POST OFFICE

tele communications

JOURNAL

ONE SHILLING AND SIXPENCE

WINTER 1956

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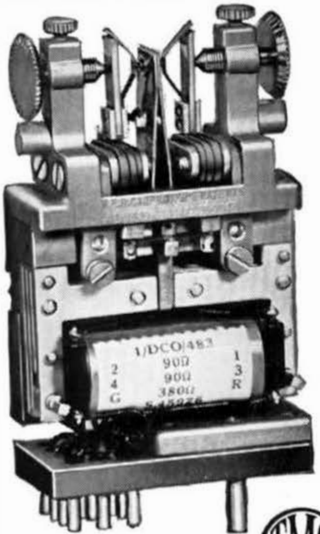

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Contents

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Stimulus to Expansion

THE INTERVIEW WITH SIR Gordon Radley, Director General of the Post Office, published in the *Daily Mail* last November, not only told the public of our determination to make the telephone service "the best in the world"; it was, in effect, a message of encouragement to the administrative, engineering and traffic staff.

The stimulus came at an appropriate moment. The White Paper outlining plans for development and new financial arrangements, had only recently been published—a summary appeared in the Autumn *Journal*.

The new financial arrangements under which we can plan three years ahead, and, from April this year, shall be able to retain our surplus after meeting expenditure and paying the fixed annual sum of £5 million to the Treasury, constitute, Sir Gordon was reported as saying, a " new era " which " gives us more freedom to tackle the bottlenecks and to plan ahead for a greatly expanded service". The Director General confirmed the objective, stated in the White Paper programme, of 8,000,000 telephones in service by March, 1959; according to the interviewer, he was "thinking ultimately in terms of a British telephone service with 20,000,000 subscribers, a telephone in just about every home".

Sir Gordon emphasized that expansion "cannot happen overnight; man-power, materials and cash are still problems". But, the objective "is to give the public what they want, and at a reasonable price".

This is an objective to achieving which every single member of the staff concerned with the telecommunications services can make a contribution.

Expedition to Newfoundland

F. A. Hough

THE HISTORY OF THIS CONTEMPORARY STYLE expedition begins at the end of the winter, 1953. A small party of British Post Office and American Telephone and Telegraph Company engineers met in Newfoundland among the ice and snow, to choose a landing place for the transatlantic telephone cable and to determine broadly how the cable should continue thereafter to Nova Scotia. The choice was between a completely submarine route around Newfoundland to, say, Halifax; to go out again into Trinity Bay, cross into Placentia Bay, and thence to Sydney; or to make for the top of Fortune Bay by a third route and thence to Sydney, with other minor variations. The direct land route to Fortune Bay would give the shortest route and would avoid most of the hazards of existing cables and fishing grounds, but it is difficult country for cable laying. After long discussions and many calculations of comparative costs, we decided to recommend the land route.

The climate and ground and travel conditions dictated the time programme of subsequent work. There is only one road from Clarenville, the main terminal point, to Terrenceville, a small village at the head of Fortune Bay, and this is impassable during a thaw and often blocked by snow in winter. It is constructed without any foundation material (save over the bogs where it is laid on mats of brushwood) simply by piling the dirt from the sides into the roadway with a top dressing of poor gravel taken from numerous borrow pits all along the route. Such a roadway has to be avoided by cables. A route, therefore, had to be found away from the road and the operations and depredations in connexion therewith.

The survey took place during the summer of 1954, when the land (and water, of which there is a quite remarkable amount), could be traversed and seen, when not blanketed by fog and rain. After many days of tramping through bogs and fighting a way through thickly grown timber, we found a route, and a Newfoundland surveyor, aided by one of our engineers, took over the task of plotting and marking it by chain and theodolite survey. The local brand of anti-fly oil provided a continuously objectionable atmosphere only slightly less distressing than the persistent attentions of the flies themselves. The only map available of this part of Newfoundland at that time was 10 miles to the inch scale, but the Canadian Ordnance Survey Department had overlapping aerial photographs. Copies were obtained and the British Ordnance Survey people produced a set of excellent contoured maps at two inches to the mile, as well as a mosaic of the photographs that gave a continuous aerial picture of the country. These were invaluable in finding a route and maintaining a sense of direction.

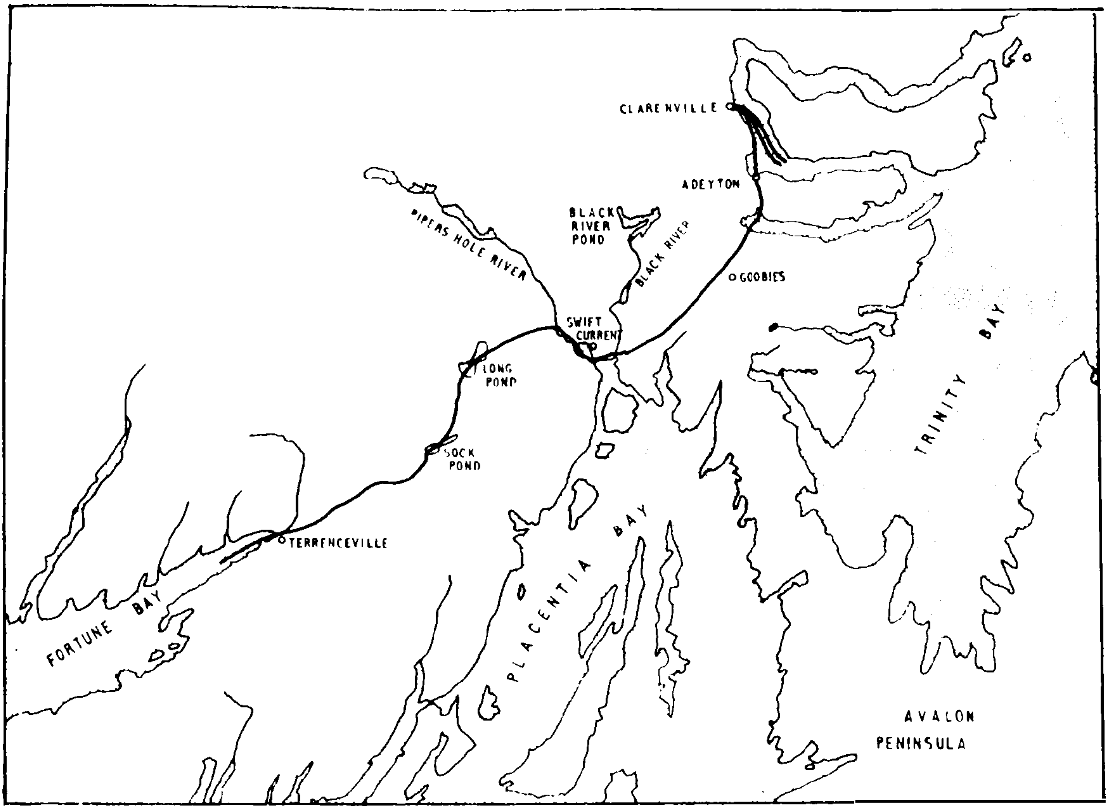
Meantime, the special cable to be laid had to be designed, tested and manufactured. This cable differs only from the submarine cable in that it has been screened against pick-up of electrical interference by incorporating five layers of thin iron tape, and it is armoured with No. 10 gauge steel wire. At the same time, the engineering specification for laying the cable was written and the cable-laying contract was placed by the Canadian Overseas Telecommunications Corporation with the Canadian Comstock Company, a firm which had experience of building pipelines but little of cable laying.

During the winter of 1954-55 the technique for jointing and testing the cable was designed, the equipment was made, and volunteer technicians from the Telephone Areas were trained to a very high standard of proficiency.

At the end of March the expedition set sail for St. John's, Newfoundland. It consisted of two supervising engineers, two testing engineers, five technical officers to supervise the laying work, and five pairs of cable jointers and mates; along with 91 drums of cable, test vans, four-wheel drive transport, power and other trailers and several tons of stores. One significant item was a case full of tins of British Army type anti-fly oil.

During April the contractor assembled his equipment and set up his first camp near Goobies. Progress at the start was very slow, largely because of long spells of continuous rain that made the ground impassable for the digging machinery and for the cable trailer and its tractor. A contributory factor was the contractor's understandable reluctance to use hand labour for trench excavation when he had been accustomed to doing everything by machinery. For a long time not a single pick and shovel was available on the job, yet the mechanical excavators were bogged down and the camp was besieged by a crowd of people wanting to work. This large force of available man-power

The route had to be plotted through bogs and timber



to operate what the contractor's project manager called "Mexican draglines" (hand shovels) eventually modified the plan of mechanization and a measure of hand-digging over the bogs, and the use of the back-hoe type of excavators among the trees and hard going, made good progress possible. Where the ground was too soft to support the cable trailer on timber laid alongside the trench, the cable was hauled off and carried by a gang of men, stepping from trunk to trunk and floundering deep in the bog if they missed a step.

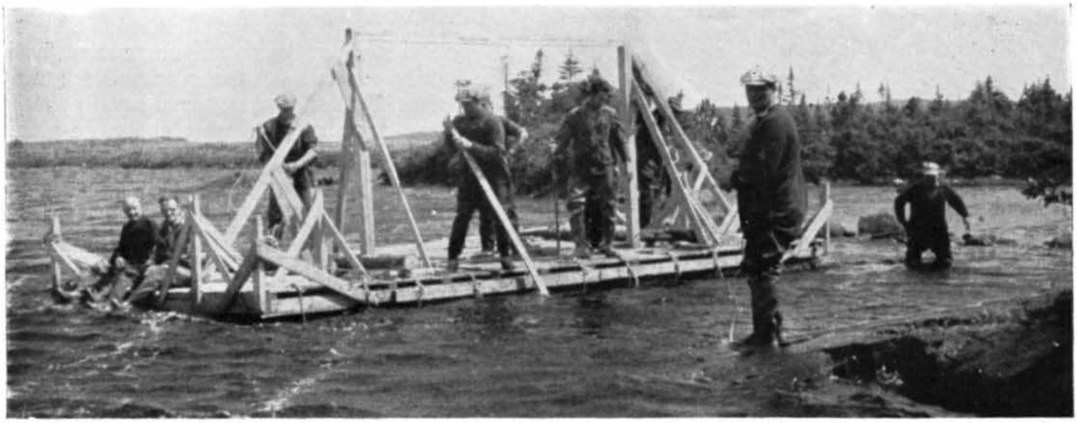
Avoiding Cliffs

Towards the end of June, after a period when visibility was only about 20 yards and work was almost at a standstill, the sun returned in full power to welcome the arrival of H.M.T.S. *Monarch*, and all the dignitaries assembled to celebrate the laying of the main cable shore end. *Monarch* also laid two sections of the "land" cable, the first five miles out of Clarenville and a piece two miles long across the south-west arm of Random Sound. These two pieces, quicky dropped into the sea, avoided some very rough country with precipitous rock cliffs, and incidentally provided a pleasant change of occupation for some of the party who did the shore end work.

On the way to Clarenville, *Monarch* called in at Argentia, the harbour where, during the war, the Atlantic Charter was agreed, and there handed over to a local craft some 70 tons of "land" cable, specially made with heavy armouring, and all in one length, for laying along the estuaries of the Black River and Piper's Hole River. Under the direction of an officer from the cable ship, assisted by a couple of "professional" seamen cable hands, the land party laid this cable from the barge from the mouth of the Black River, past a delightful village called Swift Current, and up the winding estuary of Piper's Hole River.

After a period of suspense, when no visible headway was being made against the strong tide, the sharp bends were successfully turned during the short period of slack water, and the procession emerged into a broad shallow basin surrounded by wooded hills, and set off for the landing point on the far side. A strong cross wind took the scow aground out of the narrow channel twice on this mile trip, but she floated off with the rising tide and eventually settled on the mud some 400 yards

Left to right: H. Lewis, F. Cowan, C. C. Duncan, W. Leech, J. Gilbert, F. A. Hough



The launching of the "Kon-tiki" raft

from the beach, where she was left for the night after the ends had been put ashore. At dawn next day, on a full tide, we set off back along the course to lay the smaller speaker cable, and this was done without hindrance.

The ponds provided lots of interest. We avoided small ponds, but the larger ones provided a good safe home for the cable. They were crossed by the normal techniques of passing over a line, and then hauling out the cable, attaching 40-gallon oil drums every 25 yards to keep it afloat. The cable was then sunk into position by releasing the drums by pulling on the quick-release knots. Since the ponds are generally shallow it was necessary to have the cable bound up closely to the drums and the attachment is therefore different from that used by the cable ship. Furthermore, the cutting adrift process was more demure than that employed by the cable ship's First Officer, who was wont to proceed along the line in a fast launch and hack off the ropes with a curved scimitar, in a manner reminiscent of repelling a boarding party. The main source of amusement for the land-lubbers was the regular occurrence of someone being toppled into the water.

Three of the ponds were more than one cable drum length (1,000 yards) across. For the first of these the two lengths of cable were laid off line, with the joint made ashore opposite the mid point. Thereafter, the plan was to straighten up the line, with the cable still afloat, by hauling on the ends. This scheme did not work in the shallow water, since we could not keep sufficient tension along the cable to prevent sagging between drums, and it fouled the big rocks on the bottom of the pond. A long and weary process of unhooking the cable ended by wading and carrying it by hand. For the other two big ponds, both over 4,000 yards, the jointers launched a new style Kon-Tiki expedition on a raft built to our specification (if one can call a sketch on a plank of wood a specification) by the local people. The raft was 24 feet long, supported the jointing tent, and was built with a special superstructure to produce the effect of a roof truss to achieve stiffness, necessary for the jointing work. On this the joints were successfully made. The law of cussedness operated in full measure for one of these joints when a strong wind blew up, and we found an inclusion about midnight by X-ray photograph necessitating re-moulding the joint on a rocking craft with waves lapping over it, during the dark hours.

Two major rivers were crossed, the Sandy Harbour river, and the Duns river. The mechanical diggers just waded through the former and dug a trench six feet deep in the sandy bed. The second was notable for the very large bang produced by the explosion of a couple of tons of dynamite that had been carefully placed in holes drilled five feet into the rock strata over which this river flows.

Until the last three miles or so were reached, the cable route was anything from 150 yards to a mile from the road, and this presented access problems for the equipment, and for the jointers and testers who had to carry in their moulding

Ready for cable laying

machines, electrical generators, brazing machines, 40,000 volt testing machine and the X-ray camera in addition to all the familiar paraphernalia of a cable gang. Sometimes it was just carried by hand, sometimes driven part way in the water around the edge of a pond, sometimes carried in coolie fashion slung from poles. Except where streams had to be crossed, the most successful method used was to haul gear on a sledge pulled by a small tractor. It says much for the construction of the equipment that it withstood five months of such treatment without a fault.

But at the far end of the route the road falls down from the 700-foot plateau along the side of a deep gorge, at the bottom of which runs the river to the sea at Terrenceville. Reluctantly, after considering the merits of continuing along the top among rocks rising to 900 feet, and then running down the cliff to the sea, or dropping down immediately to the river bed and putting the cable in the gravel banks, we decided to stick to the road; and so the cable was laid in a trench blown out of the cliff on the rock side of the road. This piece of route was quite expensive, but the result has been a vastly improved highway down to the village at which it ends. Cars now pass one another at most places along the road. Disposal of spoil along here presented no problem as it was simply pushed over the edge and fell away to the river. Back fill was obtained equally simply by pulling down material from above. In places the road is bridged across streams that come tumbling down the rocks from the high ground. Here the cable was turned away into the gully and buried deep in the rock under the water.

And thus the cable arrived at Terrenceville cable hut, awaiting connexion to Sydney Mines across the sea in 1956. The first section of this sea cable was laid in 1955. It is a piece one nautical mile long, from the cable hut to a sand bar which stretches across for more than a mile, leaving only a small gap near the cliffs for the river to flow through, and enclosing a broad expanse of quiet shallow water at the top of the bay. Here the Terrenceville people provided co-operation with their dories, which are small craft with narrow flat bottoms and straight sides, capable of carrying just over a ton. They are all painted bright yellow and look like the paper boats folded up by small boys; laterally they are rather unstable, but they turn up high fore and aft and are said to behave well in rough water if they can be kept head on to the waves.

Since commercial fishing appears to be dying out in the small villages, presumably because of the difficulty of disposing of the catch to cold storage as demanded by modern standards, most of the people are unemployed and welcomed the work provided by the cable laying.

There was considerable feeling between the people of the three or four small villages near which the cable route passed if the contractor did not engage men in their home territory. The communities differ markedly one from another, one being people largely from Irish stock, strongly Roman Catholic, the next being mainly Presbyterian from Scotland, and there are some whose forebears landed from France, whence came the discoverer of the island, Jean Cabot. The American plant superintendent who spent the summer with the team, helping with the work, hailed from South Carolina where, we believe, the climate is somewhat pleasanter than Newfoundland's. This gentleman remarked that he had no quarrel with the guy Cabot about finding the place, but why in h—l did he not keep his so-and-so mouth shut about it ?

