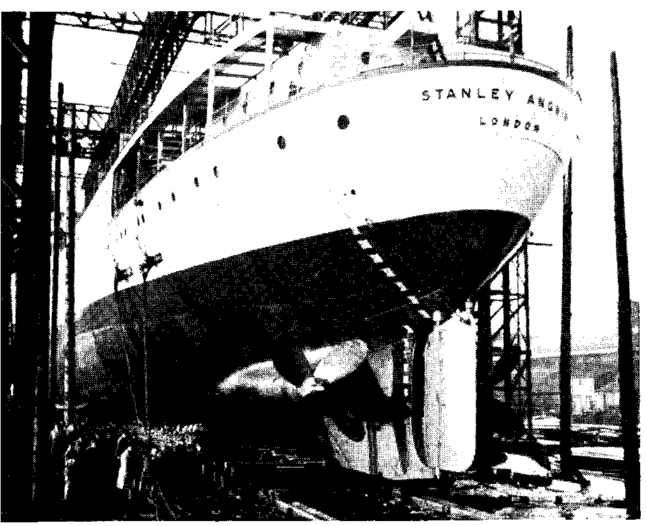
A typical multi-channel V.H.F. radio station

nominal value. Since the location of the radio station is determined largely by radio propagation conditions, it is generally found that it is well removed from any convenient maintenance or supervisory base. Arrangements are therefore made to extend over a cable pair, to the nearest convenient point (usually either a staffed repeater station or the test desk of an exchange), signals indicating the condition of the radio equipment and to provide means for remotely changing over from main to standby equipment. In all stations, arrangements are made to preserve continuity of service in the event of failure or interruption in the public power supply. A standby power supply is provided in the form of a small Diesel-driven generator. This is designed to start up and connect itself automatically to the radio equipment when the mains supply either fails or departs from pre-arranged voltage limits and to shut down when the mains supply is restored. It is also customary to arrange for a signal to be given at the remote control point that the generator is running and so ensure that an unduly prolonged mains interruption is investigated before the fuel supply becomes exhausted.

It has been found that in the circumstances prevailing in the United Kingdom, where access to staffed engineering positions is fairly easily available, this limited form of remote control has proved very satisfactory and considerably simpler than a fully automatised change-over system, for which supervisory signals would still have to be supplied.

In considerable contrast to the above is the simple compact subscriber's radio-telephone equipment recently developed in the Engineering Department. The problem of providing a radio-telephone service to remote subscribers depended largely on the provision of a suitable power supply. The radio "phonogram" links provided since 1935 have depended, in places, on wind-driven generators. The main difficulty with these is their liability to damage under gale-force winds. Hence, the new subscribers' radio-telephone equipment has been built to use primary batteries, which, at a calling rate of about twelve 3-minute calls a day, are designed to last some 4–6 months. The development was made possible also by the availability of a range of miniature valves, some of which were originally introduced for deaf-aid appliances. The equipment, being small, compact and housed in sealed, waterproof, metal cases, can be located in any convenient position not more than 100 yards or so from the aerials, which latter, being also small and similar to the familiar television H-dipole, can be mounted on a single self-supporting pole.

As a first stage, the earlier radio "phonogram" sets are to be replaced by the receiver equipment. In the second stage, as equipments become available, a programme of provision of service to islands hitherto not linked with the trunk network will be initiated.



New Cable Ship

A 2,500-ton cable ship for Cable and Wireless, Ltd., was launched on the 11th February at Newcastle-on-Tyne. The ship was named *STANLEY ANGWIN* by Lady Angwin after her husband, Sir Stanley, Chairman of the Commonwealth Telecommunications Board and former Chairman of Cable and Wireless, Ltd.

An article on the construction and equipment of the ship will appear in this journal later in the year.

Photograph by courtesy of Messrs. Swan, Hunter & Wigham Richardson, Ltd.

LONDON TELECOMMUNICATIONS REGION, LONG DISTANCE AREA

This Area is unique in that it has no size—a mere 700 trunk subscribers, no Accounts, Sales or External Engineering Divisions. It makes up for these omissions by having Kelvin House, one of the latest exchange buildings, and the best known exchange building in the country, Faraday Building. This is an agglomeration of four buildings, containing, in its 10 acres of floor space, three long-distance automatic units and 1,310 positions, of which 190 are for completing continental traffic. This centre, together with the International Radio Exchange and three trunk demand control centres, comprise the Area, which is being increased by the addition of two more automatic units. The Area Office occupies Wren House, in St. Paul's Churchyard.

In this Area are terminated 47 radio-telephone links, 365 continental lines and 12,895 inland and toll lines. The staff numbers over 5,000, of whom 4,000 are telephonists and allied supervising grades.

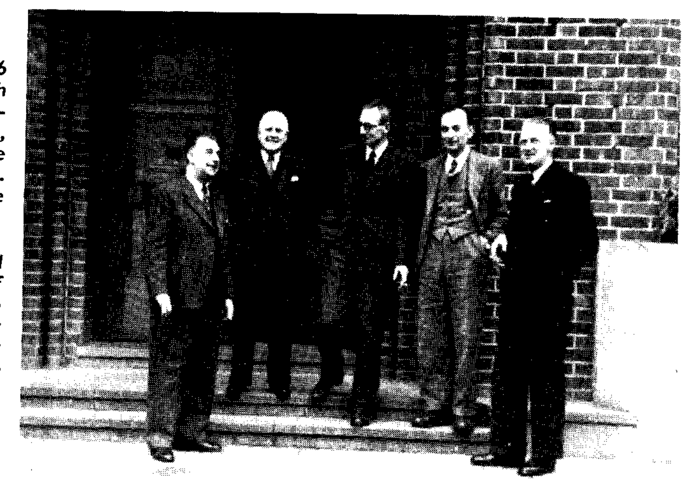
Left to right: R. F. HOLLIDAY, Area Engineer; R. C. DEVEREUX, Area Engineer; A. L. GODDEN, Chief Traffic Superintendent; E. S. RUSSELL, Chief Traffic Superintendent; W. T. J. DONOVAN, Telephone Manager; W. G. AYLETT, Chief Traffic Superintendent; L. R. SMART, Acting Chief Clerk.

BOURNEMOUTH TELEPHONE AREA

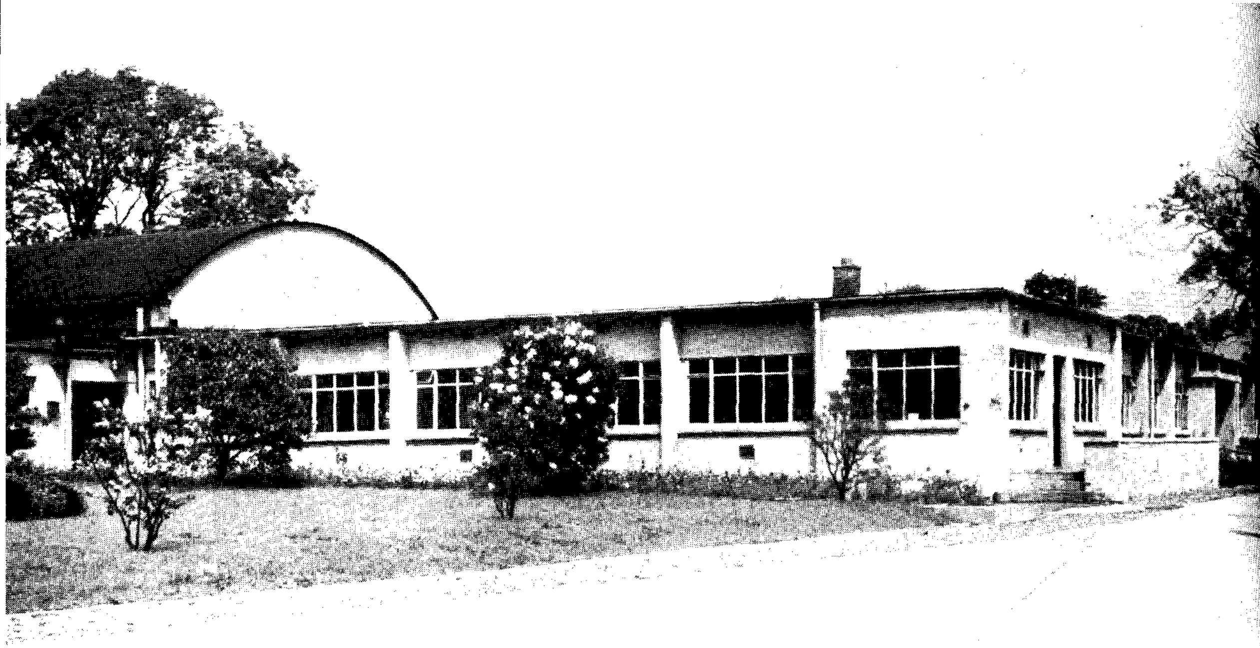
The Bournemouth Telephone Area comprises 1,056 square miles, mainly in the County of Dorset, although the most densely telephoned part is around Bournemouth, which is in Hampshire. There are 70 exchanges, 22 manual and 48 auto, 70,300 stations, 43,300 exchange connections, and a total staff of all grades of 950. Almost all the largest exchanges are still manual. The annual revenue is now about £1,000,000.

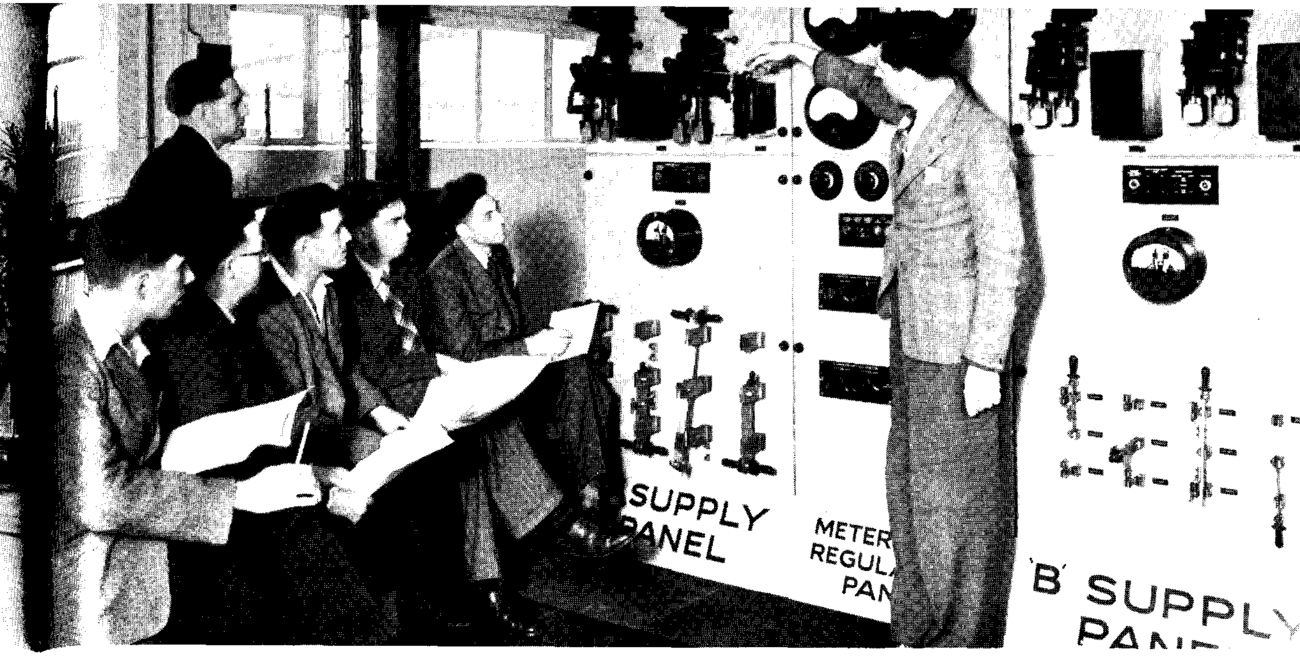
The Area has a beautiful coast line and hinterland and its boundaries closely coincide with the Wessex of Thomas Hardy. Its most important industries are holiday making (which keeps Telephone people very busy!) and agriculture, and there is also the important naval base of Portland—a huge rock which supplied the stone for St. Paul's Cathedral and other famous buildings. It is packed with relics of English history, ranging from the days of the earliest British inhabitants to the invasion of Europe in 1944. The first cross-channel cable to the Normandy Beach Head was terminated at Southbourne, in Poole Bay.