During our time on the expedition, the administrative requirements of the British Post Office were provided for by an officer attached from the Canadian Overseas Telecommunications Corporation who thereby relieved the engineers of many problems. In addition, the weekly visits of the Manager from St. John's, besides fulfilling the official function of general contract supervision, were welcomed by everybody in that he came loaded with supplies of films and many other bits and pieces from "town". Undoubtedly his extremely broad and generous interpretation of his role contributed largely to the excellent spirits that were a feature of the work. Excellent relationships between all the people engaged were maintained throughout and were not marred by petty disputes. For our part, we perhaps looked forward to our task of dealing with tough Canadian contractors with a certain amount of trepidation; and there is some evidence that the contractor wondered how he would fare with a bunch of British civil servants as "Inspectors". It is fair to say that the contractor's project manager, an enormous genial man from Texas, matched his huge frame with an equally big heart and personality.

Cross-country with the cable gang

Taking joint out of mould

Towards the end of September ice began to appear at nights and we were glad that the work was drawing to a close. On the very day that the contractor planned to close down his camp, Hurricane "Jane" arrived from somewhere in the Atlantic and tore the place apart, overturning the huts and ripping the tents to shreds.

We had the final meal outside in the gathering dusk and most of the contractor's key men set off for home on the night train from Goobies.

The final stages of the back fill, and the tracing and clearing of a few faults on the light speaker cable that had been laid alongside the main cable were all that remained, and the party dispersed in twos and threes by air and sea over the following days.

As we passed through Swift Current for the last time on the late September afternoon we contemplated the beauties of the spot now that the maple trees had turned to all their lovely colours. We thought of the first time that we had seen it, with the hills shrouded in mist, the water grey and cold, and snow all round. We had passed through, later, in the heat of July, the water impossibly blue and inviting after the dust of the roads. And now we were leaving behind a country that we had come to like, and friendly and simple folk—leaving, with a most satisfying sense of achievement, the results of a whole summer's work that was our contribution to the transatlantic telephone cable system.

Transistor Materials

J. I. Carasso

A crystal of germanium ... "Crystal growing is the most delicate step of the whole process"

Transistors are amplifying devices using the special electrical conducting properties of some crystals. They are smaller and more efficient than thermionic valves, and can replace them in some applications in telecommunications. In the following article Mr. Carasso outlines some of the problems associated with the materials from which they are made; transistors themselves, and similar devices will be considered in a later article.

THE INVENTION OF THE TRANSISTOR BY Bardeen and Brattain of the Bell Telephone Laboratories, in 1948, was immediately hailed as one of outstanding potential importance in the field of telecommunications. The magic with which the popular Press endowed the new device faded somewhat as its limitations became more generally appreciated, and the potentialities of the transistor are only now beginning to be realized in practice. The gap which must always exist between the invention of a new device and its satisfactory mass-application has proved longer with the transistor than was originally expected owing to the unusual chemical and metallurgical problems posed by the materials used.

Transistor materials, among which germanium and silicon are at present the most important, belong to a class of substances known as *semiconductors*. The well-remembered "cat's-whisker detector" of the early days of wireless is, perhaps, the most familiar example of the use in electronic devices of a semiconductor, in this instance galena, so patiently probed by so many enthusiasts. The development of radar, during the Second World War, caused a revival of interest in improved devices of this type and ultimately resulted in the invention of the transistor, a space and power-saving semiconductor triode which can perform many of the functions of the more familiar thermionic valve.

Electronic Semiconductors

Many elements and compounds form crystals in which the atoms are bound together in a fixed pattern (called a *lattice*) by a kind of chemical scaffolding consisting of pairs of electrons. Each atom contributes an equal number of electrons to the lattice framework, and these are shared symmetrically with the nearest atoms (four in silicon and germanium). In the pure materials at very low temperatures all these bonding or *valence* electrons are confined to the immediate vicinity of their parent atoms; no electrons are free to move, or therefore to carry electric current when an electric field is applied. The material thus behaves as a perfect insulator.

As the temperature is raised, however, the increasing thermal vibrations of the lattice are able to "shake" a small but increasing number of electrons free from their fixed locations. These electrons are now free to move under the influence of an applied electric field, and the crystal is no longer a perfect insulator. There is a further important result of this process. The site in the lattice where an electron (which carries a negative electrical charge) is missing behaves as if it were a mobile positive charge able to assist conduction, and is termed a "*positive hole*". Its mobility is caused by the ease with which electrons from successive neighbouring complete bonds are able to move in to fill the gap. Current flows in such materials, therefore, as a result of two processes: part of the current is carried by the freed (conduction) electrons and the other part is due to the directed drift of an equal number of positive holes in the opposite direction. Materials of this type are known as *intrinsic* semiconductors. They differ from true metallic conductors in that, in the latter, the current carriers are all electrons, and their number is very much larger and is independent of temperature.

It is possible to alter the number of electrons and positive holes in a sample of semiconductor by deliberately introducing certain impurities into the material. This process, known as "doping", is an essential part of the treatment of the material, as the completely pure, intrinsic semiconductor is not generally suitable for direct incorporation into electronic devices.

For example, if the crystal pattern of pure germanium is disturbed at some points by replacing a few germanium atoms by arsenic or antimony atoms, there is an excess of free electrons, since these impurities have five valence electrons per atom, of which only four can be accommodated in the chemical framework, the fifth being free to conduct electric current. Such material is known as "n-type germanium" (n for negative current carrier).

Alternatively, if germanium is doped with gallium or indium, each of which has only three valence electrons per atom, there is an excess of positive holes, and the material is called "p-type" (p for positive current carrier). It should be stressed that the presence of any impurity with a number of valence electrons not equal to four will produce such effects. Hence, to produce devices of reproducible properties, it is necessary to purify germanium until it is electrically intrinsic and then to add carefully controlled amounts of the required impurities. This necessity has led to the refining of germanium to a degree never before achieved or even attempted, in the field of technology of solid materials, and has brought about many significant advances in the knowledge of physics and chemistry of solids.

Production

Germanium can now be produced so pure that only one atom in every 10,000 million is *not* germanium. It is a rather brittle material with a steely lustre, and melts at 940° C. When its potential electronic uses were first appreciated it had been known to chemists for nearly 60 years yet, owing to its great rarity, it had remained very much of a chemical curiosity. The invention of the transistor, however, stimulated a search for cheap and abundant sources of germanium. In this country, such a source had been found in the flue-dusts of gas-works using certain types of coal, notably, coal from Durham and Northumberland, by the careful exploration of Morgan and Davies, of the Department of Scientific and Industrial Chemical Research Laboratory in 1937. The traces of germanium had originally been assimilated in the tissues of the growing plants from which the coal was derived, and are again concentrated in the flue-dust to an extent which permits relatively cheap extraction of germanium compounds.

The germanium is extracted on a commercial scale by smelting the flue-dusts with coal, copper oxide and fluxes, whereby it is further concentrated in the form of an alloy with copper, arsenic and certain other elements. Chemical purification is the next step ; the alloy is chemically dissolved and the solution is distilled so as to drive off the germanium and the arsenic in the form of their volatile chlorides, which are collected and separated by a further distillation.

Chloride to Crystal

The germanium chloride is converted first to germanium oxide, by treatment with distilled water, and next to an ingot of metallic germanium by heating the oxide in an atmosphere of pure hydrogen. Impurities which escape the chemical purification (a trace of arsenic, mainly) are still present in the ingot; its purity at this stage is very high if judged by ordinary fine chemical standards, but it is still hopelessly inadequate for transistor purposes. Further purification treatment therefore has to be carried out, using metallurgical recrystallization techniques.

These require the use of special crucibles and highly purified atmospheres, to avoid contamination. The most elegant method, and one which is almost universally used, is a technique known as "zone-refining" which has the effect of sweeping the impurities into the extremity of a long, narrow ingot, the remainder of which is left in a state closely approaching theoretically perfect purity.

The germanium is now electrically intrinsic, and the final stages of making transistor material can begin. The doping impurity, usually antimony, is added in minute, controlled amounts to a melt of intrinsic germanium (a pin-head of antimony would be sufficient to dope several pounds of germanium). The doped melt is converted into a single crystal, to give the final product a physical perfection to match its chemical purity, by dipping a small "seed" rod of single-crystal germanium into the germanium, maintained at a temperature just above its melting-point, and very slowly and smoothly withdrawing the seed out of the melt by means of a geared-down electric motor. Under these conditions, molten material is pulled out of the melting-pot and solidifies as a continuation of the crystalline lattice of the seed. The figure shows a crystal of germanium grown by this method. Crystal growing is the most delicate step of the whole process, since the most carefully controlled experimental conditions, and considerable operator skill, are required to produce the flawless crystals which are necessary for satisfactory transistor performance.

The experience gained during the development of transistor germanium is being used in a search for silicon of comparable perfection, as this material offers the designer of electronic devices some very distinct advantages ; the most important of these is probably the ability of silicon devices to operate satisfactorily at higher ambient temperatures than germanium devices. Owing to the higher melting-point of silicon, however, and to its greater chemical reactivity towards crucible materials and gaseous atmospheres, the difficulties associated with its refinement and crystallization are considerably greater, and have so far prevented silicon from challenging germanium as the most popular transistor material.

Post Office Work for I.T.A.

J. F. Gates

ON THURSDAY, SEPTEMBER 22, 1955, THE Independent Television Authority started broadcasting. The six months before this event had involved the London Telecommunications Region—under the Engineering Department's guidance—in widespread activity providing vision and sound circuits between studios, switching centres and the new transmitter. Hitherto, for the B.B.C. television service, the permanent circuits provided by the Post Office comprised only short links between the larger centres such as Broadcasting House, Alexandra Palace and Lime Grove, and the longer links to the provincial transmitters, but the I.T.A. organization is very much more widespread.

In London a temporary transmitter has been erected for the I.T.A. adjacent to Livingstone exchange; programme material is provided from Monday to Friday by Associated Rediffusion and on Saturday and Sunday by Associated Television. Each of these companies has set up its own switching centre for controlling programme continuity, and each has taken over a number of theatres and former film company studios which have been adapted to TV studios.

A coaxial cable which was being provided for the new B.B.C. transmitter at the Crystal Palace has been extended to Livingstone exchange. Coaxial or balanced pair cables have been laid between the studios and the Post Office Network Switching Centre at Museum exchange, and to the Associated Rediffusion and Associated Television switching centres. Post Office repeater stations have been set up in the studios and switching centres, and intermediately at Western, Wembley, Ladbroke and Livingstone exchanges. Terminal equipment for this network has doubled the amount of equipment in the Network Switching Centre at Museum exchange and has added to the Post Office the responsibility for switching the link between the I.T.A. transmitter and the appropriate programme contractor. It has been necessary to make the Post Office Repeater Station at Western exchange a secondary switching centre staffed by the L.T.R., and Highbury Studios a switching centre to be staffed by Associated Television. The lay-out as it exists at the moment is shown on the drawing.

The I.T.A. expects that commercial television will be operating in Birmingham by February, 1956, and in Manchester by May, 1956. The London week-end programme contractor, Associated Television, will also be the week-day contractor in Birmingham ; week-end programmes in both Birmingham and Manchester being provided by A.B.C. Television and week-day programmes in Manchester by Granada. At first London and Birmingham will be linked by the radio equipment provided when the B.B.C. started programme transmission from Sutton Coldfield. Birmingham and Manchester will be linked by a new coaxial line system. Then, for instance, a programme originated by Associated

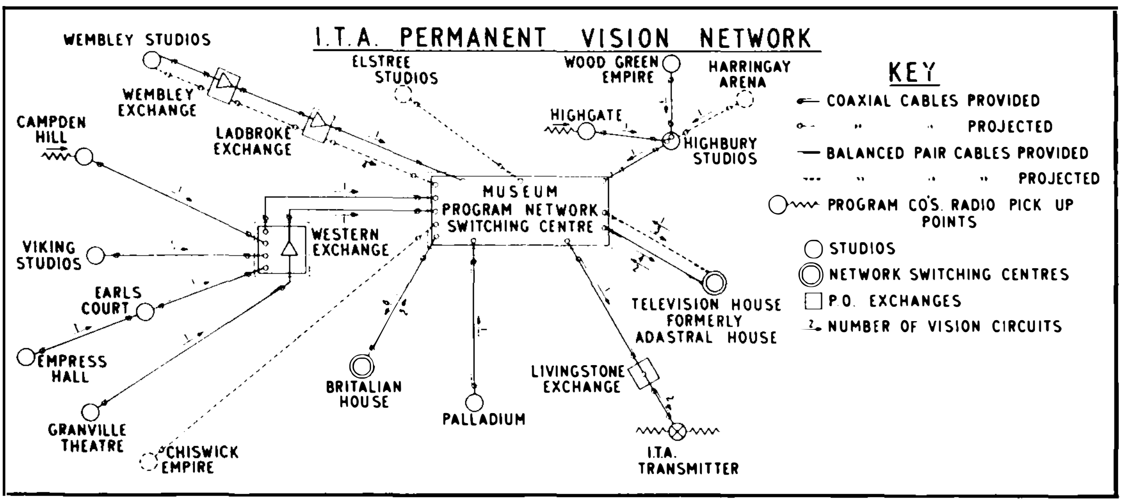
Television in London may be relayed through A.B.C. Television to the transmitters at Birmingham and Manchester.

Each programme company has a radio pick-up point for use with outside broadcasts. One is on a water tower at Campden Hill and linked to the Repeater Station at Western exchange; the other is at the top of some flats at Highgate and is linked to Highbury Film Studios. Other O.Bs are routed into Museum by the L.T.R. outside broadcast group as required and thence extended to the appropriate switching centre.

Meeting these requirements has involved laying 30 miles of coaxial cable and 1½ miles of balanced pair cable, with a total of 80 miles of vision pairs, and the provision of 5 miles of duct route through London's streets. Although the bulk of the cable was specially manufactured and laid by contract (incidentally increasing by 1,000 the ordinary telephone pair mileage) no fewer than 9,000 man-hours were expended by the L.T.R. external staff. The programme companies and I.T.A. had considerable building work to carry out before the Post Office could gain access to studios and switching centres; the first of these was available late in April but the last requiring service on the opening date was not available until the end of August. Associated Rediffusion's requirements were known reasonably early, but Associated Television's plan was not formulated until a very late stage, and the location of their network switching centre was not settled until the end of June.

The delay in gaining access to buildings hampered the termination of external cables and compressed the internal construction programme—which involved making up and installing more than 100 racks of equipment taking 12,000 man-hours. Many of the panels mounted on the equipment racks were specially manufactured under Engineering Department arrangements. Delays in meeting delivery dates were causing increasing concern as the opening day approached, especially as after installation the Engineering Department's testing and lining up had to take place before circuits could be handed over to the renters. However, despite all the difficulties, all commitments were met. The vision circuits for Associated Rediffusion were handed over on September 11 and those for Associated Television on September 16. Additional music equipment was also provided and nearly 200 special circuits on ordinary cable pairs for music, control and engineering purposes were provided for the opening of the service as well as the provision of the usual telephone facilities commensurate with a large-scale venture.

Carrying out this installation programme at short notice involved a great deal of temporary work and the installation of permanent equipment may take another two years; but in the meantime more orders for circuits in the L.T.R. have been received and enquiries indicate that more are contemplated from the London companies and from those that will be operating in the provinces as commercial television expands.



Telephone Exchange Planning in London

C. O. Horn, B.Sc., A.C.G.I., M.I.E.E.

IN COURSE OF TIME, AS WITH ANY OTHER expanding business, the telephone service requires new premises or extensions to existing ones. For a new shop, apart from the obvious requirement that it must be in the community from which its customers will come, the proprietor will aim to have it in an established shopping centre, with good frontage and window space, reasonable facilities for loading and unloading goods, and at a price which he feels justified in paying. Although price is equally important when planning a new telephone exchange, customers do not come to the "shop" but each subscriber must have cable wires from the exchange to his premises. Location must therefore be thought of in terms of the economics of the cable system that will go with the new exchange, and of the cost and ease of connecting the exchange to the main cable network of the whole country; convenience of access for the staff must also be borne in mind.

A new automatic exchange equipped to serve 10,000 subscribers may cost upwards of £400,000 for site, building and equipment, exclusive of the line plant. It will be obvious, therefore, that extreme care must be exercised in deciding where it shall be built and the extent to which it will be equipped (short of 10,000 subscribers' requirements) at opening; and in timing its opening date.

As a first step it will suffice to say that Regional Headquarters see the need to consider a new exchange from statistics provided in ordinary course by the Telephone Manager, from his special reports or from likely engineering and traffic requirements as visualized by the Engineering and Telephone Branches; and that the responsibility for recommending a new exchange to the Regional Director rests with the Telephone Branch.

Such a recommendation is made only after considerable discussion and exploration between the Engineering and Telephone Branches, with the Staff and Buildings Branch being consulted if site acquisition has to be considered. A recommendation is, in effect, a composite one on which the two (or three) Branches are agreed. In broad terms it will cover the area to be served by the new exchange, its size at opening and subsequent dates, its character (unit auto, non-director or director) and the location of the auto-manual board.

But what sort of statistics does the Telephone Manager provide? What likely requirements cause the Engineering and Telephone Branches to initiate a full scale study? And just what planning is involved before and after making a recommendation to the Regional Director?

Before answering these and other questions it should be noted that :—

1. An applicant may be waiting for stores, for labour to install his telephone, for exchange equipment (possibly including site and building), for line plant between his house and the exchange—or for any conbination of these. Applicants living outside the area at present served by plant to the nearest exchange may be given service by providing new plant or by "out of area" service on another exchange at higher rental terms. But there is a temporary restriction on the amount of labour permitted in providing telephone service and, in consequence, some applicants who are waiting for this reason may need to wait until their number and needs justify a new exchange being built.

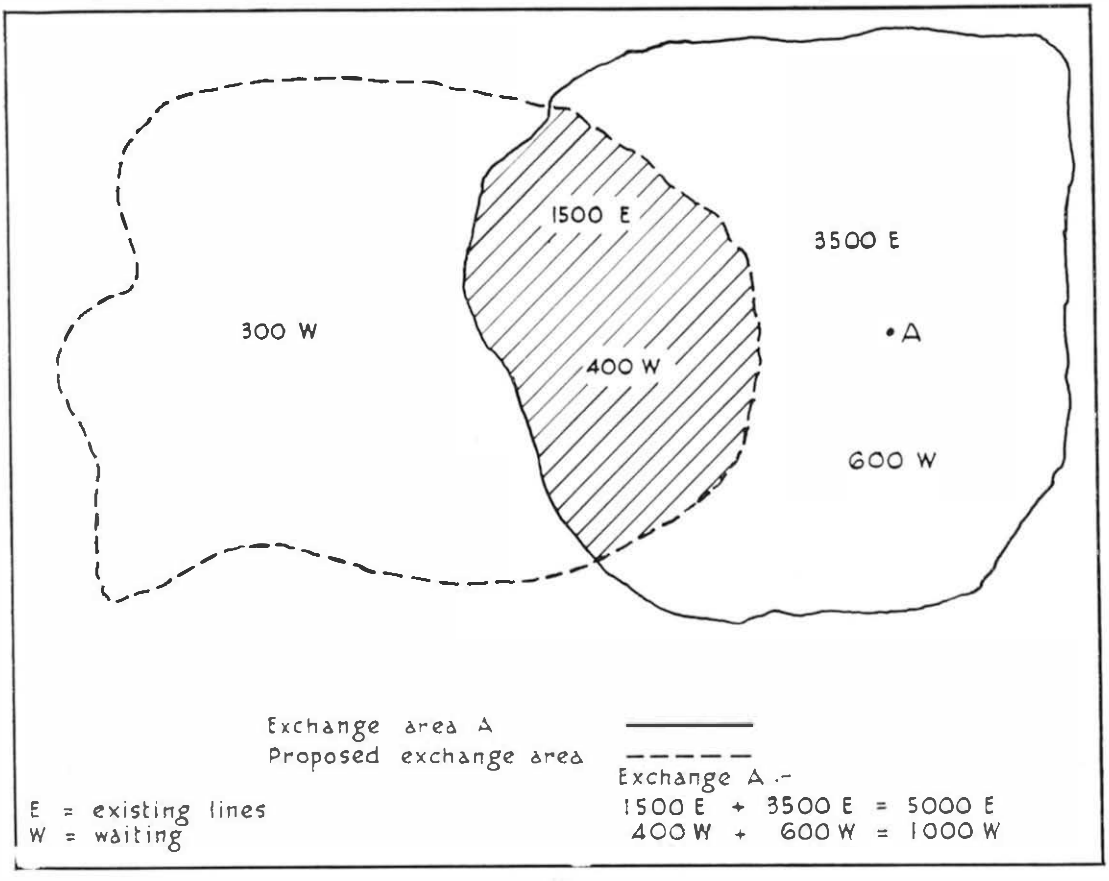
2. There may be applicants within an existing exchange area, for whom a new exchange will be built and whose neighbours—already on the telephone—will be transferred to the new exchange. This involves an "Area Correction Transfer", which will be best understood by reference to the diagram opposite.

The exchange "A" serves the area within the full line, with 5,000 subscribers at present and there is a current order list of 1,000 waiting applicants. The capacity of the building is such, say, that no more than 6,500 subscribers can be accommodated, and new applications are being received at the rate of 500 *per annum.* Obviously if the 1,000 applicants are connected immediately, the exchange will be exhausted in a year's time.

It may happen, however, that 400 of the 1,000 applicants are in the shaded portion of the exchange area, where, say, 1,500 of the present subscribers live. There may also be applicants, say 300, in the area bounded by that portion of the dotted line outside the full line boundary of exchange area A. The Engineering and Telecommunications Branches may recommend an area correction transfer of the subscribers in the shaded portion of exchange area A to a new exchange to serve the area bounded by the entire dotted line.

As a result, the new exchange would have to cater for 1,500 existing subscribers to be transferred, for 400 of A's 1,000 current applicants, and for 300 applicants already outside A's original boundary. The new exchange would thus need to be big enough for 2,200 subscribers (1,500 + 400 + 300) at opening, plus sufficient margin for growth. A recommendation to the Regional Director might therefore be on this basis—but the effect on exchange A with a then constricted area is not without significance.

Exchange A will now need to cater only for the 3,500 subscribers remaining after the Area Correction Transfer, and for the residual 600 applicants proper to the constricted boundary (that is, 3,500 + 600 = 4,100 subscribers immediately); and for an annual growth which will conceivably be less than 500 *per annum.* There will thus be margin for 2,400 subscribers (6,500—4,100), and for 6 years' growth at a reduced rate of say 400 applications *per annum.* In practice, it is doubtful whether such a big component as is represented by the shaded portion of the diagram would be "hived off" but the example chosen illustrates the principle involved while reducing the arithmetic to its simplest form.



Area Correction Transfers are an inevitable feature of an expanding telephone system but they are usually unwelcome to existing subscribers who suffer a change in the name of their exchange and telephone number.

So much for general introductory points. Now to the reports, statistics and so on, which bring to light the need for a new exchange.

It will be obvious that the current and expected rates of growth can be set against the amount of spare equipment which (*a*) exists (*b*) can be fitted into any spare apparatus space in the exchange or (*c*) can be installed after vertical extension of the building or after its horizontal extension if there is site area to spare. From these the expected exhaustion date can be worked out, that is, the desired "ready for service" date for an extension or for a new exchange. This is a matter for collaboration between the Branches at Regional Headquarters; their study must obviously be a long term one for in the interim a site may need to be acquired and building erected; equipment will have to be installed and tested, and line plant may need to be laid.

Sometimes exhaustion of the auto-manual board is a factor; that is, the switchboard work becomes more than the operators can handle and additional auto-manual positions cannot be accommodated within the existing switchroom. Auto-manual board loads are constantly being watched by the Telecommunications Branch.

External Factors

A Telephone Manager may hear that a new industry is coming to a relatively untelephoned area, or that the plan for the creation of a satellite or expanded town has been announced. Matters like these would prompt him to report the circumstances to the Regional Director.

In the London Telecommunications Region the effect of exhaustion dates, manual board loads and Telephone Managers' reports are studied by a Forward Planning Committee on which Engineering, Finance, Staff and Buildings and Telephone Branches are represented.

No matter what "triggers off" perception of the need for a new exchange or for an extension, statistics from the Telephone Area play a most important part in the subsequent studies; in some cases they suffice in themselves to bring to light the need for specific future planning. Most of these statistics are included in the "Development Forecasts" for the existing and potential exchange areas concerned. These forecasts are so important that quite a lot could be said about them, but in brief a development forecast is a forecast of the number of subscribers' connexions expected in an exchange area at 5, 10, 15 and 20 years from the date of the forecast.

From a development forecast it is possible to decide:—

(i) The "theoretical centre" for a new exchange: that is, the point from which the cable plant required to serve the whole area will be the minimum. The theoretical centre is rarely a practicable one for it may come in, say, the middle of a park, or on the site of an existing building. But it leads to the determination of the "practical centre": that is, the spot near the theoretical centre where a new exchange could be most conveniently and economically linked with the national telephone network. From this latter starting point it is possible to work out the added cabling costs which would be entailed by building other than at the practical centre and to provide the Ministry of Works with an "area of search" within which to seek a suitable site. When alternative sites can be offered within an area of search the added cabling costs can be put against site prices in reaching a decision as to which should be bought.

(ii) The amount of equipment to be provided at opening date, and in the ultimate, in a new exchange or extension. Size of site and size of buildings are governed by the size of equipment ultimately required.

(iii) The size and location of the territory involved in an area correction transfer.

(iv) The dividing line when splitting an existing exchange area into two.

(v) The plan for a new cable scheme or the extension of an existing one.

From a development forecast and other data, it is possible to make a recommendation to the Regional Director for a new or extended exchange. If the forecast has been right, planning will be economical but it is still necessary to see that installation of the plant proceeds at economic periods and this is roughly covered as follows:—

(i) It is necessary to ensure that line plant will be available by the time the exchange is opened; actually its provision slightly in advance of the equipment being ready for service is not without advantage.

(ii) Ducts are cheap and the greatest proportionate cost of a duct contract is in opening up the ground to lay the ducts. Usually, therefore, sufficient duct is laid for the 20-year period.

(iii) Main cables—those immediately from the exchange—are usually laid to meet no more than 5 or 8 years' growth.

(iv) Branch cables—those beyond the main cables—are smaller and are usually laid to cater for 8 to 12 years' growth.

(v) Distribution cables—those terminating at distribution points—are the smallest and can be put in more generously. In the London Telecommunications Region if the average growth on these is estimated to be less than eight lines *per annum* over the 20-year period the cables are put in at the outset to meet the estimated 20-year figures; if estimated growth over 20 years averages over eight *per annum* the cables are laid to meet five to ten year requirements only.

(vi) Flexibility, and thus a measure of reserve, is obtained by using the next larger size of cable in marginal cases. For example, if 125 pairs are justified, a 150 pair cable is laid (there being no 125 pair cables) in preference to the next smaller size, which is 100 pair. Further flexibility comes through using cabinets and pillars; development schemes pay regard to these and to possible economy in cable sizes resulting from shared service.†

(vii) Buildings large enough to meet the estimated 20-year requirements are erected; they should also be capable of a 100 per cent. increase in size over the 20-year requirement, by vertical or horizontal extension.

(viii) Site size is determined primarily by the size of building but provision has to be included for outbuildings, yard space and so on. Endeavour is always made to acquire a site double that dictated by the 20-year requirements of the building—but this cannot always be guaranteed.

(ix) The equipment installed at opening is invariably less than will be required at the 20-year period. The planning periods the L.T.R. aims to work to for equipment are as follows:

For a new exchange

Sufficient for opening, plus rack requirements for the next 5 years and switch requirement for the next 4 years.

† See article on "Local Line Plant Provision" by A. Morris in the February, 1950, *Journal*.

For an extension

Racks for a 5 year growth but switches for 3 years only.

Multiple

Whether for a new exchange or an extension, is put in, invariably, in blocks of 200.

So much for the broad considerations followed in planning for a new exchange. Development forecasting and all that goes with it warrant a separate article. In its present form it is based on a procedure recommended by a Study Group in 1935, and slightly modified in 1953. But it is now being reviewed and there may be some changes in the method of forecasting in the future. A separate article on development forecasting will be considered when that review is completed.

The timing involved in planning a new exchange and the planning which follows acceptance of a scheme are very important.

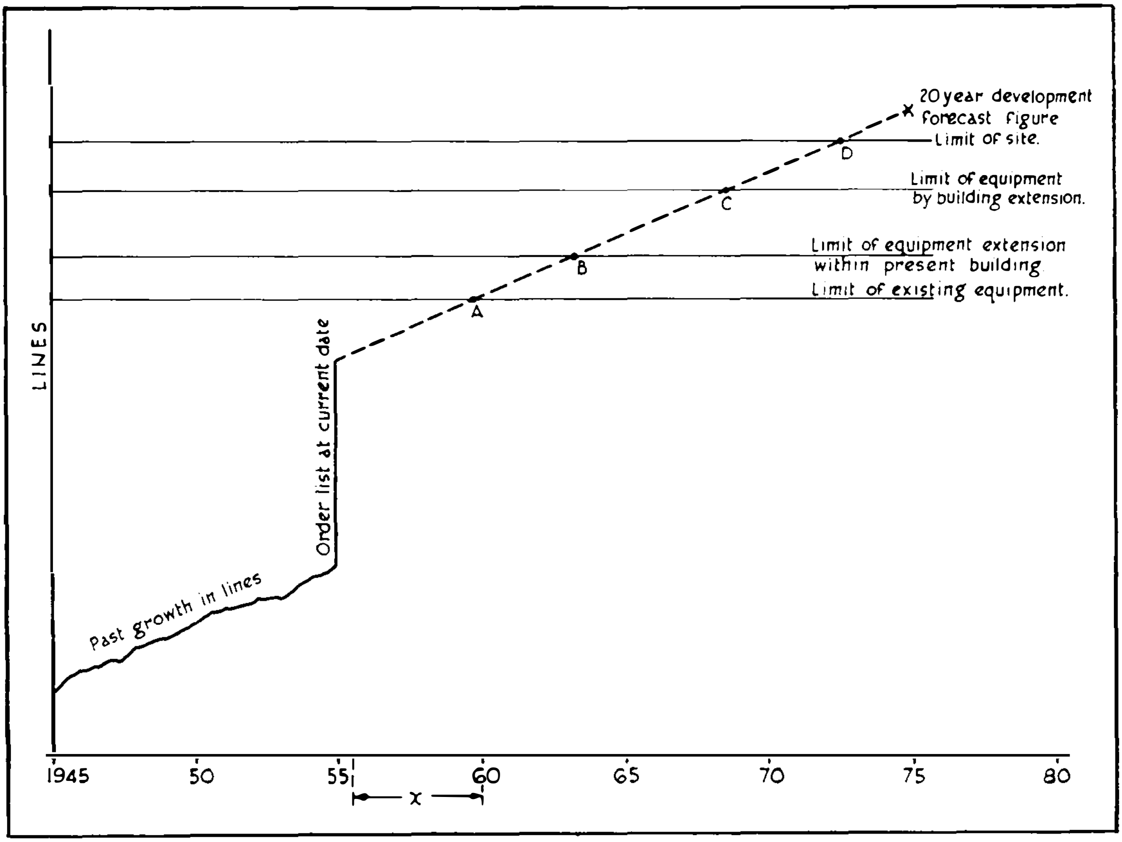
Timing and Planning

For any exchange area it is possible to produce at any time a chart of telephone lines against dates, which will look something like the diagram overleaf :—

The four horizontal lines are important, for the points A, B, C and D indicate the dates by which (A) the existing equipment exhausts, (B) an equipment extension needs to be provided within the existing building, (C) a building extension will be required and (D) a new exchange will be required—and the size of the required extensions.

The need for an equipment extension at A (1960) must be appreciated sufficient years ("x") before 1960 for planning to be carried out, the necessary equipment to be ordered, put into a financial year's programme, installed, tested and ready in 1960—not in 1961 or later. This is not easy to achieve and it is still more difficult for C and D where building extension and new sites are respectively needed in addition to the equipment to go with them.

In a large multi-exchange territory (such as London) where a new exchange may conceivably affect two or even three adjacent Telephone Managers' Areas, deciding what will be the value of "x" in "x years before year 'A'" (1960 in the diagram) is dependent on what is going to be done at adjacent exchanges, what Area Correction Transfers are in mind, and what time can be gained by displacing any engineering staff (who need not imperatively be housed at an existing



exchange) to rented or other exchange accommodation.

In the London Telecommunications Region the Telephone Branch representatives of the Forward Planning Committee, with the Area Traffic Division, review quarterly every exchange area in each Telephone Manager's area. They know in some detail what is contemplated or planned for the Area (and Region) as a whole and, by studying the development forecasts, exchange capacity schedules and other information, are able to pick out which exchanges need "initiating" action at a forthcoming quarterly meeting of the Forward Planning Committee. In effect they work out what figure "x" years needs to be, and are able to submit individual cases to the Committee at a meeting "x" years before the required "ready for service" date. (With the current drive on the order list and the considerable emphasis this is throwing on sites and buildings work it has recently been necessary to work in terms of "x + 1" years owing to building dates receding and delay in publication of those County Development Plans in which designated sites for exchange buildings are still being considered by the County planning authorities.) With the injection of a new case into the work of the Forward Planning Committee, and approval by the Regional Director of a recommended outline scheme, final planning can proceed.

Final Planning (in London)

Assuming that the site exists, has been acquired by purchase, or is assured as the result of designation under the Town and Country Planning Acts, the next requirement is the building. Nearly all branches at Regional Headquarters play their part in preparing a "Schedule of Requirements" which is an essential preliminary for the Ministry of Works.

The Telephone Manager first provides a "schedule of accommodation" which quotes the number of operators to be employed, the number of switchboards, the amount of clerical space required and the like. He associates a traffic form giving traffic design data; for example, multiple requirements, busy hour calling rate, dependent exchanges and so on. From these the Engineering Branch calculates the quantity of apparatus required item by item and thus the area required for each type of equipment—power, batteries, meters and automatic apparatus. The Branch adds particulars of the essential engineering staff to be accommodated, that is, those essential to the running and maintenance of the finished exchange; they allow for test desks and switchrooms, collaborating with and using data supplied by the Telephone Branch. The Staff and Buildings Branch next works out and adds the welfare requirements to complete the "Schedule of Requirements".