No report about the Area would be complete without mentioning the close ties with the Channel Islands, where a number of our Engineering staff maintain the trunk communications.



Left to right: W. H. GROVES, Senior Sales Superintendent; S. G. M. CAPLE, Chief Clerk; H. C. PINCH, Chief Traffic Superintendent; E. S. RUSBRIDGE, B.Sc.(Eng.), Area Engineer; W. R. TYSON, B.Sc.(Eng.), M.I.E.E., Telephone Manager.





Demonstration on a power switchboard

The Central Training School of the Post Office Engineering Department

by H. R. Harbottle,
Training Branch, Engineering Department

WITH THE RAPID EXTENSION OF AUTOMATIC telephony in this country from 1926 onwards, it was soon evident that engineering staff must be carefully trained in the maintenance and installation of the equipment. Most of the comparatively few experts in this development at that time were located in London, and a central training school was therefore established in King Edward Building, E.C. The success which attended this new phase of the Engineering Department's activities and the increasing use of thermionic valve repeaters for long-distance trunk circuits resulted in an expansion of the school for training staff engaged on the maintenance of transmission equipment.

Continued increase in the demand for training necessitated larger premises, and these were built and occupied in 1931 at the Post Office Engineering Research Station, Dollis Hill, N.W.2.

At the outbreak of war in 1939, centralised training was suspended temporarily, but it was soon started again at Cambridge. The automatic school was subsequently dispersed to Otley, Yorkshire, and Birmingham. Part of the transmission school was transferred to Wood Street, London, at a later date.

After the war, the Engineering Department's centralised training was regrouped at Yarnfield, near Stone, in Staffordshire. This site was selected from many visited, because temporary, single-storey wartime hostel buildings were available there and were suitable for conversion to meet the requirements of the school. The hostels were built originally to house staff employed at the Royal Ordnance Factory, Swynnerton, but, in fact, three —Duncan, Howard and Beatty Halls—had been occupied by United States Air Force personnel.

Each of the three hostels occupies about 15 acres, Duncan and Beatty Halls being about a quarter of a mile in opposite directions from Howard.

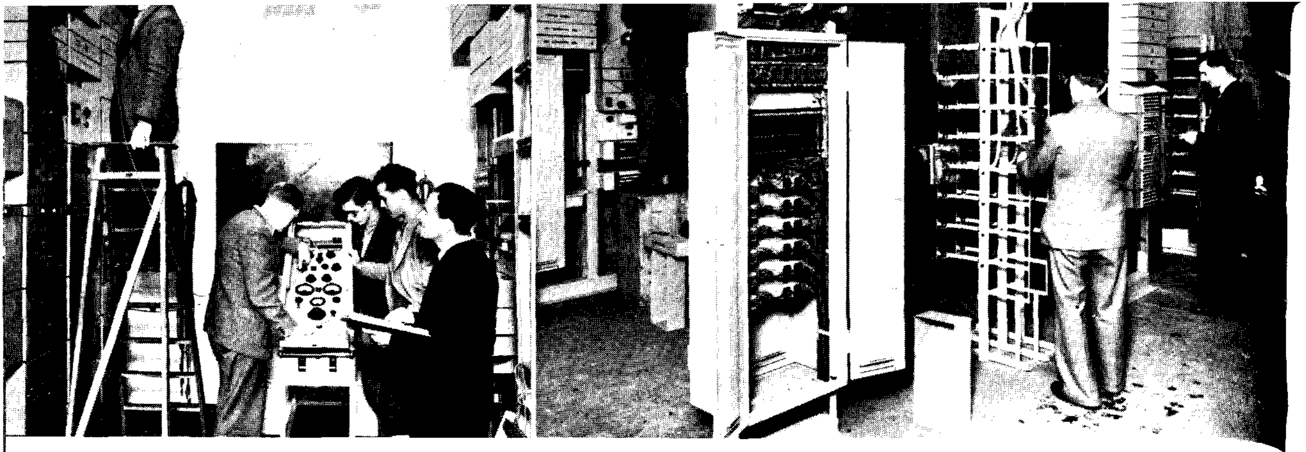
Following the recommendation of the Post Office Training Committee, the school is residential and, because of housing difficulties, official living accommodation is provided for single and married school staff. Duncan Hall is the school proper; Howard Hall retains its original function as a hostel for students and unmarried school staff; Beatty Hall has been converted into 89 two- or three-bedroomed bungalows for married school staff. The latter provision soon proved inadequate, and an additional 61 bungalows have recently been made available by converting hostel buildings at Raleigh Hall, which is some four miles from the school.

To reduce the cost of conversion, certain departures from an ideal layout had to be adopted. For instance, as some bays of the standard equipment required for demonstration are 10 feet 6 inches high, these were installed in those parts of the existing hostel buildings which had adequate headroom—for example, dining rooms and kitchen—irrespective of the location relative to lecture and practical rooms.

The school has three main functional divisions, Automatic Telephony, Transmission and Miscellaneous, but the general scheme of training in each is the same, namely a basic course followed by more specialised courses. More than 100 different courses, varying in length from two to seven weeks, are available, and these cover a wide range of subjects for a variety of staff, from a Youth's course in Radio to a course in Management for Area Engineers. As over 7,000 students attend the school annually for an average period of four weeks, the normal student population is approximately 600.

The maximum number of students on any one course is limited to 24. Generally the lecturer, an Assistant Engineer, in charge of a full course, is assisted by three demonstrators, who are Technical Officers. Hence, during a demonstration, it is possible for the demonstrator to give individual attention to the eight students in his group, and none has difficulty in observing any part of the demonstration.

Before a student comes to the Central Training School for a course, attempts are made to ensure that he has had at least two months' "field" experience, so that he will not be unfamiliar with his subject. In some instances a satisfactory report of his performance at a preparatory Regional School course or, alternatively, some other recognised technical achievement, is required before he is accepted. Furthermore, it is considered essential



(*left*) Students lining-up a 12-channel carrier telephone system (*right*) Demonstration repeater stations

that, for at least three months after leaving a Central School course, a student should be employed on duties which will enable him to consolidate the training given. Thus, the Central Training School course can be regarded only as a part, but a vital part, of the training required for particular engineering duties.

As an example, before a student attends for a Basic Automatic course, he should spend at least two months in an automatic exchange, so that he becomes familiar with the equipment and its general layout and function. On return to his Area, after the school course, he should continue his "field" experience in the exchange and undertake appropriate testing and adjustments of the equipment, at first under supervision and, when competent, unaided. While such a student is at the Central Training School, he receives instruction in tracing the operation of automatic exchange equipment from circuit diagrams and in identifying the actual components in correct sequence on demonstration equipment. Faults are introduced to give him practice in location and clearance. Practical experience in adjustments is also obtained.

It will be realised that the conditions under which this is done at the school are vastly superior to those existing in the field. This is one obvious reason for requiring the "field consolidation" after a school course.

The more specialised Automatic School courses relate to non-director, director and unit automatic exchanges.

For many years, engineering training was directed almost entirely towards what might be described as the inanimate side of the work—that is, the purpose, construction, operation and performance of the various types of equipment used by the Department, but more recently greater study has been given to developing the most effective utilisation of the manpower available, in an endeavour to increase the output per individual. Hence, when supervising officers attend the courses in Organisation and Supervision, which have been held at the Central Training School for the past two years, they are encouraged to think about their job and how to get the best work from the staff under their control. The subject of management is not an exact science, and so the nature and conduct of these courses are very different from others. Broadly, the students teach themselves by means of guided discussions and role playing and by solving live "cases".

Other Courses

In addition to the Basic course in the Transmission School, courses are held for staff who will be required to maintain teleprinters and other telegraph apparatus or who are to be employed in amplifier stations or repeater stations, which may contain audio, carrier, coaxial and, perhaps, voice frequency telegraph equipment, or who may be concerned with circuit provision and other aspects of line transmission.

The Miscellaneous School is responsible for training in a variety of subjects. These comprise Power—from simple office wiring to lifts and automatically-operated prime movers driving generating plant for exchanges and repeater stations—Radio and Television (including interference suppression), Local Line Planning, Teaching Methods and Management.

To facilitate instruction and demonstration, the audio, carrier and coaxial equipment necessary for complete systems is housed under one roof, although each terminal and the intermediate repeaters may be in separate rooms.

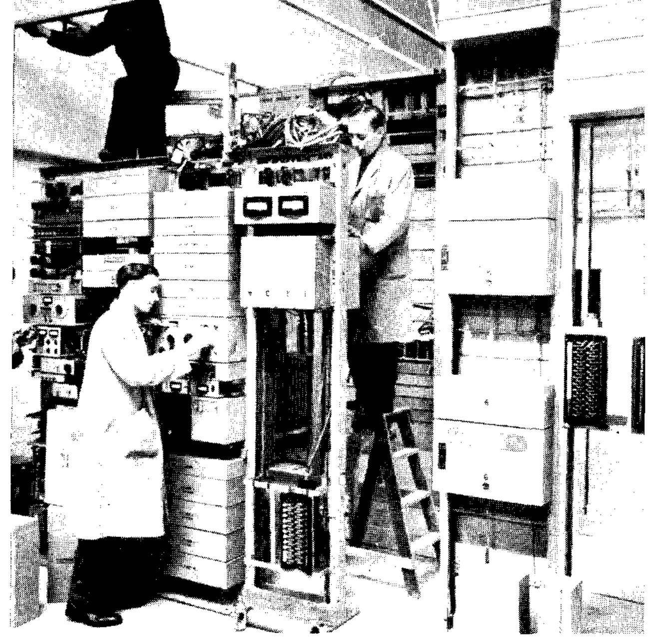
To complete this brief survey, a short description of the hostel arrangements and welfare facilities for students follows. Two students are allocated to a bedroom, which contains two single beds, two dressing tables, two wardrobes, table and chairs. Each hostel sleeping block at Howard Hall has 96 such bedrooms and communal lounges and lavatories. There are two similar dining rooms for students, each seating about 200, so there must be more than one sitting in each dining room for the main meals.

The theatre at Howard Hall is renowned throughout the district for the high standard of its cinema and stage shows. Dances are held twice weekly and the floor area is sufficient for two badminton courts. The theatre is also used for the reception of students when starting their courses.

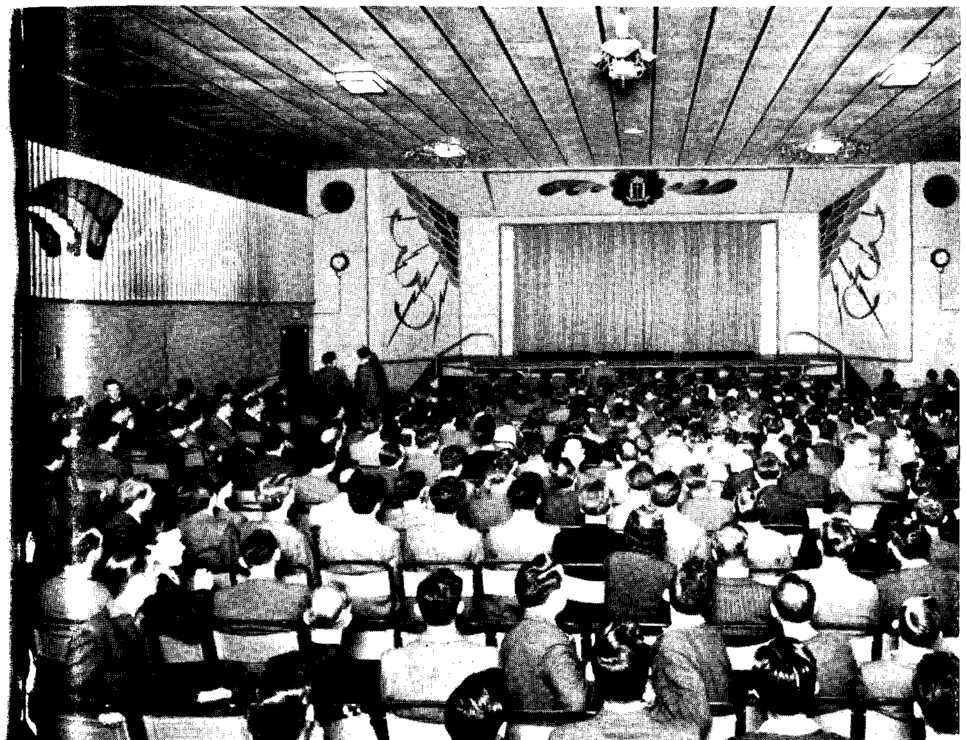
Students can enjoy indoor and outdoor games and sports. The students' billiard room is a popular feature. It is well equipped and, in spite of heavy use, the maintenance is very good.