It is the responsibility of the Ministry of Works' architect to provide preliminary sketch plans (P.S.Ps) to meet the requirements of the schedule in a building within the site area he has available. Approval of the P.S.Ps in principle is next sought from all the interested Branches, the Telephone Manager and the staff associations. After approval of the P.S.Ps the architect prepares final sketch plans (F.S.Ps) which incorporate any modifications suggested to the P.S.Ps; on approval by the Region of the F.S.Ps he proceeds to working drawings, (W.Ds) and to the building contract and in due time he hands over the building as "ready for equipment". By the F.S.P. stage, however, the Finance Branch has come into the picture and financial authority is obtained for the building.[*]

Working very precisely, the Engineering Branch would need to make elaborate calculations from the data it has been given to determine the floor areas required for each type of equipment (racks, selectors, meters and so on), and a drawing office job would be entailed in converting these into room sizes as a preliminary to completing the schedule of requirements. Recently, however, it has been possible to save time in the L.T.R. by preparing tables from which the floor areas can be read off against the expected multiple size for different busy hour calling rates. These tables have been compiled from the figures used in existing L.T.R. exchanges, separate tables being prepared for director exchanges of 5,000, 7,500 and 10,000 multiple, for non-director exchanges of 1,000 to 7,000 multiple (in steps of 1,000 multiple), for the rack quantities in each of these categories, and for the additional allowance for manual boards.

With the knowledge that a building is in a buildings programme year and that it will have such and such a "ready for equipment" date it falls to the Telephone Branch to ensure that the equipment contract will be let in time for the desired "ready for service" date to be met. Each year the Telephone Branch of the L.T.R. prepares a programme of the extensions and new exchanges to be ordered for each of the three financial years ahead. This is converted at Post Office Headquarters into a tentative national three year programme; but limitations on the total value of orders and on the building programme lead to adjustments which take account of the degree of urgency between the Regions.

Agreeing the Programme

Eventually Headquarters officers visit each Region, discuss the requirements of the first year of the Region's modified three year programme and agree which cases are to be included as orders in the next financial year. (The degree of modification to a Region's original "bid" will affect its second year requirements—which, one year later, become the first year of the subsequent three year programme.) The agreed programme is converted, in consultation with the Engineering Branch, into "Regional contract" dates and the Engineering Branch then draws up the respective equipment specifications in their required order for placing equipment contracts. Preparing each specification is a complicated process but is not unlike some of the work done in connexion with the schedule of requirements. Floor areas are not now required, but this time the number of racks, selectors, meters and other apparatus has to be calculated, not as for the 20-year requirements (which determined the building size) but for the smaller quantities required at the opening date.

Such then is an overall picture—without too much detail—of the considerations which affect the building of a new exchange and the planning which has to be gone through in the L.T.R. The right note to end on, seems to be that even agreed plans have to be amended from time to time to keep pace with policy changes or technical developments; and that the L.T.R. Forward Planning Committee is even now taking the first look at exchanges which may not be required until some time after 1970.

[*] Mr. Horn's article "Before the Building Starts—" in the November, 1954-January, 1955, *Journal* dealt with this subject.

Telephone Service at Hotels

R. H. McGann

IN OUR MAY ISSUE, MR. McGANN DISCUSSED telephone service for Government departments, following the report of a study group on service in hotels and Government departments. Below, he discusses the second subject of the report.

The quality of the service given by hotels' private branch exchanges is very much a matter for the hotel management, but the Post Office can do a great deal to help hotel managers to plan and use their telephone arrangements to the best advantage. London hotels have a constantly changing population of all nationalities; the question is—do visitors find the telephone service completely satisfactory?

At the instigation of the Postmaster General, the British Travel and Holidays' Association agreed to write a personal letter to the managements of the principal hotels catering for overseas visitors. This letter said that the telephone switchboard, although it is not seen, is, in a sense, the hotel's shop window, and managements were urged to see that the service given is worthy of their hotels. The letter went on to say that the visitors' impression of the telephone in this country must be based on the service they get in the hotels where they are staying. A list was enclosed of " Ten Golden Rules for P.B.X. Operators", the first of which is "Your hotel will be judged by your voice and manner. Speak pleasantly, courteously and distinctly". The rules were published in several trade journals.

This initial approach to selected hotels was a good beginning and the study group followed by arranging visits—which were well received—to survey the telephone arrangements at 46 London hotels. Most of the hotels have P.B.Xs in the range 1-4 positions and the majority have between 100 and 1,100 bedrooms. At about a third there is a telephone supervisor.

In general the hotel P.B.X. staff conditions are comparable with those of Post Office employment. Length of duty appears to be about the same as for Post Office telephonists. Late evening and week-end duties are probably more frequent, but to the operators the "romanticism" of hotel life seems to offset these disadvantages.

The training of hotel P.B.X. operators is limited to a short course arranged by either the hotel or the Post Office. An hotel manager can send a newly recruited operator to a Post Office course of instruction free of charge. The study group thought that this service might be made more widely known and some of the hotels have already been asked if they would be willing to send their operators regularly to Post Office controlled refresher training classes designed solely for hotel operators.

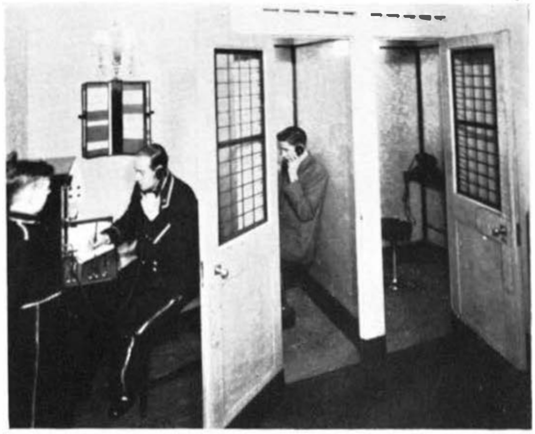
At some of the hotels the extension numbers in the bedrooms are the same as the room numbers, an arrangement which simplifies the P.B.X. operating and the charging for telephone calls on the guests' accounts. Nearly all the hotels without this arrangement were ready to adopt it. The trouble is that a Post Office charge is involved in making the change, but in view of the service advantages there may be room for considering whether the charge can be abandoned.

One of London's principal hotels is equipped with bedside telephones with an inset electric clock and four press buttons for domestic services—valet, chambermaid, waiter, servants' quarters. Three of these services are represented pictorially below the buttons for the benefit of foreign visitors who might otherwise have language difficulties. The equipment is ideally suited to the needs of the luxury hotel where staffing costs and staff recruitment are not major problems. This particular type of bedside telephone is in use in only one hotel in this country, and after twenty years it is still giving excellent service.

Consideration of parallel telephone extensions to the bathroom introduced the study group to the more intimate domestic responsibilities of hotel management. Visitors have been very impressed with this facility because the noise of the bathroom shower may cause the bedroom telephone bell to be inaudible and an important call may be delayed or ineffective.

The telephone administrations of Paris, Brussels and New York were asked if they could give information on a number of questions affecting hotel telephone facilities. The information sought was given willingly and fully but it did not introduce any new line of thought or offer any information about facilities not already considered by the British Post Office. Many visitors from abroad are not familiar with the telephone system in this country and it seemed to be a new thought to the foreign telephone administrations that a small booklet might be produced setting out the facilities available and how they could be obtained. The booklet —or card folder, or both—would supplement the information in the directory preface and would also

Hotel bedside telephone with inset clock and service press buttons



Part of the call office suite at the Dorchester Hotel

be useful to hotel managers and to their P.B.X. operators.

It is in the interests of hotel management that dial centre labels, the telephone cords and general condition of the bedroom or other extensions should be regularly inspected. A few hotels print their own labels and make the replacements. But unless items of wear and tear—as well as faults, which put an extension out of use—are reported to the engineering staff no attention is normally given to these things until a fault requires a visit to the room by the faultsman. When a guest vacates a room the hotel staff inspect the room, remove bed linen and so on; when this is being done it should not be difficult for the same staff to inspect the extension telephone, test the line to the switchboard and report any items which need to be renewed.

A fault which occurs on a bedroom telephone extension line on Friday evening may not be cleared before Monday morning. A business executive with a lot of work to do at the week-end may be very put out by a fault on his extension line, and it is not satisfactory for the management to have to move a guest to another room so that he can use the telephone. These conditions are very different from those at a business house which closes down for part or the whole of a week-end. It is only infrequently that the need for special attention arises but when it does, a good impression may be left in the mind of, say, an influential overseas buyer if the telephone is put right with the least possible delay.

The daily traffic peaks at London hotels occur between 8.30 and 10.30 in the morning—usually later at the luxury hotels—and between 5 in the

Training London hotel P.B.X. operators at the Post Office Training School

afternoon and 7 in the evening. Business men make most calls; tourists make fewer. Sometimes a business visitor gives the P.B.X. operator first thing in the morning a long list of twenty or thirty telephone numbers and asks that the calls be connected in quick succession.

Sometime ago the then Assistant Postmaster General suggested to business men they should test the quality of their telephone service by ringing their office from an outside telephone. Some test calls made to London hotels showed that the time taken by P.B.X. operators to answer calls is generally not unsatisfactory, but that about one in four of all incoming calls from the public network might be better handled—usually because the operator failed to repeat the caller's requirements or to keep him informed of the progress of the call.

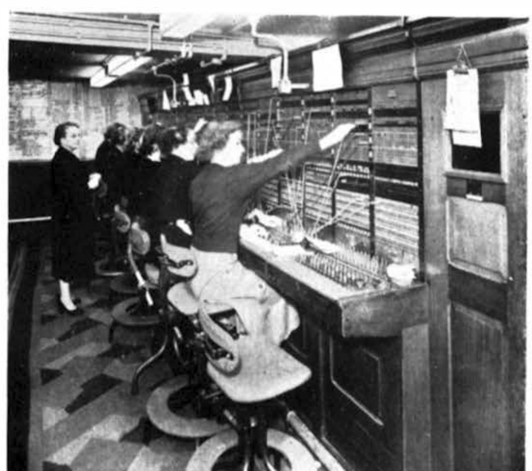
Travelling supervisors regularly visit the hotel P.B.Xs to advise on the service—they can do no more—but it may well be that something more is needed particularly at the larger hotels where, in total staff and number of positions, the P.B.X. is comparable with a small public exchange. Problems of the telephone service might, for example, be regularly discussed with the hotel manager by senior traffic or sales officers. This would enable the Post Office to keep in closer touch with an important body of public and overseas opinion and help to promote the interest of London's increasingly thriving tourist business. The first lecture on the subject of "The Telephone Service" has already been given to hotel management trainees at the Westminster Technical College.

In outline some of the other subjects examined by the study group were these. Directory enquiries made by guests should, as far as possible, be handled by the hotel staff. Cloth-bound directories might be supplied instead of, and to the same value of, paper-covered copies. The advice of Telephone Managers might be sought about combining the operating with other work at small hotels. The forms used in telephone exchanges for recording the results of routine tests can be used with advantage by the P.B.X. operators at the larger hotels. Messages for guests are best taken at a point away from the switchboard.

The study group was forestalled on one point of investigation which concerns the larger hotels. Consideration was already being given to an arrangement for using a P.A.X. or a P.A.B.X. No. 2 as an auxiliary to an existing P.M.B.X. installation; this would give automatic intercommunication between, say, the executives and the staff of the hotel. The automatic extension users would have direct outgoing dialling facilities into the public network, but all calls made by guests would have to go through the manual board.

The lush splendour of London's luxury and first-class hotels can rarely, if ever before, have formed the background to the deliberations of a prosaic official study group. For fleeting visionary moments the mind wandered, but these fugitive thoughts at least helped to point out the directions in which the telephone service could best contribute to the common aims of service and to the country's valuable tourist business.

P.B.X. Switchboard at the Regent Palace Hotel



Post Office Finance—An Outline

E. W. Shepherd

ANY STUDENT OF POST OFFICE AFFAIRS MUST soon become aware of the complexities of the financial background to them, and nowhere will he strike more difficulty than in the telecommunications field. Fundamentally, these complexities are the direct consequence of the dual nature of the Post Office, at once Government department and public utility.

There is no doubt that Parliamentary accounting requirements complicate our affairs. It is, however, something we must accept; and it is the purpose of this article to shed a little light on some of the obscurities. Our finances involve three different concepts which we may describe as cash, commercial and capital investment. These headings are not mutually exclusive, but it is convenient to deal with them separately to some extent. Each has its importance: each, indeed, has a realm within which it is paramount.

Cash Position

Under this head we are concerned solely with finding the money to meet all our expenses and with disposing of the money we collect from the public. (We need consider here only Post Office business proper, leaving out of account services such as payment of National pensions and sale of National Insurance stamps, which we handle purely as agents of other Government departments.) It would be convenient in many ways if we could use the money we collect to pay our expenses as they arise, but as a Government department under the control of Parliament we must conform with the rules governing Exchequer accounting. These rules require in general that expenditure must be authorized by Parliament and that all expenses must be met from money issued out of the Exchequer under Parliamentary control. Cash income, on the other hand, must normally be paid straight into the Exchequer. Meticulous account has to be kept of these two separate streams of money flowing simultaneously out of and into the Exchequer to and from the Post Office. The shape of this system as it applies to Post Office affairs is outlined in the following paragraphs.

Vote: The bulk of Post Office cash requirements is met from Vote; that is to say, the money is voted by Parliament under what is known as Parliamentary Supply procedure. This requires submission of a detailed Estimate each year, and keeping expenditure within the limits authorized. At the end of the year the actual spending is accounted for and compared with the Estimate in an Appropriation Account, which is subsequently scrutinized on behalf of Parliament by the Public Accounts Committee. Voted money provides essentially for all our requirements except expenditure on capital account, dealt with in the succeeding paragraph. It should be particularly noted that Renewals as well as Maintenance are charged to Vote.

Expenditure on Capital Account: One activity, and one alone, of the Post Office is not financed from Vote, but is charged to capital (or "Loan") account. The work concerned is that which adds capacity to the Post Office system by way of buildings, additional blocks of exchange equipment, cables and so on. It is important to note that additional capacity is the test. Of two precisely similar cables newly laid, one replacing an earlier type carrying an identical number of circuits and the other laid on a new route; the first will be paid for from Vote and the second from Loan. Of course, most works both replace old capacity and expand it, and then an apportioning process determines the charges to Vote and Loan respectively.

Money Acts: The money needed for expenditure on capital account as defined above is provided under the authority of a Money Act, and not by the normal Parliamentary Supply procedure involved in the case of Vote. Post Office Money Acts, which are passed every two years or so, authorize the Treasury to issue up to a certain sum out of the Consolidated Fund (which may be regarded for this purpose as meaning the Exchequer). The Act also empowers the Treasury to borrow, if desired, to raise the money required, and it is to this part of the provisions that we owe the familiar term "Loan". Whether Exchequer borrowing is resorted to or not, the amounts issued to the Post Office are repaid in the form of annuities charged on the Post Office Vote. This is not much more than a book-keeping transaction.

The effect is that over a period of years (normally 20) the amounts spent on capital account are converted to Vote charges.

There are, of course, accounting rules governing the spending of money provided under Money Act authority, but they are less stringent than those governing Vote. In particular it is unnecessary to secure Parliamentary authority for the precise amount of money required in a given financial year, although an account of the actual spendings has to be furnished to Parliament. The account concerned is published in a table at the end of the Appropriation Account for the year.

Relation to National Budget and Accounts: The transactions described above all take their place in the National Accounts. Post Office Vote expenditure and Cash Revenue both find their place in the Chancellor's Budget statement "above the line"—that is to say, as part of the nation's income and expenditure on current account. The funds provided under Money Acts, on the other hand, represent a draft on the nation's capital resources and are accordingly treated as below-the-line expenditure. The figures concerned may be traced in the published Financial Statements and Finance Accounts of the United Kingdom.

Commercial Accounts

General Purpose: It will be apparent from the description already given that a true picture of the Post Office as a business cannot be formed from the cash transactions of any one year. On the one hand, a great many services are rendered to the Post Office (for example, by the Stationery Office and Ministry of Works) for which no cash charge is borne on Post Office funds. On the other hand, the Post Office renders many services, particularly in the postal field, to other Government departments who make no cash payment for them. Moreover, the conventional period over which capital account expenditure is amortized in the form of annuity payments from Vote, as described above, has no necessary connexion with the rate at which Post Office assets are being consumed. It is essential, therefore, to have a set of accounts comparing for each year the cost incurred in providing services with the income derived from them (whether or not received in cash). Only on such a basis can we determine whether we are paying our way, both generally and as regards particular services.

This is the function of the Commercial Accounts. They are fundamentally similar to the accounts which would be prepared by a trading concern not required to conform to the specialized cash requirements of Parliamentary Accounts. Some of the ingredients in the Commercial Accounts do, of course, correspond with Vote expenditure, and the Balance Sheet duly reflects Money Act expenditure, but in other respects there are important differences from the Cash Account.

Relationship of Commercial Accounts to Cash Accounts: A reconciliation between the Cash figures and their Commercial counterparts will be found at the end of the published Commercial Accounts volume (see page 50 of the 1954-55 Accounts). The principal features of the Commercial, as compared with the Cash presentation, are:

(*a*) The allowances made for services rendered to or by other Departments without payment.

(*b*) The substitution of interest and depreciation charges for annuities.

(*c*) The exclusion of Renewals as a charge against the year's revenue (they are, of course, debited in the depreciation account).

(*d*) The charging of pension liability on existing staff instead of current pension payments to former employees.

Post Office Capital: The total sum spent on additions to the Post Office system in a year may be expected to result in a corresponding expansion of the prime cost of Post Office assets shown in the Balance Sheet. We find, indeed, that this is so, subject to some small adjustments, the principal of which is that, whereas the Money Bill provisions represent the gross value of assets added, there are also in any given year some assets permanently displaced and the growth in the Balance Sheet figure will, therefore, be a net one.