As regards outdoor sports, the Central Training School Sports and Social Club has developed a nine-acre field between Howard and Beatty Halls for cricket, hockey and Association football. Six hard tennis courts have also been provided. The Civil Service Sports Council has given valuable advice and assistance, but the success achieved so far has been due largely to the voluntary efforts of the school staff.

A well-equipped sick bay under the care of a matron, assisted by two nurses, is available for students and staff. A local doctor attends twice weekly. During 1950–51, there were 865 in-patients, and 6,640 out-patients received treatment.



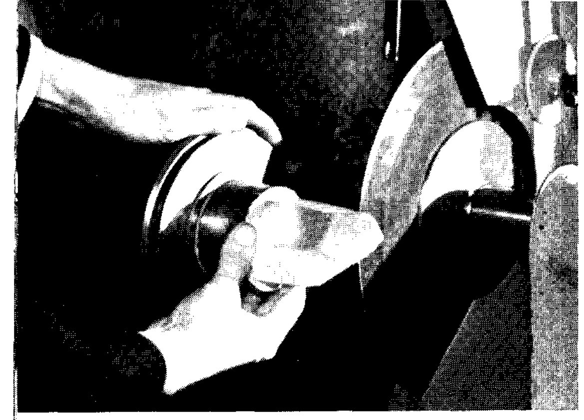
Co-axial repeater equipment



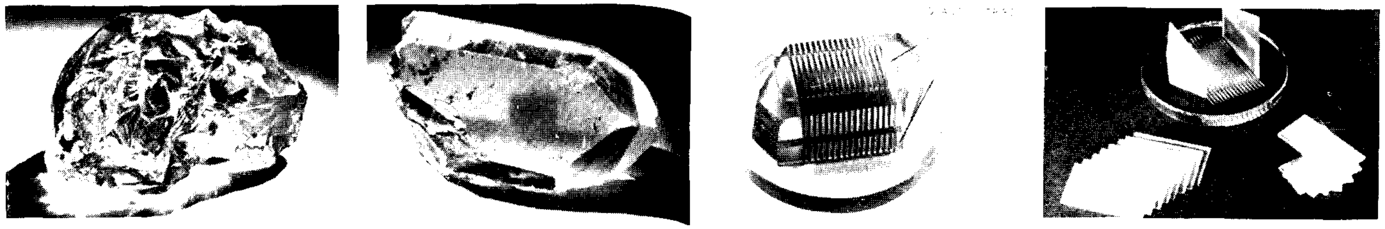
School Theatre, Howard Hall

Piezo-Electric Crystals

by J. E. Thwaites, A.M.I.E.E., Engineer-in-Chief's Office



Crystal being set in machine ready for cutting into slabs



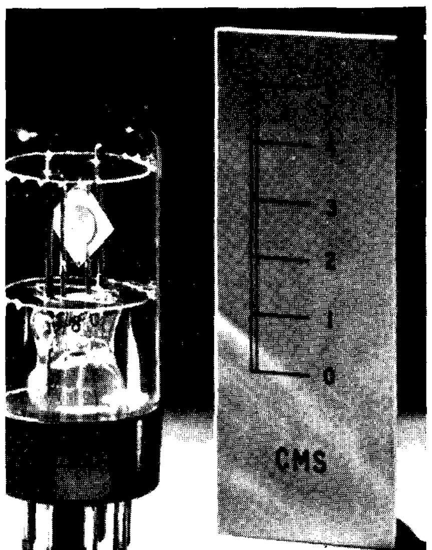
left to right: Irregular and well-faceted natural quartz crystals—Quartz slab sliced into plates—Plates removed from slab and cleaned

Testing orientation of cut surface of crystal with X-ray spectrometer

CRYSTALS WHICH DEVELOP AN ELECTRIC charge when squeezed or stretched, or which become mechanically stressed when an electric charge is applied to them are called "piezo-electric" (from Greek *piezein*, to press). They are not to be confused with the rectifying crystals used in "catswhisker" detectors.

The piezo-electric phenomenon was discovered by the Curies in 1880, but has been applied to telecommunications only within the last twenty-five years or so. Piezo-electricity is a property of many crystals, some being minerals and some being capable of manufacture from solution. Chief among the mineral varieties is quartz. Of the synthetic water-soluble crystals, ethylene diamine tartrate (EDT) and dipotassium tartrate (DKT) have received much attention and are probably the most useful for telecommunications. No satisfactory substitute has yet been found for quartz when great precision and constancy are required.

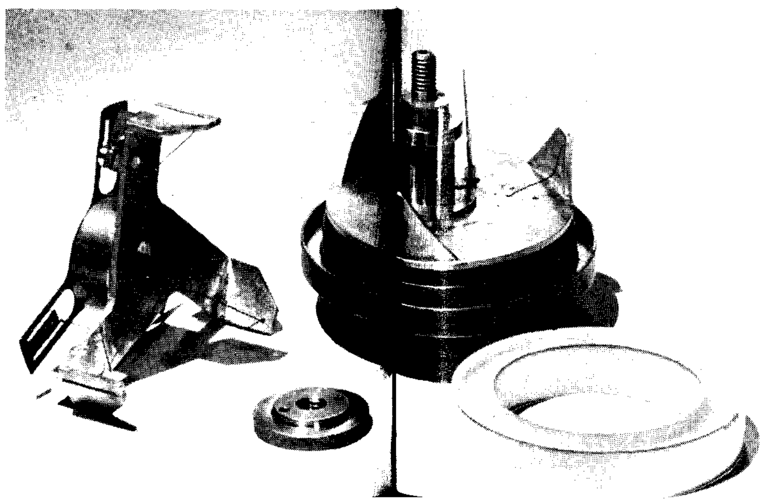
Typical mounted unit for radio transmitter frequency control



The phenomenon is utilised in the crystal oscillator by placing a plate or rod of piezo-electric crystal between electrodes and connecting these to a thermionic valve in such a way that the valve and its batteries supply sufficient energy to keep the crystal vibrating and the frequency of vibration is primarily determined by the crystal itself. Such an arrangement is widely used for generating the carrier wave of a radio transmitter. Another use for crystals in telecommunications is as resonators in the numerous filters required in multi-channel telephone systems. Here they remain passive until excited by the particular frequencies for which they were designed and thus are able to filter out or separate one band of frequencies from others.

In the manufacture of such vibrators, the natural crystal is first carefully examined for flaws such as internal cracks and is then cut in the appropriate direction, with a metal disc charged at its edge with powdered diamond, to form slabs. These slabs are then cut into slices of about the right size and shape required and the slices are ground or lapped precisely to specified dimensions. In the lapping machine shown, plates of quartz are located in holes in a thin diaphragm resting on a cast-iron plate or lap and another similar iron lap is placed upon them. The diaphragm and the quartz plates are driven round between the laps by the crank, a mixture of liquid and abrasive powder such as carborundum or emery is applied at intervals through the holes in the top lap and the process is continued until the crystal plates are worn down to the desired thickness.

100 kc/s. quartz ring used for frequency standards and quartz clocks



The edges of the plates are trimmed to size and the plates then receive coatings of gold, silver or aluminium, which form the electrodes. Their vibration frequencies are measured and small adjustments of dimensions are made until the correct frequency is obtained from each unit. Finally each plate is mounted in a container, usually of the glass valve type, which is evacuated and sealed.

The frequency of vibration of a crystal plate or rod depends not only upon its dimensions, but also upon its mode of vibration—flexural, extensional or shear. Quartz flexural vibrators a few centimetres long may have frequencies as low as 1,000 cycles per second, whereas small plates a few hundredths of a millimetre thick can be made to vibrate in "thickness-shear" one hundred million times a second.

The most important effect of the cutting direction is its influence on the stability of the product when subjected to temperature change. Modern requirements are so stringent in this respect that it is necessary, in some cases, to make the cutting angle correct to within two or three minutes. For this reason, an X-ray spectrometer is generally used to check the correctness of a cut surface by reference to the atomic lattice structure of the crystal.

Quartz vibrators, when carefully prepared and maintained, constitute perhaps the most accurate and constant standards of frequency and provide the most accurate time-keeping instruments known. Quartz clocks controlled by ring units of the type shown here can have a rate predictable to 1 100th second per month. (Readers will remember the article on "Quartz Crystal Clocks" in this Journal in February, 1951.)

The photograph of cleaned plates (above, centre) appears by courtesy of the "Post Office Electrical Engineers' Journal".

The drill press lap

Ceremony in 1927

25th Anniversary of the Opening of the Trans-Atlantic Telephone Service

TELECOMMUNICATIONS, WITH THEIR ability to shrink the world to small proportions, have become such a part of our daily life that from time to time we tend to forget just how young some of the greatest achievements are.

The 7th January of this year marked the twenty-fifth anniversary of the first trans-Atlantic telephone conversation. On that day messages were exchanged between Lord Salisbury and Sir Alexander Little, Director-General of the Post Office, in London, and Mr. Walter S. Gifford, American Ambassador to the Court of St. James's, who was visiting Washington, and Mr. Craig, President of the American Telegraph and Telephone Company, in New York.

The occasion was the more interesting because Mr. Gifford had taken part in the inauguration of the Trans-Atlantic Telephone Service. As President of the American Telegraph and Telephone Company, he made the first call, in 1927, to Sir Evelyn Murray, Secretary to the General Post Office, in London.

Mr. Gifford repeated on this occasion a sentence which he had used in 1927, and its aptness is even greater now than perhaps he realised at the time of that first call. It was:

"*Through the spoken word, the people of New York and the people of London will become neighbours in a real sense, although separated by thousands of miles.*"

LONDON: Lord Salisbury (*left*) and Sir Alexander Little

NEW YORK: Mr. Craig

WASHINGTON: Mr Gifford

(*Photo. of Mr. Gifford by Buckingham Studio, Inc., Washington, D.C.*)

The First Printing Telegraph

by G. R. M. Garratt, M.A., M.I.E.E.

Deputy Keeper, Science Museum, London

WE ARE SO ACCUSTOMED TODAY TO THE almost universal use of the teleprinter in the practice of telegraphy that we sometimes forget that the printing telegraph is almost as old as the electric telegraph itself. An interesting reminder of this has been given recently by the discovery at King's College, London, of the first two printing telegraphs ever made—by Charles Wheatstone, in 1841.

As may be remembered, the introduction of the electric telegraph as a practical means of communication was due principally to the work of W. A. Cooke and Charles Wheatstone from 1837 onwards. Cooke, a practical man who had been compelled for reasons of health to resign from the army in India, was not a scientist, but he realised the potential value of electricity as a means of signalling. Early in 1837, he had devised a telegraph instrument but, meeting certain difficulties, he was led to consult Wheatstone, who was then Professor of Experimental Philosophy at King's College. This meeting led to a partnership and to the granting of their first patent for an electric telegraph on the 12th June, 1837.

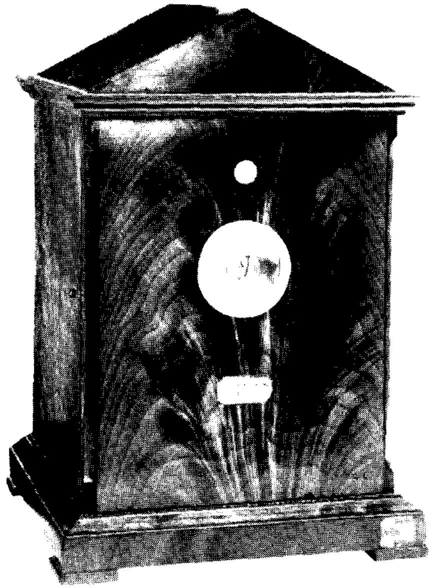
Cooke at once began to develop and exploit the invention commercially, and the new railways then beginning to spread over the country provided a splendid opportunity. Early in 1839, the Great Western Railway was about to open its new line from Paddington to Slough and, as a first step, it was decided to install the electric telegraph on this line between Paddington and West Drayton. It was successfully completed in May, 1838, and later extended to Slough.

The instruments used on this and many other lines that followed were of the needle type, a form of instrument favoured by Cooke for practical signalling. His partner, Wheatstone, was less interested in the immediate practical applications, however, and favoured a form of instrument in which the letters to be signalled could be transmitted and read directly as ordinary letters by unskilled persons. He considered any form of code undesirable, and this led him to develop his step-by-step or "A.B.C." form of telegraph early in 1840. This instrument was very slow in operation, but in an improved form it was later to find wide use on private circuits.

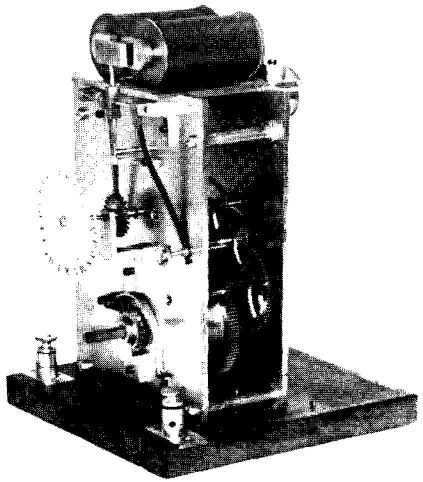
While it seemed to Wheatstone that a telegraph in which the letters were directly indicated was better than one in which some form of code had to be employed, it seemed obvious that an even more desirable step would be one in which the message was actually printed by the receiving instrument. Leaving Cooke to develop the telegraph commercially, Wheatstone therefore proceeded to develop his step-by-step instrument as the basis of a printing telegraph in 1841.

It had been known for many years that Wheatstone had invented a printing telegraph in 1841; it is mentioned in the 1860 edition of the *Encyclopaedia Britannica* and it was covered in Wheatstone's Patent No. 9.022 of 1841; but with the exception of these and two or three other isolated references, all record of the instrument seemed to have vanished. There was no positive certainty that the invention ever became anything other than an idea or that a working instrument had ever been constructed. Hence, Wheatstone has never been regarded as a pioneer of the printing telegraph.

A few months ago, I was invited to make a survey of a considerable number of instruments in one



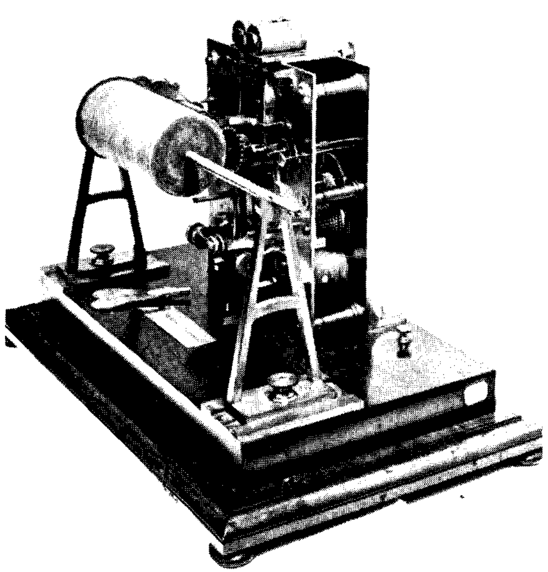
Wheatstone's A.B.C. or Step-by-Step Telegraph of 1840.

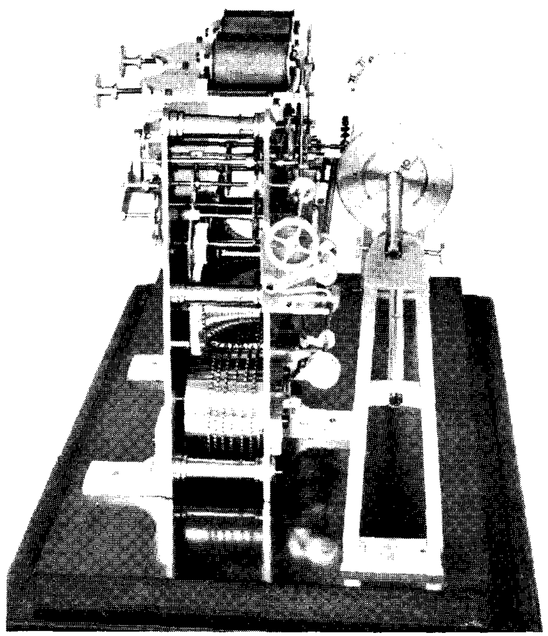


WHEATSTONE'S PRINTING TELEGRAPH OF 1841

This instrument, probably the earlier of the two made by Wheatstone in 1841, is now in the Royal Scottish Museum, Edinburgh.

This later version of the printing telegraph, which is still in perfect working order, is now in the Science Museum, London.





of the laboratories at King's College, London. Many of them were connected with Wheatstone and dated from about 1830–1850, and many related to the early days of the electric telegraph and to other scientific fields in which Wheatstone worked.

Among the collection were two instruments which were obviously designed for printing a message. They were in such an excellent state of preservation that it seemed unlikely that they were made over 100 years ago and, as I was certainly not anticipating the discovery of the original printing telegraph instruments, I did not at once appreciate the significance of these two. Even the fact that one of them was labelled "Patented in 1841" did not "make the penny drop".

It was not until some days later that the probable importance of the instruments occurred to me, and some weeks elapsed before I was able to establish beyond doubt that these two instruments were in fact the first two printing telegraphs ever devised. Careful comparison with the patent drawings, however, with contemporary step-by-step instruments and with the known history of the instruments in the laboratory of King's College left no doubt whatever that these were the original instruments devised by Wheatstone in 1841. A contemporary description appeared in the *Year Book of General Information for* 1843.

The two instruments are similar in principle but differ quite substantially in detail, and it is safe to assume that they represent the first and second stages in development. One of the instruments—it is almost certainly the earlier of the two—has now been lent to the Royal Scottish Museum at Edinburgh; the other is now on exhibition at the Science Museum, London.

In their basic principle, the instruments are very similar to Wheatstone's A.B.C. or step-by-step telegraphs of 1839–40. In these instruments, the letters of the alphabet were printed round the edge of a small disc of cardboard mounted on the escapement shaft of a clockwork mechanism. The escapement, controlled by an electro-magnet, was arranged so as to allow the disc to rotate letter by letter, in single steps, in response to impulses from the electro-magnet. The disc was divided into twenty-four divisions (23 letters and a +) and thus it follows that although only one impulse had to be sent to signal the letter *B* if the preceding letter had been an *A*, no less than 23 impulses had to be sent to indicate an *A* if the previous letter had been a *B*. In consequence, signalling was slow, a maximum of only five words per minute being attainable.

In Wheatstone's two printing telegraphs, the cardboard disc was replaced by a similar disc of thin brass, slotted from the circumference almost to the centre so as to form twenty-four flat springs, upon the ends of which were fixed a set of type characters. The disc was rotated in exactly the same manner as in the simple A.B.C. telegraph, but an additional mechanism was provided for causing a hammer to strike each selected letter against a cylinder, around which was wrapped alternate sheets of white and carbon paper.

The mechanism that operates the hammer is complicated and is arranged also to rotate and traverse the cylinder after the printing of each successive letter. There are substantial differences in the details of this mechanism as between the "Edinburgh" example and that in the Science Museum, although the final operation of the hammer is similar in both cases.

The instrument in the Science Museum has been thoroughly cleaned in the Museum workshops and two broken springs replaced. With these two replacements and several minor adjustments, the instrument was found to be in perfect working order.

These instruments were never used commercially. In 1841, electric telegraphs of any form were novelties, the real need for which was scarcely appreciated. The world was certainly not ready for a printing telegraph, especially as its rate of working was still no higher than two words per minute. Nevertheless, these two instruments are of much historic value and their discovery after all these years in such a perfect state of preservation will be of interest to all communication engineers.

(The photographs accompanying this article are reproduced by courtesy of the Science Museum, London, S.W.7.—Editor)

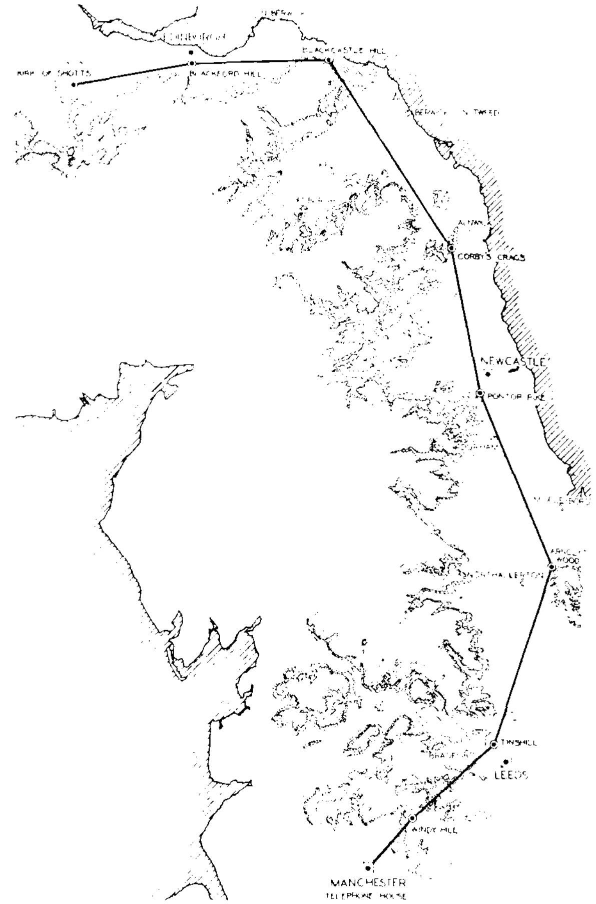
Manchester-Kirk o' Shotts Television Radio Relay System

When the Post Office was asked to provide a connection between Manchester and the projected Scottish television broadcast transmitting station between Glasgow and Edinburgh, it was decided that this should be by radio relay, as no cable route could be made readily available. The contract was placed with Standard Telephones and Cables, in June, 1950.

The route is 250 miles long and the television signals are relayed between Manchester and Kirk o' Shotts by seven intermediate repeater stations. The receiving and transmitting aerials at each station have to be "in sight" of the aerials of the stations on both sides of it, as the very-high-frequency radio waves used are transmitted efficiently only over optical paths. This means that the stations are on hill-tops and often in inaccessible positions. The longest hop is 46 miles.

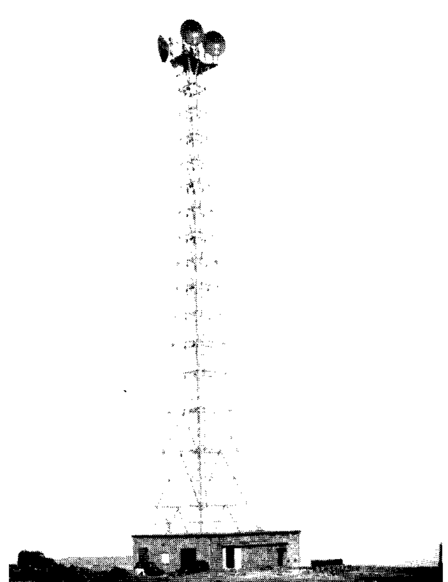
The radio frequencies used are around 4,000 megacycles per second and about four times those used for the London-Birmingham radio relay system. The wavelength is about 3 inches. Use of these very high frequencies allows much less power to be used.

The frequencies used are beyond the limits of ordinary valves, however, and use is being made of a new kind of valve known as a travelling wave amplifier, which was invented by a physicist working in the Clarendon Laboratory at Oxford University. This is the first large-scale commercial application of this amplifier anywhere in the world.



At each radio relay station, the equipment is housed in a small building at the foot of the mast carrying the receiving and transmitting aerials, to which it is connected by hollow tubes known as wave guides. This is the first service use of wave guides by the Post Office. The aerials are paraboloids, somewhat like searchlight reflectors.

When completed, the relay stations will have working and stand-by equipments, the latter being brought automatically into service on failure of a working equipment. They will also have stand-by petrol-driven generators, which will be started up automatically if the mains supply fails. There will be comprehensive remote-control and supervisory facilities provided over a telephone line interconnecting all stations. When all the stand-by and remote-control equipment has been provided, the relay stations will not normally be manned.