It is convenient here to note in more detail one of the important divergences between cash and commercial treatment of the same subject. In the cash field we have seen that the Money Act advances are repaid by means of annuities. But this so-called repayment is merely from one Exchequer pocket to another. The Post Office itself continues to enjoy the use of all the capital which has been advanced to it, its assets remain in being, either in their original or in a renewed form indefinitely. In the Commercial Accounts we therefore charge ourselves with interest in perpetuity on all our capital. Our situation is thus akin to that of a commercial concern employing borrowed capital which, normally, it never repays.

Depreciation: Since any asset in current use is being consumed at a rate corresponding with its useful life, it is necessary to charge in the accounts not only interest on the original capital value but also depreciation. The necessary provisions are credited to a separate depreciation account. To this account are charged Renewals of plant as they arise; but since the amount of plant falling due for replacement in a given year reflects the size of the system many years earlier, the cost of Renewals, in an expanding system, will tend to be a good deal less than current depreciation charges. There is thus a sizeable balance in the account, which, for the time being, is at the disposal of the Exchequer in the capacity, as it were, of our Banker. This balance earns interest, so offsetting to some extent the interest charged on the prime cost of our assets.

In short, the same effect is produced as if we had reinvested the balances in our business and borrowed that much less new money for development.

It will now be seen to be logical that when Renewals are incurred they should be financed from the Exchequer via Vote, since we have already provided for them in past depreciation contributions. The corresponding effect in the Commercial Accounts is the raising of a charge against the depreciation fund.

Capital Investment

We turn now to the third concept. Capital investment, in the special sense attached to that term for the purpose of the controls which have applied since the war to all public bodies, is the measure of our consumption of plant and manpower on the creation of assets. Thus it excludes all expenditure on maintenance, or on the handling of traffic or other costs needed to keep the machine running from day to day. The question arising each year is how much of the national resources can be devoted to longer-term needs, and how much must be allowed to produce goods and services for current consumption. Against this national background the Post Office can obtain its share only in competition with the corresponding needs of other bodies.

The fundamental problem is to determine at what rate we can afford, in the national economic sense, to expand and renew our long-lived assets. Of course, capital investment has to be measured in money terms, although its purpose is primarily a physical one. The total ranking as investment consists essentially of expenditure on capital account, plus expenditure on Renewals (because Renewals consume the same kind of resources, and create the same kind of assets, as expenditure on capital account).

Some confusion occasionally arises from the fact that "Renewals" for capital investment purposes is not the same as the Renewals charged against depreciation in the Commercial Account. The reason is that "shifting" of existing plant, which arises very largely in the course of works of construction, ranks as capital investment, but, since it does not involve the renewal of the plant concerned, is charged as year-to-year expenditure (under the heading of Maintenance) in Post Office accounting. In the opposite direction a book-keeping adjustment, included in Renewals in the Post Office accounts and representing the writing down to scrap value of recovered stores, has no place in capital investment.

The White Paper

Readers of the *Telecommunications Journal* will be familiar with the White Paper (Cmd. 9576) on Post Office Development and Finance, a summary of which appeared in the Autumn, 1955, issue. This provides for some novel features to be introduced into Post Office financial procedure.

In the first place, it embodies a return to the Bridgeman concept of self-contained Post Office finance. This means that once the Post Office has paid its way in commercial terms, including the payment of a fixed £5 million contribution to the Exchequer (broadly the equivalent of taxation which, as a Government department, the Post Office does not bear in cash), any residual surplus may be retained.

Any such surplus is, in effect, deposited with the Exchequer, and interest is added to it. Thereafter it is available to the Post Office in future years for such purposes as the improvement of services or for covering rising costs.

It will be appreciated that such a surplus would not confer any title to an increase in the Post Office share of capital investment, but the benefit of the new arrangement is a very real one although it carries with it corresponding obligations. Any additional expenditure incurred must now be fully matched by additional revenue earned; the

Post Office, therefore, bears even fuller responsibility than before for fixing its prices at rates which cover cost.

Secondly, the White Paper provides for increased depreciation contributions to be made, by basing provisions on the present-day worth of the assets instead of on their value at the time when they were installed. This ensures that the consumer pays for capital assets just as he does for day-to-day expenditure; that is, at the true rate, measured at current prices, at which he is using them up. In due course, this additional money will go a substantial way towards meeting the higher costs of renewal when assets fall to be replaced. Meanwhile, to the extent that we do not immediately need to draw upon our depreciation provisions, they serve to reduce the amount of borrowing which the Exchequer has to undertake for Post Office needs, with a consequent saving of interest charges to the Post Office customer. This is the meaning of paragraph 21 of the White Paper, which shows that, of some £300 million needed in the next three years for capital investment expenditure (including, of course, Renewals, etc.), not much more than half will need to be raised as new money by the Exchequer, the remainder being derived from depreciation provisions in the same period.

Books Reviewed

Telegraphy in France

Appareils et Installations Télégraphiques, by D. Faugeras (Éditions Éyrolles, Paris, frs. 3,900) is a practical handbook giving a detailed exposition of the French telegraph system.

The reader will need to appreciate that in the symbol for a battery the short thick stroke represents the positive pole, while in teleprinter systems "repos" relates to stop polarity (mark).

It is questionable whether four chapters describing the Morse-Wheatstone, Step-by-Step, Hughes and Baudot systems serve a useful purpose, for these have been fully described in earlier books. Four chapters devoted to teleprinters relate primarily to Sagem instruments. The author also refers to Creed machines, though mainly to the obsolete No. 3 and only briefly to the No. 7 and No. 11 (47) models.

Reference to power plant is limited to rectifier units. In the same chapter M. Faugeras includes a survey of the derivation of circuits—physical, phantom, and V.F. (A.M. and F.M.). In one chapter the author describes a wide variety of relay-repeaters, owing to the extensive use of central battery and single-current working. An interesting chapter on maintenance includes distortion measuring sets (synchronous and start-stop) and margin testers concluding, somewhat oddly, with regenerative repeaters. Transit problems are discussed with descriptions of reperforator switching (tape relay). The most interesting and topical chapter deals with switching, including an account of the system being installed using keyboard selection.

The book concludes with a chapter combining submarine and radio telegraphy, the latter referring to Hell, Verdan and Van Duuren systems, and one on facsimile, largely theoretical, but with brief references to phototelegraph and direct-recording apparatus.

The author invariably gives the clearest description of fundamental principles, and advances arguments for adopting particular methods. The print and the diagrams are particularly clear, but captions would have been useful. R.N.R.

"F.M. EXPLAINED". By E. A. W. Spreadbury, Technical Editor of "Wireless and Electrical Trader". 37 pp. Price 2s. 6d. Published by Trader Publishing Co. Ltd., Dorset House, Stamford Street, London, S.E.1.

The inauguration of the B.B.C's Very High Frequency, Frequency Modulation broadcasting service last year brought new techniques and problems into the servicing of domestic broadcasting receivers, and this booklet deals with frequency modulation primarily from the radio servicing point of view.

The first chapter, after a brief history of frequency modulation, gives a lucid and non-mathematical explanation of the basic principles, with the aid of very clear diagrams. Later chapters deal with the various features of frequency modulation receiver design. The author discusses the separate stages of a receiver and the circuit arrangements and special components of combined A.M.-F.M. receivers, and covers in detail the problems of frequency modulation detectors or discriminators. The final chapter deals with the alignment of receivers using both visual and non-visual methods.

The book is a useful introduction to F.M. techniques, and gives a particularly welcome account of current practice in F.M. broadcast receivers. G.F.S.

Enemies of the External Plant Engineer

Squirrel damage to cable sheath

N. Duncan

THE ENEMIES OF THE EXTERNAL PLANT engineer are many and varied. Some are serious, while others are trivial and merely a nuisance. Included among them are the natural hazards of gales, blizzards, snow, ice, fog, rain, flooding and lightning storms, which in their varying degrees of severity disrupt communication lines and isolate telephone exchanges. Fortunately, however, damage by the elements can be considerably reduced by careful design and selection of the materials used and by the methods of construction adopted.

Forty years ago, when most telephone and telegraph lines were overhead, snow and ice, as in the storms of 1916, could disrupt communications over large areas for many weeks. Since then much plant has been placed underground, and while winter's storms can still cause some embarrassment, the vulnerability of external plant in general is very much less. However, underground plant is not entirely free from other hazards. One of its worst enemies is corrosion, which attacks ruthlessly and silently, and it often strikes where it hurts most—at the long distance lines of communication.

Corrosion

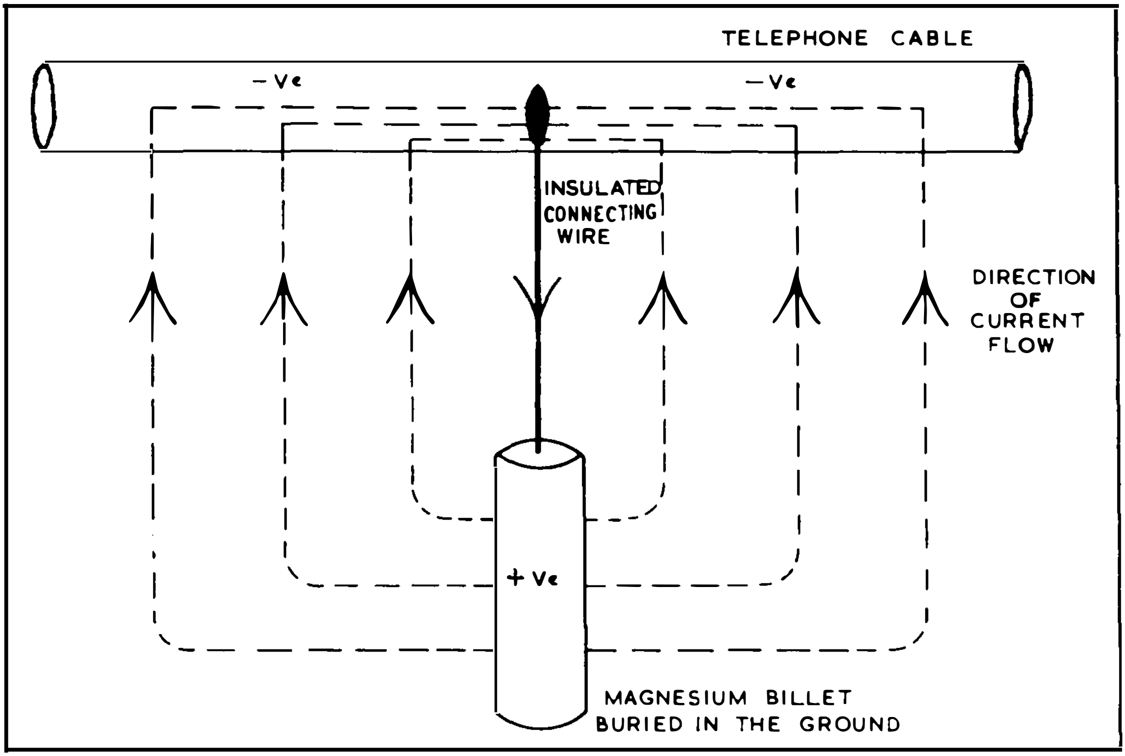
Most of the common metals are extracted from ores found in the earth, which are refined and processed for industrial purposes. If a metal thus extracted is left exposed without protection of any kind it will rust or corrode, and a remarkable resemblance is found between the corrosion products of the metal and the mineral form in which it is found in nature. Corrosion appears to be almost a reversion of the metal to its natural mineral state. Only for the "noble" metals, such as gold and silver, is the metallic state natural and stable.

Telephone cables are normally sheathed in lead, which is very durable by comparison with some other metals, but corrosion of lead-covered cables costs the Post Office over £500,000 a year.

If telephone cables are to work effectively, moisture must not be allowed to penetrate the lead sheath. Even a pin-hole caused by corrosion may make it necessary to renew a considerable length, 100 yards or more, of expensive cable.

It is well-known that the passage of an electric current from a metal to a solution will cause corrosion of the metal, and lead-covered cables, which are often in wet conduits, can be corroded by natural or self-generated earth currents, or by stray currents from electricity mains and traction systems and so on. Stray currents from electrified railways may flow through the earth over a radius of several miles. The self-generated currents arise from contacts between the lead of the cable sheath and different soils and solutions, which produce the equivalent of small electric cells, and lead sheath contained in earthenware conduit can corrode without any apparent external current source. Slow corrosion, which proves harmful over a long period, occasionally results from contact with chemicals in the soil.

To reduce the damage to his cables, the external plant engineer endeavours to identify the various types of corrosion and to trace the origin of the various sheath currents. He has special electrical instruments which enable him to measure the amount and direction of the current flowing in the cable sheath and the difference of electrical potential between the sheath and the adjacent soil.



A protective current

Once he has traced the source of the sheath currents he can often determine the best means of combating them.

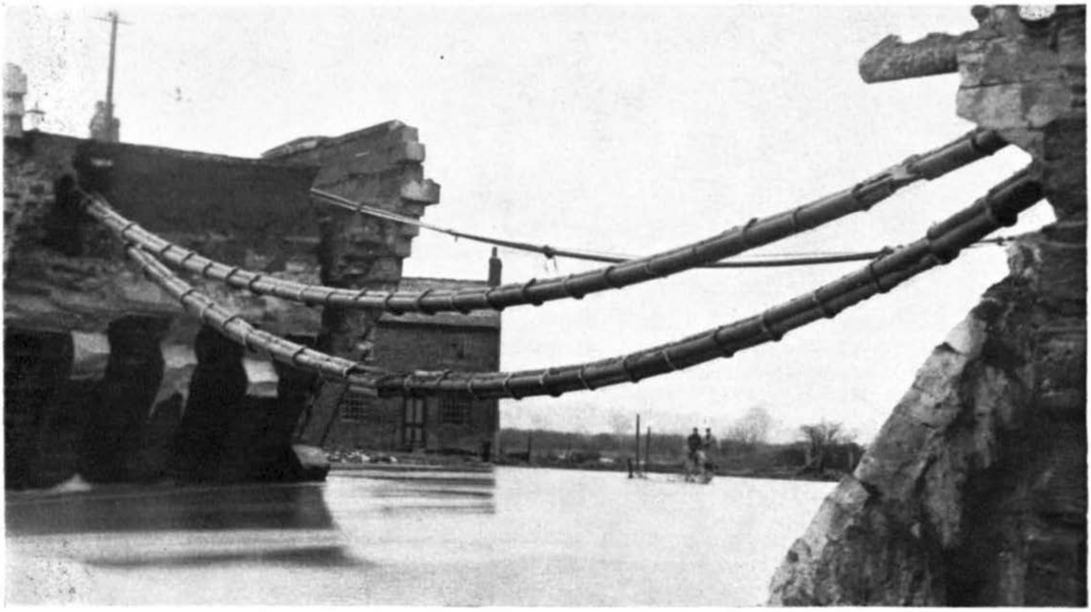
When the sheath currents are found to be caused by leakage from a tramway or an electric railway system, they may be due to a fault on that system. If they are occurring because the statutory regulations under which the system is authorized to operate are not being observed, the authority operating the tramway or railway is responsible for correcting the conditions which give rise to trouble.

Leakage from D.C. electric mains can cause severe corrosion. Not very much D.C. is in use now, but where it is the mains are often very old and prone to break-downs. Leakages in consumers' installations are not uncommon. A.C. systems cause practically no corrosion.

Where the cause of corrosion cannot conveniently be removed, a number of remedial measures can be taken. One way is to use cable with a protective covering of insulating material over the lead; another is to control the flow of stray currents by introducing insulating gaps into the cable sheath. These gaps involve removing a section of the lead sheath and covering the gap with impervious insulating material. Yet another method which is coming to be used very widely is known as cathodic protection. Corrosion normally takes place where the electric current leaves the cable sheath and goes into the soil, so that by connecting up a battery or some other source of electric power with the negative terminal to the cable and the positive terminal to an earth plate, the injurious currents can be reduced or stopped, and current will always flow from the earth into the cable sheath. In this direction it normally does no harm.

For a single cable a protective current can be provided by burying a magnesium billet nearby and connecting it to the cable sheath with an insulated wire, but when many cables must be protected it is usually cheaper to install a mains-driven rectifier as the source of power.

While corrosion is the most serious enemy of



Flooding—bridge collapse

underground cables, there are other enemies which, though not as widespread, often cause trouble.

Flooding

Flooding is the most serious of these other enemies because latent defects which have remained hidden and harmless for years are suddenly brought to light. It sometimes happens that all the circuits in a cable are rendered unworkable and that nothing can be done to restore service until the floods subside.

The force of the water running through underground conduits is often sufficient to disturb cables and seek out weaknesses. Floods usually leave behind them a crop of pipes blocked with silt and sand.