The station at Black Castle Hill

The Harbour Communications* System at Liverpool

by Captain W. R. Colbeck, R.N.R., Marine Surveyor, Mersey Docks and Harbour Board

A large port requires an efficient communications system, to enable full use to be made of all the berths and to avoid delay to incoming vessels. Although a vessel's agents usually give prior advice and make provisional berthing arrangements, last-minute alterations are frequently necessary; for instance, the previous vessel in the berth may not have completed loading or discharging, or the draught of the incoming vessel may be greater than was expected and diversion to another dock system become necessary.

The large tidal range at Liverpool, sometimes as much as 32 feet on spring tides, confines the docking of a deep-draught vessel to a short period around high water, and a delay of one hour in the delivery of instructions may mean a delay of at least twelve hours to the vessel. Lack of last-minute information as to whether a vessel will berth at the expected time may cause delay and uneconomic occupation of berths, through necessary dock labour not being arranged, or the vessel may be delayed by the absence of tugs. At the bigger dock entrances, the provision of direct communication between the Dock Master and the pilots is invaluable. With a number of ships manoeuvring in the river preparing to dock, the Dock Master is able to tell each vessel exactly what is happening with regard to outward traffic and in what order he proposes to dock the incoming vessels, thus saving dangerous congestion at the dock entrance and reducing the risk of collisions. Furthermore, a large fleet of vessels, including dredgers and buoyage and salvage vessels, is operated by the port authority and the facility for the rapid transmission of orders will assist in keeping them fully employed.

The communications system has grown up over a long period, as requirements increased and improved methods of communication were developed.

* This article is based on a paper read by the author before the Post Office Telegraph and Telephone Society.—*Editor*.

The early history of the Port of Liverpool is somewhat obscure, but in August, 1207, King John granted letters patent to the town, and by the middle of the 17th century shipping was the principal industry. The great port of today, with its system of docks on both sides of the river, was initiated in 1715, when the first enclosed dock, with gates to impound the water, enabling vessels to remain afloat throughout the tidal period, was opened. The total water area of the docks today exceeds 650 acres, the length of the quays being $37\frac{3}{4}$ miles, exclusive of the twelve dry docks for ship repairing.

Until 1857, the docks were owned by the Corporation of Liverpool, who also administered the local lighthouses and buoyage.

Dock Board

The Mersey Docks and Harbour Board, constituted by Act of Parliament in that year to take over the entire control of the port accommodation, is a body of twenty-eight members, twenty-four of whom are elected by the dock ratepayers, i.e. shipowners or merchants paying dues on ships and goods; the remaining four are appointed by the Minister of Transport. The Dock Board is also responsible for the administration of the pilot service.

The River Mersey is the highway to the Port of Manchester and the docks at Garston and Bromborough, as well as to the Liverpool and Birkenhead docks.

During the 12 months ending 1st July, 1951, 16,072 vessels of 21,156,984 gross tons entered the river, 9,180 vessels of 15,508,911 gross tons entering the Board's docks. The average number of vessels entering the river is therefore 44 per day. These figures relate to entries only and a similar number of vessels leaves the river each day.

The Dock Board is the conservancy authority for the river and the estuary, and all vessels entering

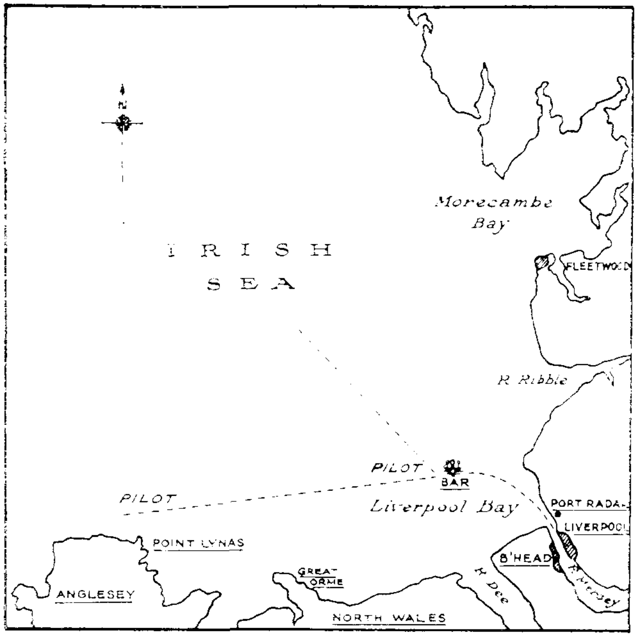


Fig. 1 Pilot stations and inward routes to Liverpool

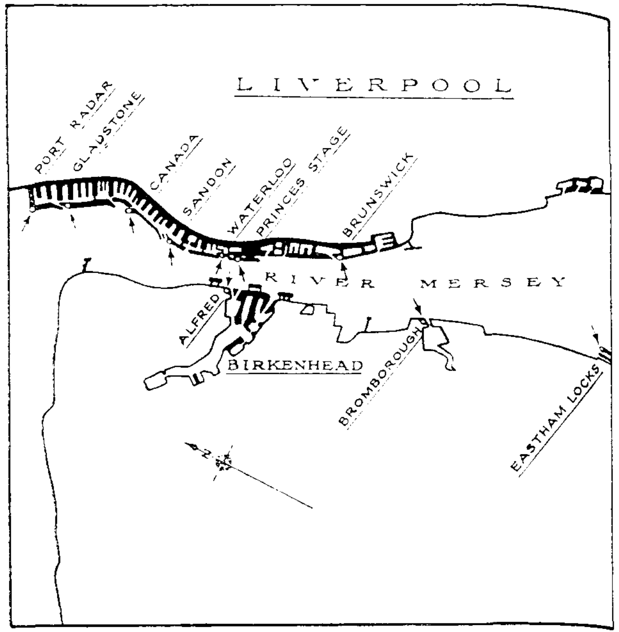


Fig. 2. Positions of dock stations

the river, whether bound for the Board's docks or docks operated by other authorities, pay harbour rates to the Conservancy Fund. This money is used for the maintenance and improvement of navigation, including the buoying and lighting of channels and approaches, dredging and the construction of training walls, removal of obstructions etc. The cost of the communications system and the Radar Station is provided from this fund.

The rapid growth of commerce in the latter part of the 18th century and the increasing number and size of ships using the Mersey, required the provision of improved navigational aids, and in 1763 the Corporation embarked on a programme of lighthouse building on the shores of Liverpool Bay.

In 1771, the Bidston Lighthouse was erected on Bidston Hill, which is 200 feet above sea level and about $1\frac{3}{4}$ miles inshore from the north coast of the Wirral Peninsula. The lighthouse commands a view of the whole of the estuary of the Mersey and it was shortly after the building of this lighthouse that the first ship-reporting system was begun. Masts were erected alongside the premises and by a system of code flags etc. particulars of any vessel observed by the keepers could be reported, the signals providing for the type of vessel, her rig, whether British or foreign, and her position in the sea channels. These signals could readily be seen from the waterfront at Liverpool and later arrangements were made for local shipowners to be advised, when one of their vessels was in the offing, by the hoisting of a flag on the appropriate mast, some twenty additional masts being erected for the purpose. Provision was also made for reporting vessels in distress.

The outer boarding station for pilots is off Point Lynas, on the north coast of Anglesey (Fig. 1), where the Corporation erected a lighthouse in 1781, Lynas being 46 miles from the entrance to the River Mersey.

In 1827, the Dock Trustees established a visual semaphore system starting at the South Stack, an island off the coast near Holyhead, with a series of repeating stations, including Point Lynas Lighthouse, through to Bidston Hill. An office was established in Liverpool, from which the Bidston signals were observed and the names and positions of vessels were shown on a board at this office as the reports were received. The stations were situated some eight miles apart and in addition to forwarding information from the outer stations a look-out was maintained and the stations also initiated reports of vessels in their vicinity, the stations being manned throughout the hours of daylight. The reporting of the positions of vessels was by the same system that is used today by the B.B.C. in its running commentaries on sports events, a gridded chart being supplied to each station and the vessel

reported as being in "square so-and-so", one-mile squares being used inshore of the Bar Lightvessel and five-mile squares from the Bar to South Stack.

In 1860, after a number of experiments, an electric landline telegraph was installed linking all the existing stations and terminating at the office in Liverpool. In 1870, this line was taken over by the Post Office and, although all the intermediate stations have been dispensed with, it is still the means of direct communication between Point Lynas and the Port Radar Station, the South Stack station being closed in 1918.

Following the recommendations of the Royal Commission on Electrical Communication with Lighthouses and Lightvessels, in 1895, the Formby Lightvessel was connected with Crosby Lighthouse by telephone, and telephones were installed between various other lighthouses and lifeboat stations at the expense of the Government, the Board having the right to use them for operational traffic.

Although the Board's officers had been interested in wireless telegraphy from 1901 and had co-operated in several experiments, it was not until 1913 that a wireless telegraph shore station was established to communicate with the Bar Lightvessel, the Formby Lightvessel being fitted the following year. In 1921, the wireless telegraph was replaced by radio-telephony, the other lightvessels and the Marine Department buoyage and salvage vessels being fitted in subsequent years. This system was fitted primarily for reporting casualties to shipping, but was also used for the reporting of inward vessels and for operational traffic of the Board.

The pilot boats were equipped with radio-telephony in 1936, but they do not operate on the Board's frequency, all traffic, which is mainly in respect of the supply of pilots, passing through the G.P.O. coast station at Seaforth.

During World War II, serious congestion and delays to shipping were experienced, due to the simultaneous arrival of large numbers of ships in convoy, as many as 70 vessels arriving in one convoy. Owing to the tidal regime of the river, as already mentioned, the docking of large vessels is restricted to a comparatively short period around high water, although at the new entrances small and medium-sized vessels can dock at any time. Such a large number of vessels could not all be handled on one tide; the order of arrival was not known in advance, nor could it be known which vessels might be missing from the convoy, and the transmission of docking instructions by wireless telegraphy or medium-frequency radio-telephony was not permissible for security reasons.

With the assistance of the army authorities, a short-range high-frequency radio-telephone system was adopted, using army type 18 and 38 equipments operating in the 7 to 9 megacycle band. Six shore stations were established at various dock entrances, with Gladstone as the main station, the pilots taking "walkie-talkie" sets with them when they boarded inward vessels. This communication system proved so valuable to the Port Authority that it was decided to continue its use after the end of the war.

In 1946, the G.P.O. was approached and a provisional allocation of frequencies in the 84–86 megacycle band obtained. Several manufacturers were asked to tender for the equipment and prototype sets tested, but in 1948, following international agreement, the frequencies were altered to the 150–170 megacycle band, requiring a considerable amount of development work by the manufacturers before a satisfactory equipment could be produced. The opening of the Port Radar Station (Fig. 2) in July, 1948, produced an additional demand for rapid and efficient communication. Owing to a further alteration in the frequency allocation in September, 1949, to meet international agreements, requiring a considerable degree of modification to the equipments being produced, it was not until April, 1950, that the new system of very high frequency radio-telephone communication could be brought into operation.

Organisation and Operation

The V.H.F. radio-telephone communication system uses two-frequency simplex, amplitude-modulated, six radio-frequency channels being allocated, spaced 100 kc. s. apart, the go and return frequencies being separated by 4.5 Mc. s. The land transmission frequencies are in the band 163.10 Mc. s. to 163.60 Mc. s, the mobile transmission frequencies being in the band 158.60 Mc. s. to 159.10 Mc. s. Although duplex operation would have been preferred, the power drain of the receiver and transmitter working simultaneously would have necessitated larger batteries in the portable equipments, increasing the weight above that which could be tolerated.

The six channels are allocated as follows:

1—Port Radar Station; 2—Port Radar Station and Bromborough; 3—Gladstone and Waterloo;

4—Prince's Stage and Canada; 5—Sandon and Brunswick; 6—Alfred and Eastham.

The M.F. radio-telephone operating on a frequency of 1,852 kc. s. is used only for operational communication with the Bar Lightvessel and with the salvage and buoyage vessels, whose duties frequently take them far beyond the range of the V.H.F. equipments.

The main communication centre is the Port Radar Station, situated at the north-west corner of Gladstone Dock at the mouth of the River Mersey. From this position a clear "line of sight" for both radar and V.H.F. aerials is obtained over the whole of Liverpool Bay and the greater part of the river where it is navigable by large vessels.

The communications room is adjacent to the room housing the radar console, the equipment comprising:

1. V.H.F. R/T. Channel 1.
2. V.H.F. R/T. Channel 2.
3. M.F. R/T.
4. Teleprinter to Marine Department Head Office.
5. Telephone direct to Marine Department Head Office.
6. Telephone direct to G.P.O. Telegrams.
7. Two telephones to Board's P.A.B.X.
8. Telephone to G.P.O., Bootle Exchange.
9. Morse telegraph instrument on private wire to Point Lynas.

Both V.H.F. channels and one line to the private branch exchange have extensions to the radar console.

The station is manned continuously by two men, one radar operator and one telegraphist telephonist, the number being increased, if necessary, during prolonged periods of fog. The men are trained to be able to carry out both duties if required.

The traffic handled by the communications staff comprises docking and berthing instructions for vessels; weather and visibility information from lighthouses, lightvessels, coastguards etc. in Liverpool Bay and the river; operational messages concerning buoyage, dredging and assisting shipping casualties; distribution of navigational warnings concerning casualties to sea marks, shoal soundings etc. and the transmission of information derived from the radar screens to aid vessels navigating the channels.

The dock stations are situated in the Dock Masters' offices at the respective dock entrances, where the staff is always on duty. The message traffic handled is confined to docking instructions: for instance, where more than one vessel is waiting to enter a particular dock, the Dock Master decides in which order they will enter and the times of entering, having regard also to the outward traffic. Communication between the various dock entrances and the Port Radar Station is by landline telephone through the private branch exchange for the Board's docks, and via the G.P.O. exchanges for Eastham and Bromborough.

Advance information of the expected arrival of vessels is received from the agents and provisional berth allocations are made by the Harbour Master. These advices are usually based on wireless telegraph messages received by the agent through the G.P.O. coast stations.

Pilotage

Pilotage is compulsory and the majority of inward vessels take their pilots aboard off Point Lynas. A second pilot boat cruises off the Bar Lightvessel, about 14 miles from the entrance to the river, for inward vessels approaching the port from the north and to take the pilots from outward-bound vessels. The pilot takes on board with him a portable V.H.F. set, and when approaching the Bar Lightvessel, at a range of about 23–24 miles from the Port Radar Station, he calls the station, giving his position, draught of water and expected time of arrival in the river. This information is passed to the Harbour Master, who confirms or, if necessary, amends the provisional docking instructions, and the necessary orders are passed to the vessel. At the same time the pilot can obtain information about weather and visibility conditions etc. If he does not require navigational aid from radar, he then closes down until the vessel enters the river, when he calls the Dock Master of the entrance for which he is bound on the appropriate frequency, to obtain permission to dock.

It must be pointed out that that system is used by large vessels. Small vessels are exempt from compulsory pilotage and the masters of most of the small and medium-sized vessels coasting or on short voyages and regularly visiting the port have pilotage licences enabling them to pilot their own vessels and do not therefore have portable sets. To date, 22 such vessels, mainly employed on the cross-channel traffic with Ireland and the Isle of Man, have been fitted with permanent ship installations to communicate on the port frequencies, and further such installations are projected. Although some 20 vessels enter the river on each tide, fewer than half of them have portable V.H.F. sets on board. During the 12 months ending July, 1951, a total of 4,048 vessels received their docking instructions by V.H.F. radio-telephone.

Outward-bound vessels do not usually carry portable V.H.F. equipments, as berthing or tug arrangements are not required. They are supplied on request of the pilot, however, if he considers he will require radar assistance during his passage of the sea channels.

There are several other bodies using radio-telephone communication on individual frequencies within the limits of the port. Although they are not controlled by the Board, the services they provide are ancillary to the port services.

The Board does not operate tugs, all the towage services in the port being carried out by private companies. The four major tug companies have their own individual V.H.F. systems for communication between the tugs and their respective head offices, three operating on 67 Mc. s. single frequency and one on 160 Mc. s. Orders for tugs to assist in docking or at shipping casualties can thus be transmitted with little delay, the owners being aware at all times of what tugs are available and where they are situated.

The Liverpool Fire Service operates a large fire boat, which also provides the transport for the Port Health Doctor, who has to examine inward-bound vessels and give them a clearance before they can enter dock. She operates on the Fire Brigade frequency of 81.7 Mc. s.

One of the oil companies has a system operating on 160.7 and 165.7 Mc./s. for the control of berthing of coastal and harbour oil tankers transporting oil and bunkering services.

The Wallasey and Birkenhead Ferries operate on 159.5 and 164.5 Mc. s., mainly for radar assistance during low visibility, from their own shore radar installation at Seacombe. This service has proved of great value and ferry delays due to fog have been very slight since it was introduced.

Radar

The operation of a shore radar station to assist in navigating vessels requires efficient two-way communication between the master or pilot of the vessel and the operator at the radar console, and this has been achieved with the present equipment.

The radar installation, with its six display units, provides a series of large-scale pictures of the sea channels and the river and enables a vessel to be supplied with minute-by-minute information about her position and the course she is making good and the positions of other vessels in her vicinity. For many reasons, the control of a vessel must remain in the hands of the master and the pilot, and the information from the station is provided as an aid to navigation and is not a control, no direct orders being given about speed or the course to be steered. Details of position are usually given in the form of a running commentary from the station, its reception by the ship being acknowledged every five minutes. Vessels have entered with radar assistance from positions as far as eight miles seaward of the Bar Lightvessel, the passage occupying over two hours, continuous positional information being supplied to the vessel during the whole of this period.

Five vessels have been assisted at the same time, one operator using Channel 1 to distant vessels and a second operator using Channel 2 to vessels nearing the mouth of the river or in the river.

During the past 12 months, over 500 vessels have been assisted in this manner when entering the port during low visibility. The majority would have been delayed in the absence of such assistance, which could not have been provided without the V.H.F. communication system.

Equipment

The telephone and teleprinter installations at all stations are the usual G.P.O. equipment and require no special description.

The telegraph between the Port Radar Station and Point Lynas is a single-wire system using a deflection needle and a clockwork-driven Morse inker. Although this equipment is rather antiquated, it still functions very efficiently.

The M.F. radio-telephone sets are the Marconi "Sea Mew" at the Port Radar Station and the Ship Stations, with the exception of the Bar Lightvessel, which has a Type T.W.12. These operate only on the Board's frequency of 1,852 kc. s.

The V.H.F. radio-telephone installation, supplied by the Automatic Telephone and Electric Company, comprises ten shore stations, nine of which are situated at the dock entrances at Gladstone, Canada, Sandon, Waterloo, Prince's Stage, Brunswick, Alfred, Bromborough and Eastham, each operating on one channel, and the Port Radar Station operating on Channels 1 and 2, and 150 portable sets. The maximum number of portable sets in use at any one time never exceeds 15, the average being 11 ships a day. The establishment would appear at first sight to be somewhat excessive, but it is necessary, to enable efficient service to be provided. A relief boat visits the outer and inner pilot stations each day, taking a number of sets to keep the establishment on each station boat up to 30 sets.

When a vessel has docked, her portable set is collected by the dock staff and later the sets are transported by van once a day to the central depot at Prince's Stage. With the various delays, including week-ends, three or four days may elapse from the time the set is taken aboard with the pilot until it is returned to the depot. It is then checked for performance and, if found correct, the batteries are changed, the old ones being placed on charge, and it is then available for re-issue.

When large vessels are coming to Liverpool from, for instance, Glasgow or Belfast, the pilot frequently travels to the port of departure to join the vessel, taking with him a portable set. In these circumstances it may be a week or 10 days before this set is again available.

Fig. 3. Portable set in operation

Stocks of spare valves and other components are maintained at the central depot, which is equipped with all the necessary test instruments and battery charging facilities. The technician in charge is responsible for maintaining all the shore stations as well as the portable equipments and for the issue of the latter.

Design

Portable Sets

The boarding stations at both Point Lynas and the Bar are in the open sea, and sets which have to be put on to a vessel with the pilot must be light, compact and very robust, as they have to be hauled up on a line from a small boat, which may be rising and falling six feet or more in bad weather. The following requirements were therefore specified:

1. The total weight of the set including batteries and aerial not to exceed 20 lb.;
2. The transmitter-receiver, batteries and aerial to be contained in a padded canvas case with no projections, fitted with suitable slings for attaching a line for hoisting on board;
3. Batteries to provide a life of five hours' continuous use, 10 per cent. on transmission;
4. The sets to provide adequate two-way communication at a distance of not less than 23 sea miles from the Port Radar Station and 8 sea miles from the dock stations, when operated on the bridge of a medium-sized vessel; the second channel at the Port Radar Station to provide a range of 14 sea miles;
5. The sets to be capable of being submerged in sea water without serious damage and to float if dropped in the water;
6. No variable manual tuning to be necessary.

The portable set shown in Figs. 3 and 4 fulfils all these requirements and is simple to operate.

The set, with the exception of the accumulators, is contained in a hermetically-sealed metal alloy case fitted with a desiccator, the outer carrying case of waterproof canvas on a metal frame and padded with kapok, arranged so that it is necessary only to open the lid of the case and erect the aerial in order to operate the set (Fig. 3). The corners of the carrying case have rope protection, which continues to form two loops for attaching the hoisting line. Secured to the back of the case are two short lanyards, with which the set can be lashed to the bridge rail at a convenient height for operation, in a position where the aerial is clear of obstructions and has, as far as practicable, a clear line of sight to the shore station. Full operating instructions and a list of the various stations with their respective channel numbers and code calls are attached to the inside of the top of the carrying case, printed on linen so that they will not be damaged by water.

The aerial is of the sectional rod type, the lowest section being flexible, with a wire running through the sections. When folded up, it stows in the pocket in the front of the carrying case, with the handset. The length of the aerial is three quarters of a wavelength tuned at the mid-point of the transmission band.

The power supply is 4-volt, consisting of two standard 2-volt dry chargeable accumulators connected in series, carried in the second pocket in the front of the carrying case.

In the event of the set being submerged, only the batteries will be damaged.

The controls consist of a channel selection switch, operating switch and calling key. The channel selection switch is of the semi-rotary type with six positive positions for the six crystal-controlled frequencies.

The on off and transmit receive switch is combined, a rotary movement being employed, biased by a spring to the "off" position, thus automatically switching off the equipment when not in operation and preventing accidental running down of the batteries. A spring-loaded stop has to be passed when switching from "receive" to "transmit", enabling these positions to be selected in the dark.

A calling note of 1,000 c. s. is transmitted by operating a watertight push-button switch with the rotary switch in the "transmit" position. This enables a coded call to be used to identify which shore station is required on the shared frequencies and whether the river or seaward directional aerials are to be used at the Port Radar Station.

Provision is made for connecting an amplifier and loud-speaker for use in addition to the handset, but it has not been found necessary in practice to supply this equipment.

The limitations of size and weight restricted the power of the transmitter to ¼ watt and the receiver sensitivity to not more than 10 microvolts.

Shore Stations

The requirements specified for the shore stations were not so rigid as for the portable sets, no limit being placed on size, weight or power. They had to be capable of being operated by comparatively unskilled staff; all tuning was to be pre-set, and the only control was to be a send receive switch.

Fig. 4. A portable equipment

The major problem in the scheme was to obtain the minimum range of 23 miles from the Port Radar Station on Channel 1, in view of the low transmitter power of the portable sets. Fortunately the geographical relationship between the main approach route to the Bar and the Port Radar Station is such that the extreme range is required only over an arc of some 20–25 degrees.

The aerial power of the ground stations is 45 watts, the receiver sensitivity being about 2 microvolts. For Channel 1 seaward, the aerial is a 32-element centre-fed beam with a meshed metal reflector giving a gain of some 18 decibels, with a theoretical beam width of ±13 degrees to ½ power. The centre line of this beam is on a bearing of 287 degrees true, which intersects the approach course from Lynas at a range of about 23 miles.

This aerial is approximately 30 feet high and 12 feet wide. It is mounted on a steel lattice tower 80 feet high, situated approximately 50 feet from the Port Radar Control Room (Figs. 5 and 6).