Creepage

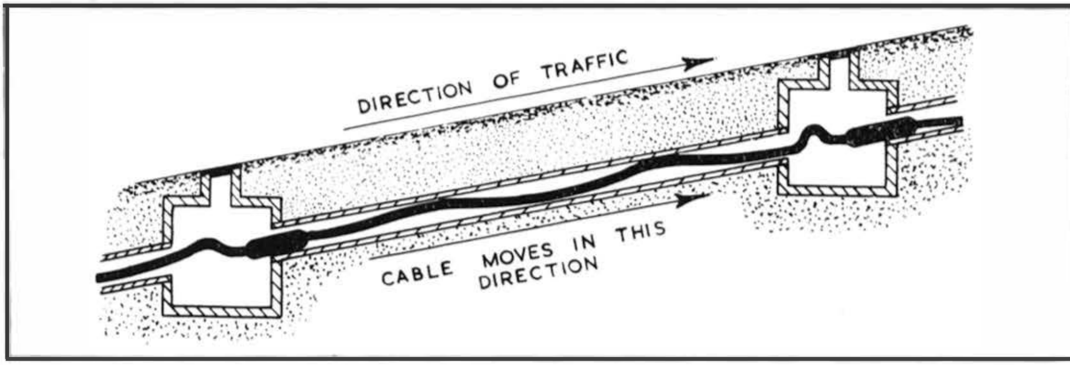
Cables sometimes move along the underground conduits in which they are installed, owing to the effects of fast-moving traffic. This "creepage" is usually found under roads with shallow foundations and where the cable lies under the wheel tracks. It is always in the direction in which the traffic is travelling, even though this is uphill.

The effect of creepage is to cause cable to pile up in one jointing chamber, where it bends and kinks, and be dragged out from the jointing chamber at the other end of the section. The tension here may be sufficient to disrupt the joint.

There are numerous methods of overcoming creepage. The most usual method is a cable anchor, which has a collar to bear against the duct mouth, and a tail which is securely lashed to the cable.

Gas Leakage

Damage is caused to Post Office plant from time to time as a consequence of leakage of town gas into underground conduits and manholes, usually owing to a fractured gas main. Apart from the danger of explosion, coal gas contains carbon monoxide which is a poison and is harmful to staff even in very small concentrations. All Post Office workers who have to enter underground chambers are provided with efficient gas detectors and as a result the majority of leaks are detected before they do any damage. The tester used depends on the colour change of sodium chlor-palladite when in contact with carbon monoxide. A spot of this liquid is applied to a filter paper and the colour changes to a light or dark brown depending on the concentration of the gas.



Cable creepage

In addition to coal gas, methane (marsh gas or fire damp) is sometimes found in Post Office plant in marshy or mining areas. This gas can be very explosive when mixed with the correct quantity of air. Similar danger has been experienced from leakage of petrol from a filling station. Both methane and petrol vapour are detected by means of an electrical hot-wire instrument which gives a direct reading of the proportion of the gas in terms of its lower explosive limit.

Carbon dioxide is tested for by means of a lamp which is extinguished by the suffocating gas.

A small electric blower fan is being developed to disperse all the above gases from manholes. The blower will obtain its power from the portable generators now in general use.

Liquids and Solids

All sorts of things find their way into Post Office conduits on occasion; for example, the drainage from a recently built bungalow was discovered to be connected to a Post Office pipe in the footway. Other unwelcome visitors are tree roots, which sometimes enter through a loose joint and eventually fill the pipe for several feet with a mass of fibrous roots.

Burn Out

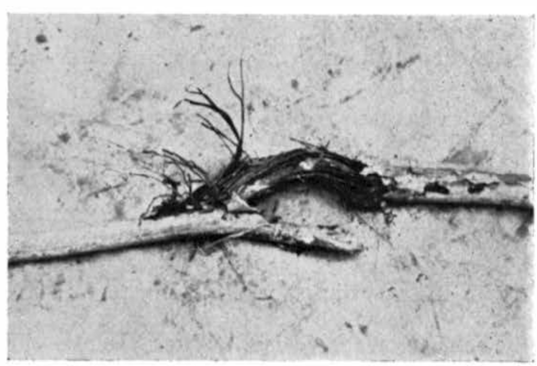
Occasionally an underground electricity A.C. supply main or service cable or a D.C. traction system feeder cable develops a fault which produces intense heat, sufficient to melt the lead sheath of an adjacent cable. Such "burn outs" are not frequent because it is the general practice to arrange as great a separating distance as practicable between the two sets of plant, with a minimum separation of not less than two inches. An electric arc may, however, sometimes be struck between the supply cable and the Post Office cable, the conductors of both sets of plant being broken or burned and the lead sheaths melted. The burning of the electric supply cable insulation may produce explosive fumes or fierce flames; in one place the insulation burned so strongly that a gas main was thought to have been set alight and it was only when the stoppage of all the trams in the vicinity was observed that the true nature of the occurrence was appreciated.

Decay of Timber

Having considered a number of subterranean enemies it is perhaps convenient to consider some which operate against plant above ground. One of the most important is decay.

Many people at some time or other have to tackle the problem of replacing the decayed wood of a

An electrical burn out



Wood-boring beetle

garden fence. They will not be surprised to learn that to the external plant engineer decayed wood presents a serious and expensive problem; serious in so far as the safety of the public, staff and plant is concerned, and expensive in the cost of renewing decayed poles.

Fungi

Decay of timber in this country is caused mainly by fungi, which are living plants deriving their nourishment from the wood. For a fungus to flourish it is essential for it to have available a food supply of oxygen and moisture. If one of these can be denied the fungus will die.

In a building it is relatively simple to deprive fungi of moisture by adequate ventilation. With telephone poles, however, this is impracticable and the only alternative is to poison the food supply. This is done by forcing creosote under pressure into the cells of the whole of the sap wood. Before a pole is treated with creosote its moisture content must be reduced to not more than 25 per cent. of the dry weight, if the creosote is to penetrate to a sufficient depth to ensure adequate protection against fungus attack. It is difficult in practice to ensure that every pole is adequately creosoted; further, the creosote also wastes away gradually due to weathering.

All the essentials for fungus life in a pole are present at, or in the immediate vicinity of, the ground line, and when the creosote remaining is insufficient to prevent attack the pole usually starts to decay in this region. Occasionally premature decay arises from insufficient seasoning, initial splits which develop after creosoting and exposure of untreated timber, or attacks by wood wasp and beetles. To find decayed poles before they become dangerous, all poles over seven years old are now subjected to a thorough periodical examination by a staff skilled in detecting decay.

Deer

Fungi are not the only attackers of telephone poles. In Highland glens deer select a pole in a deserted spot and use it for rubbing their antlers. During the rubbing the deer walks around and around the pole and the constant friction wears the pole to the shape of an hour-glass. The rubbed wood assumes a smooth and well-polished surface. Sometimes the pole actually breaks, the centre portion being worn to the thickness of a finger. As a preventive measure, a smooth wire (not barbed) is spiralled and fixed around poles likely to be selected for antler coiffure!

Woodpeckers

Woodpeckers peck out quite large holes, usually near the tops of poles, maybe under the impression that the hum of the wires indicates the presence of a tasty buried insect. Silencing the hum by lagging a short section of the wires with lead strip usually stops the trouble.

Overhead Lines

Overhead wires are still used for junctions, as well as subscribers' lines, in thinly populated areas; they are also much used in towns for the connexions between the underground cable and the subscribers' premises. The wires are, of course, erected at specified tensions, allowance being made for temperature so that contacts and breakages caused by high winds and accumulations of snow are reduced to a minimum; nevertheless the vagaries of the weather take their toll.

The effective life of the various metal fittings used overhead is much shortened by the corrosive effects of the atmosphere. Plant erected in industrial areas has often to be replaced, especially if it is near an oil refinery or gas or chemical works where smoke or sulphurous fumes are found. In some circumstances it is necessary to provide non-corrosive metal alloy fittings and to enclose the copper wires in a protective covering. Reports of wire breakages from agricultural districts suggest that the wire joints are weakened by the corrosive action of artificial fertiliser blown from the land.

Overhead lines are sometimes interrupted because boys' kites, complete with string and tails, catch in the wires. Rusty cycle chains, pieces of fence wire, tin cans and old boots are all occasionally met with in a bed of wires. Stone throwing at white porcelain insulators was at one time a considerable nuisance, but it has been practically eliminated by using black composition insulators which apparently present a less attractive target in areas where this sport is popular.

Aerial cables have their enemies. Vibration, gun shot and squirrels are a few of the hazards. The stresses and strain set up in the sheath by continual slight movement resulting from vibration, temperature changes and the wind may eventually cause the sheath to fail from fatigue. Squirrels, for some unknown reason, appear to enjoy gnawing the lead sheath. The remedy is to cut away overhanging branches over which squirrels reach the cable. When, however, squirrels climb the pole itself a deep metal band, fixed below the cable with the overlapping edges soldered to present a smooth surface, deters them.

Wires near rivers, waterways, grouse-moors and pigeon lofts are liable to be twisted together or even broken by swans, seagulls, game birds and pigeons crashing into them during take-off, flight or landing. Fortunately, some at least of these occurrences can be prevented by making the wires more easily visible to the birds; this is helped by fitting cylindrical corks to the wires at intervals in those sections of the line where trouble has been experienced or can be expected.

Power interference

Physical contact between power and telecommunications plant can be avoided by providing adequate separation between the two sets of plant and at crossings by using insulated conductors for one of the systems or by placing it underground.

The less obvious problem of induction is not so easily solved. This arises particularly under fault conditions on a power system when very heavy currents—sometimes of the order of 1,000 amperes or more—flow, causing correspondingly large voltages to be induced in any telephone wires or cables which run near to the power line. It is not always possible to provide wide separation between the two sets of plant but the magnitude of the induced current may sometimes be reduced, for example, by inserting resistance in the power transformer neutral earth connexion.

Where it is impracticable to limit the power line fault current to a sufficiently low value, protective measures may have to be applied to the telephone lines. One expedient is to connect gas discharge tubes to each circuit at intervals along the route. The gas discharge tubes normally provide very high insulation, but during periods when the electric pressure across them exceeds a certain value, the gas becomes "ionised" and conducts current very efficiently, so that the line is effectively earthed.

Another means of keeping the induced voltage within safe limits is to introduce transformers into the telephone circuits at intervals along the route, so that the length of an individual section of route is insufficient to receive a dangerous voltage.

Tree roots in duct

Whereas the induced voltages in adjacent sections would normally be additive, the transformers effectively isolate them one from another.

Underground cable circuits are less liable to power circuit induction than overhead wires, but they can be affected in this way. One possible method of dealing with the problem is to provide a high conductivity sheath to the cable; this has a considerable screening effect.

Induction does, of course, take place when power lines are working without fault, but under such conditions much smaller voltages are induced. Since the induction is continuous, however, it can give rise to noise interference if harmonics of the fundamental frequency are present. The operation of a telephone system which is under the inductive influence of a power system can become rather difficult; minor faults such as low insulation, which would normally be of little consequence, may unbalance the circuit sufficiently to make the noise level intolerable.

It is unfortunate that so many of the larger and more remote overhead routes, which are those most difficult to maintain, are in country where proximity to power routes cannot be avoided. The electricity authorities are, however, most co-operative in trying to reduce the nuisance of power interference.

We have looked at some of the worst enemies of the external plant engineer, and one may indeed wonder that the plant is so reliable in the face of such formidable foes. But our forebears designed and built well, and we owe them much for the standards they laid down.

For the future, new materials and methods are continually being tried, and there is good promise of even better performance in almost every direction.

Post Office Commercial Accounts: 1954-1955

THE *Post Office Commercial Accounts*, 1954-55, show that, for all services combined, income rose from £269.1 millions to £284.9 millions against an increase in expenditure from £261.7 millions to £279.7 millions. The net result on general account is a surplus of £5.2 millions compared with £7.4 millions in the previous year.

The telecommunications services contributed £139.5 millions of the total income and gave rise to £137.7 millions of the total expenditure. The following table analyses these figures and compares the year's telegraph and telephone results with those of the previous year.

	1953-54 £m	1954-55 £m	*Difference* £m
Telegraph Account			
Income	15.0	16.2	1.2
Expenditure ...	18.1	18.7	0.6
Deficit	*3.1*	*2.5*	*0.6*
Telephone Account			
Income	115.1	123.3	8.2
Expenditure ...	109.6	119.0	9.4
Surplus	5.5	4.3	1.2

The total capital expenditure on the Post Office system (all services) was £58.6 millions, compared with £56.5 millions in the previous year. Of this, £1.2 millions (compared with £1.7 millions in 1953-54) were spent on telegraph plant, and £49.7 millions (£46.7) on telephone plant.

Telegraphs

The Telegraph deficit was the lowest for eight years. The revenue from inland telegrams rose by £0.6 millions, the net result of the increase in charges introduced in August 1, 1954—after allowing for the consequent fall in traffic—and of a slight fall in revenue owing to the normal downward trend in traffic. Other tariff changes during the year produced a further £0.1 million.

Overseas telegrams brought in a further £0.4 million and the growth of the inland Telex service, an additional £0.1 million.

The number of overseas telegrams rose slightly from 20,356,000 to 20,859,000.

The process of adjusting staff numbers to traffic (in which the dominant factor was the decline occasioned by the increase in telegram

TELEPHONE SERVICE: 1954-1955

	1953-54	1954-55
NUMBER OF LOCAL EXCHANGES AT END OF YEAR		
Automatic ...	4,494	4,576
Manual ...	1,419	1,351
Total ...	5,913	5,927
NUMBER OF AUTO-MANUAL AND SEPARATE TRUNK EXCHANGES AT END OF YEAR	261	261
	1953-54 '000	1954-55 '000
NUMBER OF EXCHANGE CONNEXIONS AT END OF YEAR		
On automatic exchanges ...	2,748	2,976
On manual exchanges ...	1,021	1,031
Total ...	3,769	4,007
ANALYSIS OF EXCHANGE CONNEXIONS UNDER RENTAL CATEGORIES, &c.		
Business Rate —exclusive service ...	1,511	1,547
shared service ...	131	143
Residence Rate—exclusive service ...	1,400	1,425
shared service ...	611	773
Post Office Service ...	52	53
Call Office ...	64	66
Total ...	3,769	4,007
NUMBER OF STATIONS AT END OF YEAR		
Exchange Service ...	6,083	6,436
Private Circuits (telephone and telegraph) ...	53	55
Total ...	6,136	6,491
NUMBER OF APPLICATIONS FOR EXCHANGE CONNEXIONS DURING THE YEAR...	413	471
NUMBER OF APPLICATIONS FOR EXCHANGE CONNEXIONS OUTSTANDING AT END OF YEAR...	376	372
TRAFFIC—NUMBER OF CALLS		
Inland:—		
Trunk ...	277,880	306,332
Local ...	3,370,000	3,615,000
Total ...	3,647,880	3,921,332
Overseas:—		
Continental cable services:—		
Outward ...	1,629	1,816
Inward ...	1,498	1,665
Transit ...	24	29
Radio-telephone services:—		
Outward ...	84	97
Inward ...	82	95
Transit ...	20	23
Short range calls with ships:—		
Outward ...	6	8
Inward ...	40	50
Total ...	3,383	3,783

charges) led to a net reduction in staff cost of about £0.5 million. This saving was more than offset, however, by increased expenditure due to pay awards amounting to £0.8 million. Increases in other costs of £0.3 million brought the net increase in Telegraph expenditure to £0.6 million.

The sharp effect of the inland telegraph tariff increases in August is shown by a fall of 33 per cent. in traffic during the remainder of the financial year, compared with the corresponding eight months of 1953-54; for the year as a whole, inland telegraph traffic was about 25 per cent. below the 1953-54 level. During the year 19,166,000 Ordinary inland, 4,767,000 inland Greetings and 346,000 Overnight telegrams were handled. Government inland telegrams fell from 511,000 to 360,000.

Telephones

Telephone income rose owing to increased business, the main increase being from Trunk calls (£4.5 millions) followed by Local calls (£1.5 millions), Exchange rentals (£1.3 millions) and Private wires (£0.9 million).

Of the increase of £9.4 millions in telephone expenditure, £3.6 millions were accounted for by pay awards and their effect on pension liability; £0.7 millions of this represented the full year effect of 1953-54 increases. Other staff cost increases amounted to £1.9 millions. There was additional depreciation provision of £1.8 millions; increased interest charges on plant capital accounted for £1.5 millions, and there was a net increase of £0.6 million under accommodation and other items.

Local call traffic increased 7 per cent. and trunk call traffic by 10 per cent. Traffic over the continental cable and the radio-telephone services increased by 11 and 18 per cent. respectively.

During the year 353,000 additional telephones were added to the public system. The number of speech channels over 25 miles long in use on March 31, 1955, was 21,115—an increase of 877 during the year.

The table presents several other significant telephone statistics.

Direct radio-telephone links with East Pakistan, Lagos and Nigeria were opened during the year and new services were introduced with Portuguese Guinea, the Faroe Islands, Ethiopia and the Virgin Islands. In addition radio-telephone links were established with 13 ocean liners and alternative routes were provided to Turkey, Norway and Japan. The radio-telephone service to the Persian Gulf was extended to Doha and Muscat.

The main development during the year, however, was the start in the United Kingdom and North America of the construction of the Transatlantic telephone system.

Inland Telecommunications Statistics

	Quarter ended 30th September, 1955	*Quarter ended 30th June, 1955*	*Quarter ended 30th September, 1954*
Telephone Service			
Gross demand	128,810	129,803	110,567
Connexions supplied	105,195	108,615	98,703
Outstanding applications	383,949	377,240	372,318
Total working connexions	4,141,393	4,075,676	3,869,858
Shared service connexions	1,007,677	965,110	815,112
Traffic			
Total inland trunk calls	87,313,000	84,164,000	79,068,000
Cheap rate	24,052,000	22,071,000	21,319,000
Inland telegrams (excluding Railway and Press) ...	5,653,000	5,394,000	7,276,000
Greetings telegrams	1,179,000	1,028,000	1,402,000
Staff			
No. of telephonists	48,195	48,001	46,933
No. of telegraphists	7,104	7,376	8,067
No. of engineering workmen	60,793	59,932	56,264

Ireland's Mansion, Shrewsbury, 1575

SHREWSBURY TELEPHONE AREA

Shrewsbury with its castle-crowned hill and its ancient black-and-white timbered houses stands on a peninsula formed by a sinuous bend of the River Severn. This town, which is entered from England by crossing the English Bridge and from Wales by crossing the Welsh Bridge, has always been famous as a gateway to Wales and is symbolic of the interplay between the Welsh and English people through the centuries. First came the period of struggle and combat, as witnessed by the walls and ramparts that still exist: later the unifying of the two races symbolised by the Anglo-Welsh character of Shrewsbury.