Channel 2 at Port Radar requires an operational range of 14 sea miles, and a Yagi-type aerial, with one driven element and four directors sighted in a direction of 295 degrees true to the Bar Light-vessel, is mounted on a metal mast extending 20 feet above the beam aerial mounted on the same tower. Subsequently a second similar aerial was erected some six feet below the upper Yagi to improve the performance on this channel.

It is also necessary for Channels 1 and 2 to operate into the river for radar aid etc., but the range in this case would be very much less. Two similar Yagi aerials are mounted on the 20-foot pole mast looking riverward, one for Channel 1 and one for Channel 2.

The V.H.F. aerial tower extends above the height of the radar scanner but is situated in the shoreward arc, from which radar signals are not required, and therefore does not interfere with the performance of the radar.

For the dock stations, the Yagi-type aerials are used in all cases, but as the maximum range required is only eight miles, they are mounted on masts 40 feet above ground level.

There are three separate types of ground stations, two of which are installed at Port Radar, the third type being installed at all the remaining dock stations.

For Channel 1 at Port Radar, the equipment is designed to provide 100 per cent. of standby units. These are housed in a steel cabinet approximately 6 feet high, 21 inches wide and 21 inches deep (Fig. 7). The units fitted in the cabinet comprise two transmitters, three receivers and two power units. Two receivers are always in operation connected to the two separate aerials, one beamed seaward and the other looking riverward, while the selection of aerial for transmission is done by a switch situated on the remote telephone unit, which is similar in operation to a Plan 7 Post Office desk telephone, with the addition of a "press to talk" switch in the handset. Separate loud-speakers are fitted in the Communications Room and the Radar Room to listen for calls. A desk-type telephone handset is fitted in the Communications Room, but at the radar console a headset with a breastplate transmitter is fitted in two positions, from each of which four of the displays can be observed.

Separate controls are fitted for each position, by which it is possible to select the river and seaward aerials for both Channel 1 and Channel 2 and also for the broadcast of navigational information, in which transmission takes place on both channels and in both directions simultaneously. A separate 3-position switch in each control selects receive, transmit or intercommunication between the Communications Room.

In the event of a breakdown of a transmitter, a receiver or a power pack, only the appropriate plugs need be altered to restore full service.

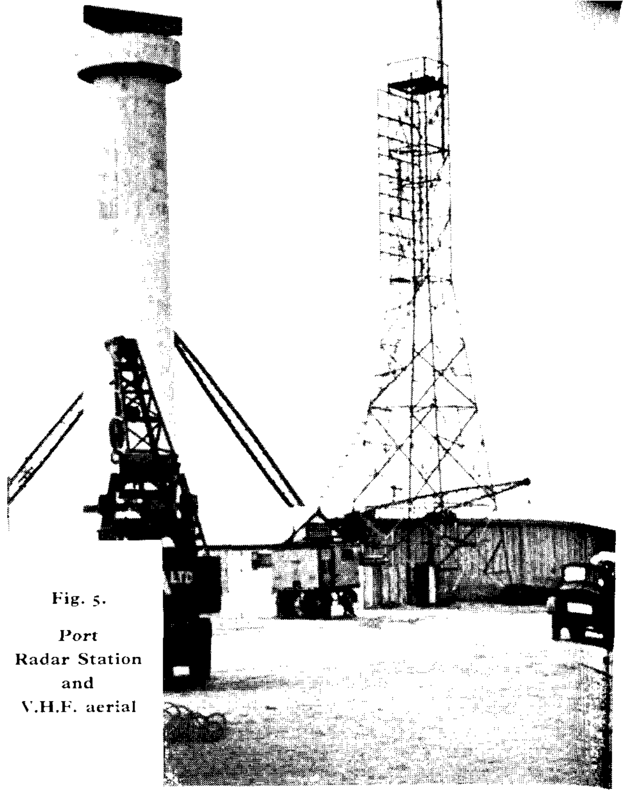


Fig. 5. Port Radar Station and V.H.F. aerial

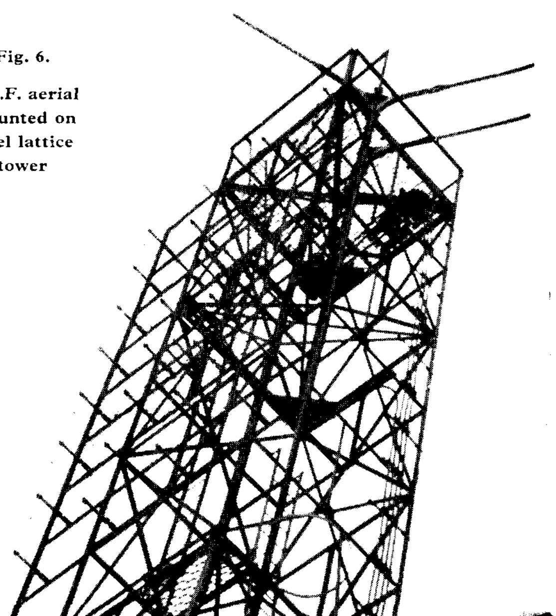


Fig. 6. V.H.F. aerial mounted on steel lattice tower

On Channel 2 at Port Radar, the equipment is housed in a steel cabinet approximately 40 inches high, 21 inches wide and 21 inches deep (Fig. 7). The units fitted comprise one transmitter, two receivers and one power unit, no standby units being supplied. The control is the same as for Channel 1, a separate Plan 7 desk telephone being provided in the Communications Room, which can be switched through to the radar console. The two receivers listen in the riverward and seaward directions, the transmission direction being selected as described above. Fig. 8 shows the Channel 1 and Channel 2 equipments in their positions in the Communications Room at the Port Radar Station.

The dock station equipments are contained in cabinets similar to that for Channel 2, but without the second receiver, as it is necessary at these stations only to listen in one direction on a single aerial. The place of the second receiver is occupied by a drawer containing spare valves etc. for maintenance, to save the maintenance engineer's carrying a large number of spares with him. It also houses a monitor telephone for test purposes. Operation is from a remote unit similar to a normal desk telephone set with a "press to talk" switch in the handset. A small loud-speaker to indicate an incoming call is fitted in the position where the automatic dial is normally situated. This loud-speaker is automatically switched off on lifting the handset.

The main units employ standard Post Office 19-inch panels and are withdrawn on telescopic runners from the cabinet housing. The transmitter and receiver units are divided into sub-units to aid in maintenance. The power unit is not sub-divided.

A complete set of main units and additional sub-units is kept at the central stores to enable a faulty unit to be rapidly replaced and obviate delay in fault finding at the station, the faulty unit being taken back to the central workshop for repair.

The cabinets are fitted with steel doors, with locks to prevent interference by unauthorised persons.

The power supply is from the mains. A separate motor alternator is provided for each channel at the Port Radar Station, where the supply is D.C. In the dock stations, where the supply is A.C., automatic voltage regulators are fitted.

Future Developments

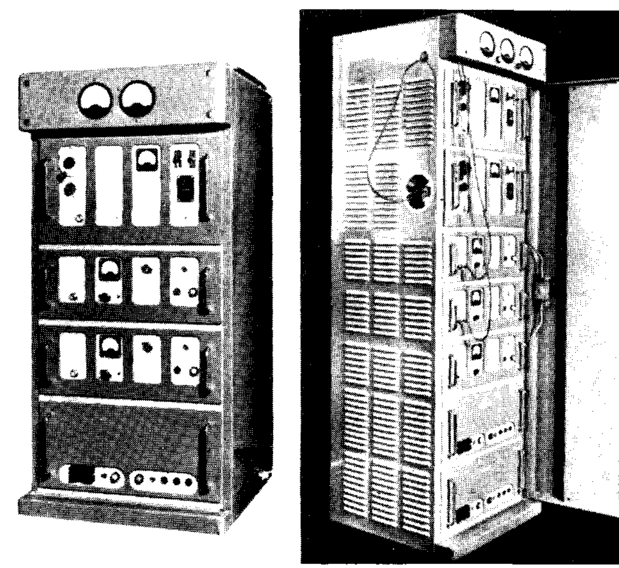
The present system is adequate as far as the pilotage services to vessels are concerned, but it is hoped that in future an increasing number of regular traders to the port will be fitted with permanent ship-board V.H.F. installations and thus reduce the number of portable equipments to be maintained.

The manufacturers of the radar and the V.H.F. telephone equipment have collaborated to produce a modification in the portable sets, to enable the set to transmit a signal on the radar frequency, to aid positive identification of vessels on the radar screen. The problem of the identification of vessels requiring radar assistance has not given rise to any difficulties during the three and a half years the radar station has been in operation, and although successful trials have been carried out with the modified equipment, in view of the expense involved it has been decided not to modify the equipments in use at Liverpool, although such facilities might be of great value in conjunction with shore-based radar installations at other ports.

Permanent ship-type installations have been ordered and will shortly be delivered for the larger dredgers and the salvage and buoyage vessels belonging to the Board.

The construction of training walls bordering the main sea channels involves transporting large quantities of stone by sea from quarries on the north coast of Wales and Anglesey. A scheme has been approved by the G.P.O. and will shortly be in

Fig. 7. Cabinets for Channel 1 (right) and Channel 2 (left)



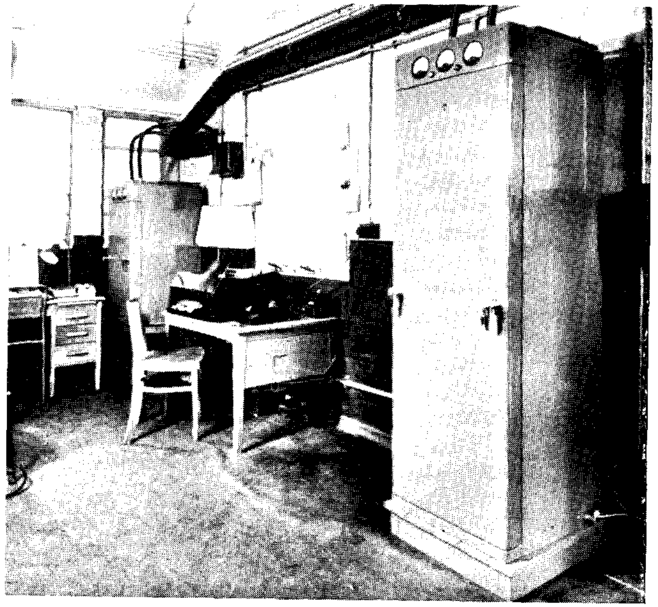


Fig. 8. Communications Room at Port Radar Station

operation for installing a shore V.H.F. equipment operating on Channel 6 at Point Lynas Lighthouse with ship-borne installations in the six vessels employed in carrying this stone, to facilitate loading and, if necessary, passing diversion instructions to them. The quarries are a few miles to the eastward of Point Lynas.

Although it has not been possible to determine the financial saving to shipping interests through the provision of the communications services and the Port Radar Station, there is no doubt that it is considerable. A 12-hour delay in docking may cost the owner of a vessel as much as £500, and on several occasions owners have stated that they have saved one or more tides.

It will be appreciated that the traffic handled by the Harbour Communications Service could not be handled by, and in no way infringes upon, the public communications services, either by wireless telegraph or radio-telephone link. The greater part of the message traffic now dealt with through V.H.F. radio-telephony was previously handled by visual signal from the shore or by verbal or written messages taken off to vessels by tugs.

I should like to acknowledge the assistance I have received from the Automatic Telephone and Electric Company in preparing this article, particularly in the provision of illustrations.

Report on Interference

The Postmaster-General's Advisory Committee on Wireless Interference from Refrigeration Apparatus, appointed in July, 1950, recommends that apparatus, new or otherwise, should comply with certain requirements as regards voltage of interference. The recommendations are based on the assumption that users of sound and television receivers will take reasonable precautions to safeguard them from interference.

The interference voltage injected for continuous periods of not less than one-fifth of a second, or more frequently than once in any two-second period, into the electricity supply mains should not exceed 1,500 microvolts for frequencies of 200—1,605 kilocycles per second (the major part of the broadcast band) or 750 microvolts for 40—70 megacycles per second (the present television band).

The Committee understands that suppressors are fitted at present by reputable manufacturers to new refrigeration apparatus as required and it observes that compliance with the requirements is implicit in observance of the latest British Standards for household refrigeration apparatus. The Committee is satisfied that financial hardship to owners or purchasers of existing or new apparatus is unlikely to arise through enforcement of the requirements.