Like the town from which it is administered, the Shrewsbury Area has a strong Welsh flavour, for here England gradually changes from the robustness of the Midlands to the lilt and fantasy of the Welsh hills as one travels from the Border Counties through the heart of Wales by Plynlimon and Cader Idris to the coast of Cardigan Bay. From industrial East Shropshire to Aberystwyth, from Denbighshire to Monmouth via the Shropshire hills, Hereford and the Wye Valley—here, surely, is some of the most beautiful scenery in the country.

A feature of the 4,400 square miles of hill, dale and coast, is the isolation of so many of the houses and farms and the scattered districts. One result of this is the abnormally high wire mileage per subscriber and the large number of small exchanges.

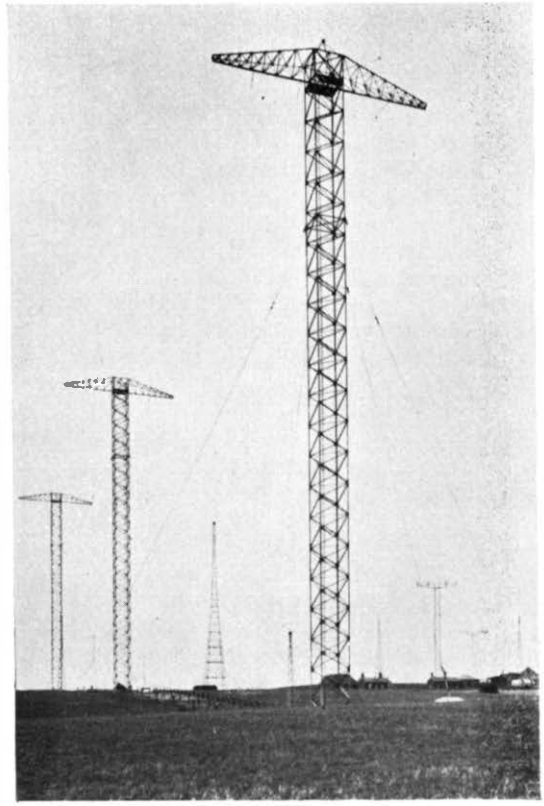
There are 226 exchanges in the Area, 176 of which are automatic. They serve about 35,500 exchange connexions with some 55,000 stations.

Many of the 1,200 staff are out-stationed mainly at Wellington, Hereford, Newton, Llandrindod Wells, Machynlleth and Aberystwyth.

Left to Right: C. BARRY, A.M.I.E.E., Area Engineer; G. J. ALSTON, A.M.I.E.E., Area Engineer; F. BATE, Telephone Manager; J. H. ANSTEE, Chief Telecommunications Superintendent; F. W. IRELAND, Chief Clerk; K. P. GOODER, Senior Sales Superintendent.

Ongar Radio Station 1920-1955

A. R. Lash, M.I.E.E.


New York Beam Masts (*Marconi's Wireless Telegraph Co., Ltd.*)

ONGAR RADIO TRANSMITTING STATION IS situated in West Essex 18 miles from London and four miles east of Epping. It occupies a site of some 730 acres, the highest point being 325 feet above sea level and the lowest 263 feet. It was originally built in 1920 and operated by Marconi's Wireless Telegraph Company. In September, 1929, control passed to Imperial and International Communications when the telegraphic communications of the Empire were placed in the hands of a single operating Company. The name of the Company was changed to Cable and Wireless Ltd. in June, 1934, and the Company owned the radio stations until the passing of the Commonwealth Telegraphs Act, 1949, whereby the United Kingdom radio services of the Post Office and of Cable and Wireless Ltd. became integrated on April 1, 1950. The control of the radio stations, at first vested in the Engineer-in-Chief's office, was transferred to the External Telecommunications Executive on April 1, 1953. These dates have figured prominently in the Station's affairs; nevertheless, the traffic has continued to flow steadily despite the vicissitudes of transition and the changes in stationery.

Although the official title of the Station is Ongar, both the entrances to the site are in North Weald. The position is further complicated, as the postal address is Epping. Those who are fortunate, or unfortunate enough, to occupy the 400-year old staff house on the site known as Ongar Park Lodge find themselves residing in Stanford Rivers. This confusion of place-names is not without its difficulties, as the four spots on the map of the Central London Line denoting Epping, North Weald, Blake Hall and Ongar appear with equal prominence.

A question which is frequently asked is, "why was the site chosen so close to the R.A.F. North Weald Aerodrome?" A complete answer is as complicated as the problem of the chicken and the egg; nevertheless, it can be explained away by inferring that the masts with their lights attached form excellent lamp-posts for the pilots to find their way home on a dark night. "Ongar" developed as a radio station long before radar was discovered. It speaks well for the stability of the early training planes that, on the only occasion when one came in contact with the wires, both pilot and pupil landed safely in a hedge well within our boundaries.

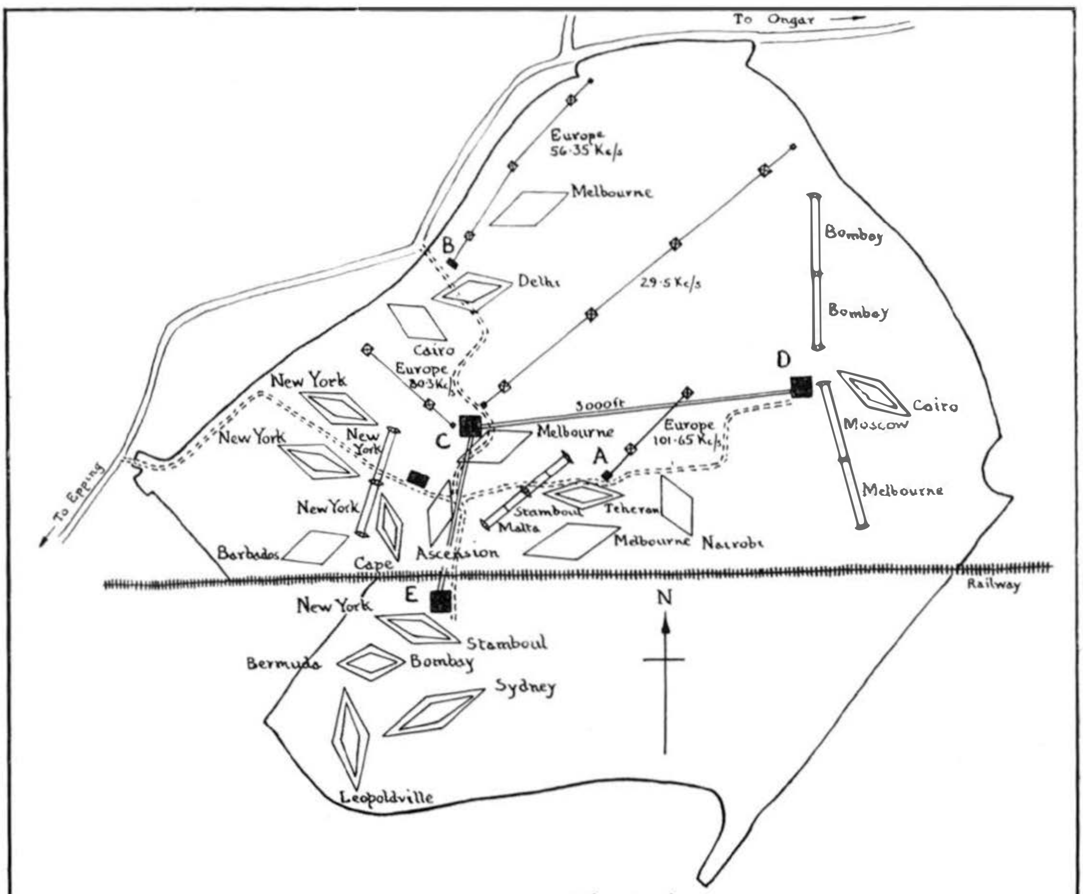
The Battle of Britain pilots made the name of North Weald famous even to those who had never heard of "Ongar". The high spot occurred when a flying bomb struck the superstructure of a 300-foot tower and exploded on impact. This million to one chance crippled the mast but probably saved part of the village of North Weald from destruction. A "near miss" occurred when a "doodlebug" passed right underneath one of the aerials with a fighter plane hot on its tail. Realizing the obstruction ahead, the pilot with great presence of mind let go everything he had and followed the "doodlebug" on its journey towards London.

Like many a great undertaking, Ongar Radio had small beginnings. The original scheme provided for four transmitters housed in three buildings, two being in "A" Station, one in "B" and one in "C". As mains power supplies did not come this way at the time there was also a power house with three Vickers-Petters semi-diesel engines coupled to D.C. generators. Believe it or not, these prime movers are still here.

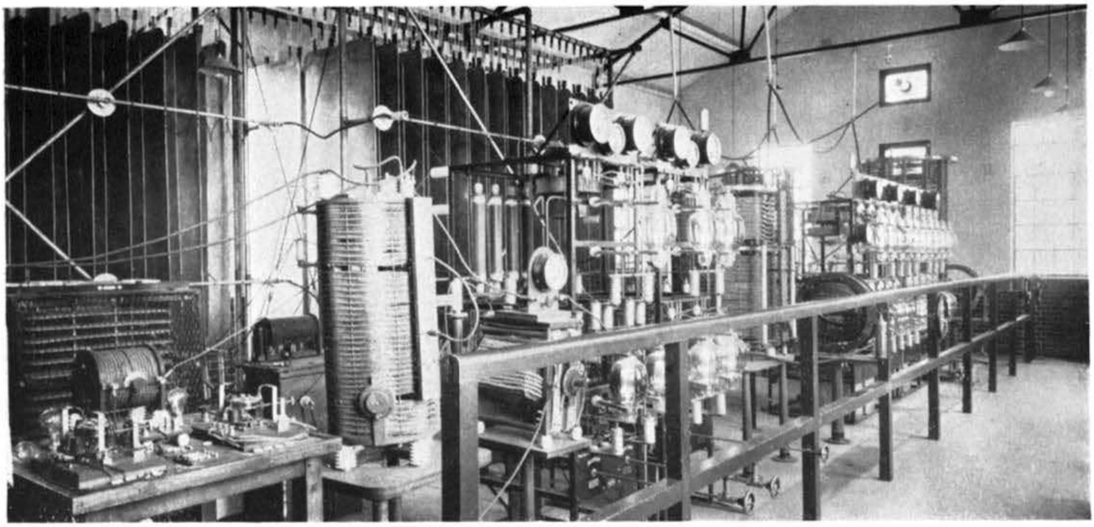
As "A", "B", "C" Station and the power house were separated by distances of up to half a mile, shift keepers were allocated to each building. The Post Office lines for the telegraphic signals were fed into the power house shift office and the recorded position in the Berne List of 00° 10′ 47″ E., 51° 42′ 47″ N. marks this spot until the present day.

The first radio-telegraphic services from Ongar in 1921 connected London with Paris and Berne,

A generalized diagram, not drawn to scale



Ongar Transmitting Station.



" B " Station 25 kW transmitter, 1924 (*Marconi's Wireless Telegraph Co., Ltd.*)

using morse code at a speed of about 80 words a minute. These transmitters were designed to operate simultaneously from "A" Station and the signals were mixed and radiated from one aerial on two different frequencies. It is to be hoped that no one will re-discover this ingenious system, as I understand the economy in masts and aerials was more than outweighed by the heavy responsibilities thrust on the engineering staff, whose duty it was to prevent these two frequencies becoming mixed up inside the building. Several of the founder members of Ongar Radio Station migrated from the Marconi Works, Chelmsford, so were accustomed to the dangers and thrills of those early transmitters where a simple wooden barrier separated life from death.

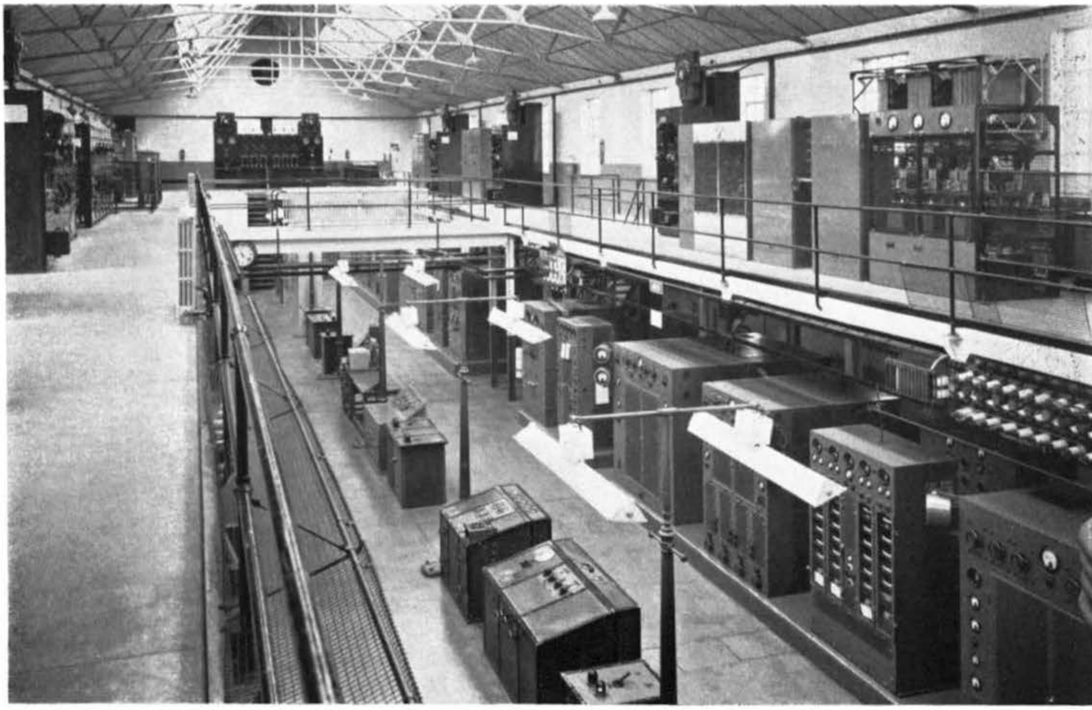
For the benefit of those born into the days of short wave, bands III, IV and so on, it may be of interest to recall that until 1924 commercial radio was restricted to long wave transmission with frequencies measured in kilocycles. Progress was slow until the radio-telegraph companies realized that the hitherto unwanted short waves found a reflecting layer in the ionosphere to aid their traverse across the earth's surface.

The first short wave transmitters installed at Ongar were GLS and GLQ, known as Gee London Sugar and Gee London Queenie (18,595 and 10,930 kc/s respectively), both rated at about 6 kW. They were installed in 1924 adjacent to the old "C" Station building and radiated from simple harmonic aerials: just pieces of vertical wire of no specific length. A new era had begun in radio. These frequencies are still in constant use by Ongar 21 years later. The original "A", "B" and "C" buildings remain until the present day but they are ghosts of the past and have long since run unattended.

It was C. S. Franklin's development of the short wave beam aerial in 1926 that changed the outlook for long distance radio communication almost overnight. The basic principle was simple: if the energy radiated could be concentrated into a narrow beam it would arrive at the receiving station with added impact. The mathematics of the designers enabled the engineers to construct the aerials so that the signals would be reflected back to earth from the ionosphere just where they were required. At least, that is how it was intended to be.

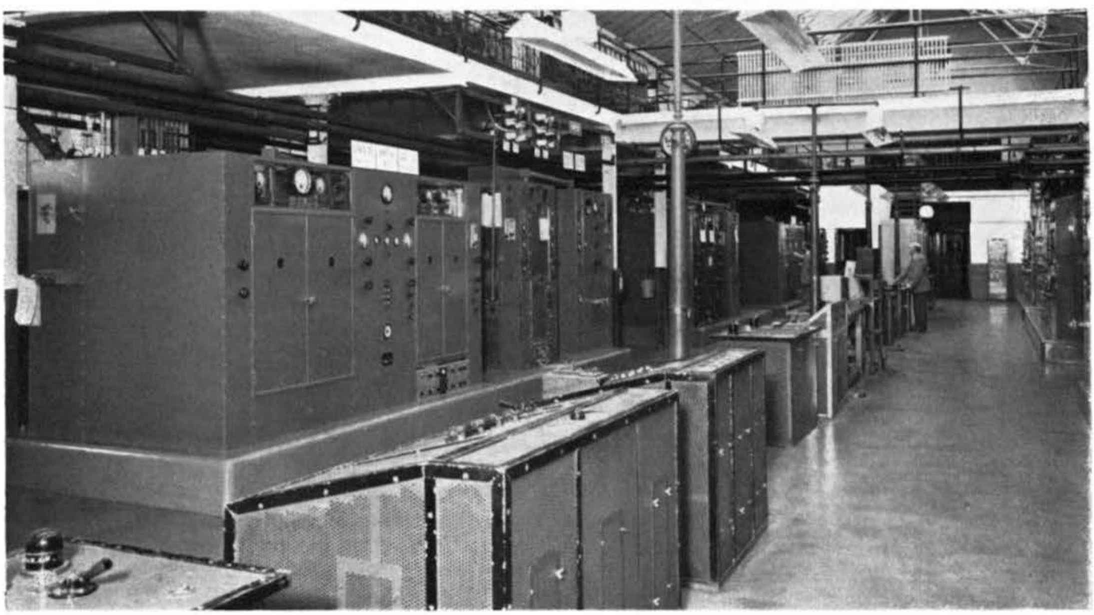
The beam masts and aerials still remain structures of great dignity and, 25 years after their erection, their efficiency has not been surpassed by later designs for the particular routes and frequencies on which they are employed.