Editorial Change

After a short but valuable period of office, Mr. F. E. Ferneyhough has relinquished the post of Editor of the *Journal*, as a result of his appointment as Telephone Manager, Southampton.

One of his greatest problems when he took over was the serious delay in publication caused by difficulties in the printing world, but he was not discouraged. All problems—and the Editor has his full share—he tackled with skill and cheerful enthusiasm, and the *Journal* owes him a great deal. In going to his new job, he takes with him our warm thanks and best wishes.

In the office of Editor he is succeeded by Mr. John L. Young, who joined the Post Office in 1950 on transfer from Cable and Wireless, Ltd., where he had been Deputy Public Relations Officer. For some years he was the Editor of "World's Press News" and associated journals, and he brings to the *Journal* a wide experience of editorial work and of all aspects of printing and typography.

NOTES AND NEWS

Multi-Digit Numbers — Skyport — Fountainbridge — Improved Dials — New Cables to N. Ireland — Multi-Metering in London Fringe Area — Stockholm Conference — Ship-Shore Services — Stonegrove — Cardiff Conversion — New P.A.B.X. — Chess by Telephone

Five and Six Figure Subscribers' Numbers.—Hitherto some hesitation has been felt about introducing 6-figure telephone numbers in Britain, on the grounds that subscribers might regard the numbers as complicated and difficult to remember. However, 6-figure numbers have been adopted with success in other countries, and they are in general use in Europe and the Dominions and in a number of exchanges in America.

When the number of telephones in a non-director area has approached the limit of a 5-figure numbering scheme, the policy in Britain hitherto has been to convert such areas to 7-digit (3-letter, 4-figure) director working. This, as well as involving some wastage of equipment and increased capital expenditure, requires wholesale number changes, and during the change-over period, which may be 10 to 15 years, necessitates a mixed and often complicated system of dialling in the automatic area.

In view of these very real difficulties, renewed consideration has been given to the introduction of 6-digit numbers in this country. As a result, it has been decided that future telephone development in provincial towns of medium size should be planned on a non-director basis, using mixed five and six-digit numbering schemes. The immediate effect of this decision is that the Bristol and Leeds automatic areas, which were due for conversion to director working, will now continue on a non-director basis, using six-digit numbers where necessary.

* * *

Trunk Calls at Christmas and New Year.—In recent years, the evening cheap rate for trunk calls has been suspended throughout the United Kingdom on three days at Christmas and on New Year's Day, with the object of freeing from duty on those days some of the evening operating staff.

For the past two years, however, in order that staff relief could be given on the days most appropriate to the staffs north and south of the Border, the suspension was: *Scotland*—25th and 31st December and 1st and 2nd January; *Rest of U.K.*—24th, 25th and 26th December and 1st January.

This arrangement has proved to be more satisfactory. On these evenings, traffic levels were 25 to 40 per cent. below those of a normal evening and, in general, each member of the operating staff was free on at least one of the holidays.

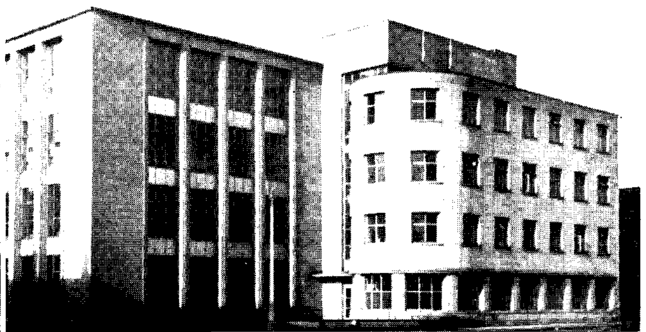
* * *

Skyport.—Work has started on building London Airport's new automatic exchange, Skyport, and is expected to be completed by 1954, to coincide with the opening of the new terminal buildings.

The present switchboard handles 3,000 incoming and 2,000 outgoing calls every day. When the new automatic exchange is installed, it will be expanded to include new lines for the ever-increasing number of firms on the airport, but the 1,000 extensions all over the airport will continue to be used for internal calls.

★ ★ ★

Fountainbridge, New Exchange.—Another phase in the conversion of the Edinburgh telephone system to director working is nearing completion and was marked by a ceremonial opening of the new building in Fountainbridge (illustrated below) and of the new trunk switchboard and directory enquiry suite in it. The upper photograph shows the Postmaster-General receiving a golden key from the managing director of the building contractors. On the Postmaster-General's left is Colonel Gardiner, Director of the Post Office in Scotland: on his right, Mr. Ramsay, Telephone Manager; the Lord Provost of Edinburgh; and Sheriff Principal Gilchrist. In the background the Earl of Selkirk; Mr. McCallum, Head Postmaster; Mr. Tom Oswald, M.P.; and Mr. Macintyre, Under Secretary, Ministry of Works Scottish Headquarters. The ceremony took place in the new switchroom, a special platform being installed and draped by the Ministry of Works.



999.—The number of telephone calls from the public received in the information room at Scotland Yard in 1951 totalled 102,271—a record. Some 95 per cent. of these calls were made by callers dialling 999 and being connected to the police by the Post Office emergency call operator. As a result of these calls, the crews of area wireless cars made 9,869 arrests. During 1950, 90,939 such calls were dealt with at Scotland Yard and the arrests totalled 8,905.

★ ★ ★

Improved Call-Office Dial.—Dials with the trigger-type mechanisms but with Diakon dial labels are now being fitted in call offices in the normal course of maintenance. The labels are transparent and have the characters on the back, thus obviating the trouble experienced from wear and tear with the present vitreous-enamel dial plates.

★ ★ ★

New Cables to Northern Ireland.—Two new Portpatrick-Belfast submarine cables, with a total capacity of 120 channels, were completed in the latter part of last year and arrangements were made for working circuits to be transferred to these new cables, so that the existing cables could be re-equipped to a capacity of 120 channels. Re-equipment of the existing cables is planned to take place in two stages, and it is intended that 60 channels shall be provided by the 1st May, 1952, and the remaining 60 by the 1st July, 1952.

★ ★ ★

Multi-Metering Facilities in the London Fringe Area.—Subscriber dialling has been introduced from Slough exchange (which is practically on the boundary of the 20-mile circle) to London director exchanges that are within the 5-mile circle. The Slough subscribers, who have non-lettered dials, dial 7, receive a second dialling tone and then dial a 3-figure code followed by the 4 digits of the subscriber's number. Within a week of the introduction of dialling from Slough to London, over 93 per cent. of the traffic proper to be dialled was being handled automatically, saving 9 operators in the busy hour at Slough. This result is a useful indication of the way in which subscribers are prepared to refer to rather long lists of numerical codes.

★ ★ ★

Stockholm Conference.—The United Kingdom has accepted an invitation from the Secretary-General of the International Telecommunication Union to attend a conference in Stockholm to consider the assignment of very high frequencies for television and sound broadcasting services in the European Area. The conference is planned to start at the end of this month.

★ ★ ★

Long-Distance Telephone Exchanges—Record Number of Visitors.—During 1951, the record number of 12,165 people visited International, Continental and Trunks Telephone Exchanges in the City of London. The previous highest number was 10,126, in 1949.

Many of the visitors were from Commonwealth and foreign countries. The remainder were representative of all parts of the United Kingdom. A large proportion came in organised parties of students, cadets, scouts, members of social and political clubs and professional associations. Their letters express appreciation of an exciting, instructive and interesting experience. All were impressed by the organisation and efficiency of the service, and they paid special tribute to the staff who acted as guides.

★ ★ ★

Ship-Shore Wireless Services.—During 1951, more than 407,359 ship communications were dealt with by Post Office coast stations, 826,640 radiotelegrams totalling over 12,900,000 words were exchanged between vessels and coast stations, 29,211 radio-telephone calls were handled, and 830 messages were received from aircraft.

On the "Safety Service" side of coast station activities, 275 distress calls were dealt with and 469 medical messages from ships at sea were handled. Post Office coast stations maintain a continuous watch for distress calls from ships at sea, and when such a call is received the station immediately ceases all commercial transmitting and directs its attention to establishing communication with the ship concerned.

★ ★ ★

New London Telephone Exchange.—A new automatic telephone exchange named "Stonegrove" was recently opened to serve part of the Edgware district and relieve Edgware Exchange. Stonegrove is the local name for a district in the area served by the new exchange.

★ ★ ★

Cardiff Telephone Exchange Conversion.—On Saturday, 16th February, the Postmaster-General opened a new automatic exchange to serve the Cardiff area.

The manual exchange at Cardiff had been in use for more than 40 years and Cardiff was the last of the main trunk switching centres to be provided with the automatic system. The new exchange is of the more modern design and is the largest single unit of automatic equipment ever to be brought into service at one operation in Great Britain.

New telephone numbers to be used from the time of the changeover have been assigned to Cardiff subscribers. Long-distance calls to the old Cardiff numbers are intercepted and the caller is informed of the new number before the call is connected.

★ ★ ★

Telephonist Recruitment in London.—Intending recruits for telephonist posts in London exchanges may now, if they prefer, apply direct to the Supervisor of their local exchange, instead of to the Regional Director's Office in central London. Would-be telephonists are thus given an opportunity not only to see the switchroom but also to obtain, at first hand, an account of the various exchange activities.

★ ★ ★

New Standard P.A.B.X. (large type).—The first P.A.B.X. of the new standard No. 3 type, fitted with about 250 extensions, has been working for some months at Australia House, London, and appears to be giving every satisfaction. The three operating positions are neat in appearance and the apparatus at the back of the positions is laid out so as to give every assistance to the maintenance staff. The press-button recall facility, which causes a supervisory lamp to flash continuously until the operator enters circuit, is much appreciated by extension users and operators alike.

★ ★ ★

Chess by Telephone.—Chess is not a game that figures much in the news, but the leaflet on Chess by Telephone issued recently aroused widespread interest. Organisers of matches will welcome the information that they can arrange their fixtures to take place over the telephone at a cost little more than half that of a long trunk call.

Local clubs all over the country connected with the British Chess Federation have been notified in the B.C.F. Year Book of the special facilities they may use for playing matches by telephone.

Such matches require special organisation and the use of tellers to arrange to collect for transmission the moves made on each board and to record and give to the players the moves received over the telephone from the opponents. On the other hand, the trouble and expense of travelling is saved.

The type of telephone service offered is not a new one—it was introduced before the war—but few players seemed to know of its existence and the attention thus drawn to it may not only stimulate trunk telephone traffic during normally quiet periods, but also encourage matches between towns that are far apart.

The contract calls, as they are named, are arranged by local Telephone Managers and can take place whenever traffic conditions permit, as they usually do during evenings and week-ends, when most matches take place. These calls cost three-quarters of the ordinary telephone charge for the first half-hour, plus half the normal fee for the remaining time. Thus a London–Nottingham call of four and a half hours would cost players a total of £3 18s. 9d.

Book Review

POST OFFICE, 1951. Obtainable from H.M.S.O., most Head Post Offices and booksellers. 64 pp. text and 20 pp. photographs. Price 3s. 0d.

This publication does all it sets out to, and more. It reviews the activities of the Post Office during 1951 in a manner informative, entertaining and thrilling. Telecommunications, in which we are primarily interested, occupies a large proportion of the space, with articles on cable ships (in peace and war), the "999" services, inland trunks, ship-shore radio stations, scrap recovery and contracts. The treatment is popular, but there is also a modicum of subject-matter for the technically minded.

Apart from the absence of capital letters from certain headings—we deplore, in particular, "festival of britain"—the most punctilious reader will find little at which to cavil. Statistics there are in plenty, but not so obtrusively presented as to mar the enjoyment of the general reader. Some of the photographs are taken from unusual angles, and most of them, we think, have never been published before. The layout and cover design are admirable.

Publication and Price. This Journal is published in November, February, May and August. Price 1/-. The annual postal subscription rate is 4/6 post free to any address at home or overseas.

Contributions. The Editorial Board will be glad to consider articles of general interest within the telecommunication field. No guarantee of publication can be given. The ideal length of such articles would be 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board or of the Department.

Communications. Communications should be addressed to the Editor, Post Office Telecommunications Journal, Public Relations Department, Headquarters G.P.O., London, E.C.1. Telephone: HEAdquarters 4330. Remittances should be made payable to "The Postmaster General" and should be crossed "& Co."