The main feature of the Franklin Beam which distinguishes it from the rhombics so extensively used at other Post Office radio stations is that the Franklin has two curtains of wires; one is fed by a system of concentric tubes from the transmitter



"C" Station short wave hall showing H.T. rectifiers and switchgear on the gallery; C6 40 kW. short wave transmitter on right and control tables in centre of hall

"C" Station short wave hall: rebuilt SWB 1 on left with SWB 8/10 to right on same plinth. Power distribution boards are on the gallery and control tables in foreground



while the other curtain, which is either half or three-quarters of a wavelength behind, acts as a reflector. The limitation is that it is suitable for only one frequency. The cost to-day would also be far greater than that of a rhombic and the maintenance requires a higher degree of skill. If one of the elements of the curtain becomes damaged it is necessary for a rigger to proceed along a triatic from pole to pole, rather like a tight-rope walker except that he travels underneath the wire instead of on top. A circus artiste might consider this a disadvantage, as every obstacle met with means transferring the point of suspension from one side to the other. If the centre element is in need of attention the rigger may have to pass 15 obstacles before he reaches the point 300 feet from a mast with 270 feet of space beneath his feet.

"C" Station Short Wave Transmitter Hall as it stands to-day was completed in 1931 when five SWB 1 transmitters were installed. The initials denote Short Wave Beam 1, not "Swab" as they and their successive editions were affectionately referred to by the Forces.

As can be seen from an early photograph the original SWB 1 with its brass trimmings stood on a plinth of considerable dimensions. The open construction was not without its advantages because one could see what was going on inside. A red lamp indicated that the high tension power was on and the spinners in the glass tubes showed that the cooling oil was passing round the anodes of the larger valves. There were no other gadgets to go wrong and safety depended entirely on the senses of smell, hearing and sight of the Technical Assistants, two of whom were on watch without even an Assistant Engineer to keep them company. The morse signals came down the lines from Radio House (the Marconi station in London) where the operators punched out the messages and the amplifiers at Ongar stepped up the voltages until the full radiated power of the transmitters was chopped into dashes and dots.

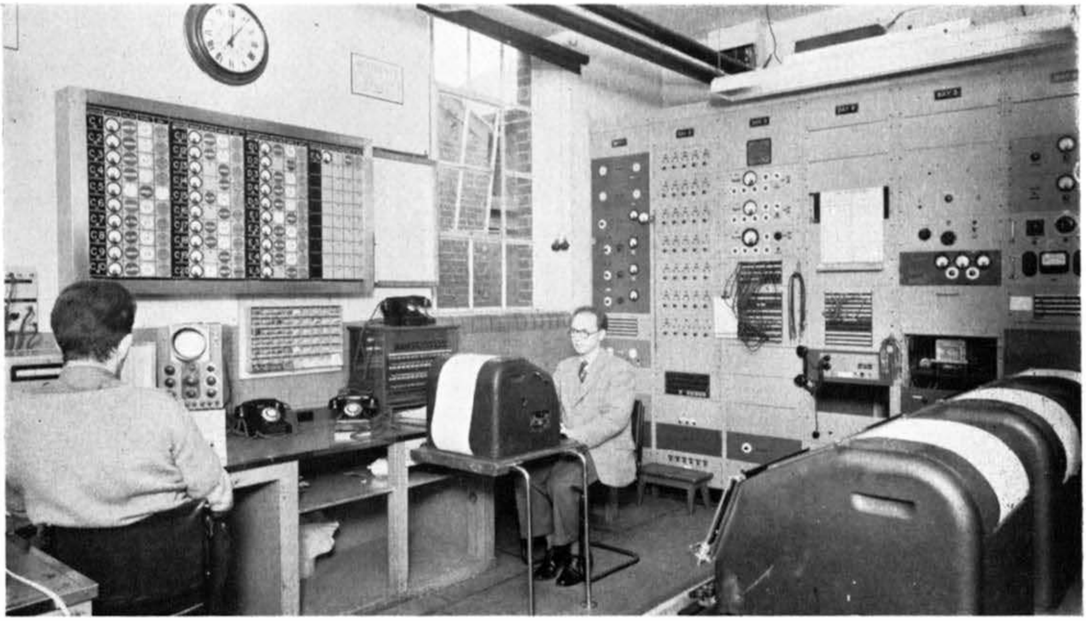
Ongar has never looked back since those early days and the story has been one of continual progress. First, the long wave transmitters were replaced by modern types installed in the new " C " Station building. Then a new giant by way of a 120 kW long wave transmitter was installed in Ongar to replace GLC of Caernarvon fame, which was due for scrapping. The gaps in the short wave building were gradually filled with transmitters; then, when more floor space was required, the SWB 1s were cut down to half their size without loss of power and four SWB 10s were installed alongside the SWB 1s on the portions of the plinths left vacant as shown in the photograph. During 1939 and 1940 the original SWB 1s were converted for cooling by water instead of oil to reduce the risk of fire from incendiary bombs.

With the closing down of the Tetney Transmitting Station in 1943 a further concentration of the Cable and Wireless services was brought about by re-erecting the Tetney masts and beam aerials at Ongar. To avoid long lengths of feeder between the transmitters and the aerials a new building known as "D" Station was erected about three-quarters of a mile from the main Station. "D" Station was probably the first transmitting station built in this country to run entirely unattended except for occasional visits from maintenance staffs. Four 25 kW short wave water cooled transmitters were installed to take over the services to Bombay, Melbourne and Moscow while the fifth transmitter known as D1, of an advanced design, communicated with Cairo and the Middle East.

Star Exhibit

For many years D1 was the star exhibit of Ongar radio as it bristled with features. From a distance of three-quarters of a mile this 20 kW transmitter could be started up, any one of four frequencies selected, and the transmitter tuned and connected to the correct aerial—all in 30 seconds. The electric motors, chains and cams which sprang into action to perform such operations with precision did credit to the ingenuity of the Marconi's Wireless Telegraph Company's designers, for D1 was the first high power air-cooled transmitter to run by remote control. So ambitious was the specification that it even included provision for shifting the frequency up or down to avoid jamming at the receiving end.

By 1944 "D" Station was completed with all five transmitters working unattended. Another building to be known as "E" Station was under way for further expansion of the telegraphic services. As this was built on the south side of the railway and it was not permissible for aerials to cross the railway lines, it was designed for six transmitters and a self-contained group of rhombic aerials. The transmitters were of the normal SWB 8/10 type modified locally so that they



Control Room " C " Station: monitoring position on left, operational position on right and transmitter disposition board below clock

could be started, stopped and the directions of their aerials changed by remote control at a distance of about half a mile from the Main Station.

Radio engineers sometimes dream of a transmitting station where every piece of apparatus from the landlines to the aerials is interchangeable. This dream may become a nightmare if carried too far, as complexity is likely to overshadow flexibility when powers of 20 kW or so are involved. Ongar has struck a middle course by providing full flexibility for aerial switching in "C" Station, which is the only transmitter building continuously manned, and limited facilities for switching at the remote stations, where the transmitters are allocated more or less fixed directions for their services.

The coaxial feeder commutator in "C" Station was installed in 1946 and gives full flexibility of connexion, manually between 14 short wave transmitters and 28 aerial feeders. Further sub-division is obtained through remote-controlled feeder switches which increase the choice of aerials to 52 covering all the important telegraph routes from this country. Another interesting switching circuit was designed to enable any one of the 14 "C" Station transmitters which may be idle to substitute for any one of the "D" Station transmitters taken out of service because of breakdown or maintenance.

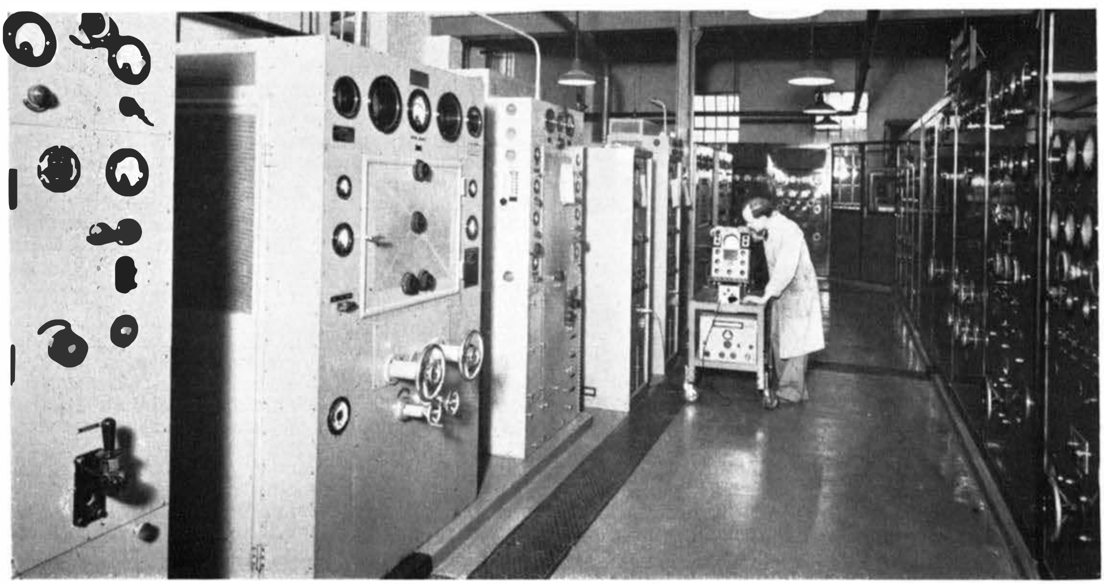
It is common practice for 26 of the 31 transmitters to be radiating simultaneously during the peak traffic periods of the afternoon and evening. This represents a load of over 800 kW from the power supply and some 280 kW of energy radiated into space. By the use of modern telegraphic systems and codes one transmitter may be sending as many as four telegrams simultaneously so the traffic handling capacity is very considerable. Other codes have error-detecting qualities to ensure that the telegrams are printed correctly at the other end of the circuit. Again, two different pictures may be transmitted simultaneously on the transmitters which employ single side-band transmission.

The complexity of circuits and the mechanization of equipment has shifted much of the responsibility for the efficient operation of the station to the Control Room and Maintenance staffs. The failure of any transmitter is instantly indicated in the Control Room, where appropriate action is taken to deal with the defect.

Fortunately such failures are few, as preventive maintenance, which is allocated at the rate of one shift a month to each transmitter, eliminates nearly all faults except valve failures. More than 1,500 valves are in use, directly connected with the transmission of signals. One test instrument alone has 80 valves in circuit. This ingenious piece of apparatus will count any number from 1 to 7 million in one second to an accuracy of one in a million; furthermore, it is prepared to go on counting frequencies every second of the day.

There is also a frequency synthesizer, a masterpiece of ingenuity developed by the Radio Research Laboratories at Dollis Hill, which can instantly provide any frequency of oscillation between three and 7 million cycles per second in steps of 250 cycles and maintain the constancy within one part in ten million. Then there is the spectrum analyser which displays the complete radiation pattern on the tube of an oscilloscope. When all these instruments fail to give an answer one usually falls back on the lineman's galvanometer to verify whether a conductor has two ends!

What strikes visitors to Ongar most forcibly is the extent to which the transmitters are left unattended. It is quite exceptional to see any signs of active human life in the transmitter buildings, even at the Main Station. The Control Room is the only section which is manned continuously—by two technical officers. This desirable state of affairs, where the transmitters more or less look after themselves, has been brought about to a large extent by the efforts of the Station staff. The aim has been for every assistant engineer, technical officer and technician to be able to work with his hands as well as his head. When attempting to attain the ideal, one must always be satisfied with something short of perfection; nevertheless, the opportunities and encouragement given for creative work have resulted in employment at Ongar Radio Station being considered something more than a livelihood by the majority of the staff. Until comparatively recently, all maintenance, modernization and installation work was carried out by the regular station staff. Whereas watch-keeping duty has always proved either a feast or a famine owing to the exigencies of the service, the work of maintenance and construction is spread evenly over the working hours. The achievements may be judged by the "New Look" which has recently been given to the original SWB1 transmitters. Designing, cutting, welding, refitting and paint spraying these old timers has improved



"C" Station annexe: long wave transmitter to right and end of hall and SSB transmitters on the left

their appearance out of all recognition and the degree of safety is now in accordance with the very highest standards, as will be gathered from the photographs.

When thinking of Ongar Radio Station one cannot dissociate it from the farm and the use made of the land beneath the aerials. Out of the total acreage of 730, no fewer than 322 acres are under intensive cultivation and a further 347 acres are used for grazing. The abundance of wheat, barley, oats, sugar beet and potatoes testifies to the excellence of the husbandry, as also does the fine herd of 70 Friesian cows, who all receive their sustenance from what is now Post Office land. The tenant farmer will not admit that the earth losses from our radiating systems are responsible for his good fortune; however, it is of some satisfaction to know that fat cattle may be considered a by-product of radio telegrams.

Our Contributors

J. I. CARASSO ("Transistor Materials") is a chemistry graduate, working on the chemical aspects of semiconductor devices in the Research Branch of the Engineering Department. He came to the Post Office in 1949 from the West Midlands Gas Board, where he was employed as an Analytical Chemist. During the war he served in the Royal Hellenic Navy, and obtained British nationality on demobilization.

N. DUNCAN ("Enemies of the External Plant Engineer") for the past five years has been an Executive Engineer in the Engineer-in-Chief's Office, Construction Branch, engaged on external maintenance of overhead and underground plant. He entered the Post Office as a boy messenger at Dundee in 1915. Two and a half years later, he became a Youth-in-Training in the Engineering Department. After 18 years' service, he was promoted to Scotland West (North) Area as an outstationed Inspector, rising to Chief Inspector in 1942 and later to Assistant Engineer in 1946.

JAMES F. GATES ("Post Office work for I.T.A.") is an Assistant Engineer, and has been with the London Telecommunications Region Engineering Branch, Equipment Group, since 1939, except for six years with the Royal Corps of Signals, from which he returned with the rank of Major. Since 1946 he has worked on transmission equipment for telephony and television, including work on behalf of the I.T.A. He entered the Post Office in 1938, by open competition, as a Probationary Inspector.

C. O. HORN ("Telephone Exchange Planning in London") is the Deputy Regional Director (Planning) of the Post Office London Telecommunications Region and a member of the Editorial Board of the *Journal*. His previous contribution was "Before the Building Starts—" in the November, 1954—January, 1955, issue. He is a B.Sc.(Eng.), Associate of the City and Guilds Institute, and a Member of the Institution of Electrical Engineers.

During his Post Office career he has been a Probationary Engineering Inspector (1922), first Assistant Officer-in-Charge, Rugby Radio Station, and Sectional Engineer, Coventry. He was one of the first of the Telephone Managers (Leeds) to be appointed as the result of the Bridgeman Committee's recommendations in 1932. He then became a Telecommunications Controller, first in Scotland, and then in the Home Counties Region. During the last war in 1942-1944, he was seconded to the Inland Telecommunications Department for special (War Group) duties.

F. A. HOUGH ("Expedition to Newfoundland") was transferred to the Transmission and Main Lines Branch, Post Office Engineering Department, in 1953 to help with the work for the Transatlantic Telephone Cable. He is a M.Sc.(Eng.) and an Associate Member of the Institution of Electrical Engineers.

He entered the Post Office by open competition on January 1, 1932, as Assistant Engineer in Scotland, where he served in Section, Area and Regional offices until 1939. On return from war service with the Royal Engineers he was appointed Area Engineer in Bournemouth from January, 1946, until April 1, 1949, when he was sent as an Assistant Staff Engineer to the Organization and Efficiency Branch, Engineering Department.

A. R. LASH ("Ongar Radio Station"), who is a Member of the Institution of Electrical Engineers and Manager-Engineer, Ongar Radio Station, joined Marconi's Wireless Telegraph Company in 1920. After training at the Chelmsford works, he served at Towyn Transatlantic Receiving Station, Calypson Bay, Spitzbergen, while on loan to the Northern Exploration Company; the Falkland Islands, in charge of the Colonial Government Radio Station at Port Stanley, and Lisbon, with the Companhia Portuguese Radio Marconi. Since returning home he has served at Caernarvon and Ongar Radio Stations.

R. H. McGANN ("Telephone Service at Hotels") has been Deputy Controller of Telephones in the London Telecommunications Region since December, 1950. After some years spent in Provincial areas and Regional Headquarters offices—and a short spell at Post Office Headquarters—he moved to the newly-formed Long Distance Area in the London Telecommunications Region in 1943 and to L.T.R. headquarters in 1947. He has written previously for the *Journal*, contributing an article on "Telephone Service for Government Depts." in the May, 1955, issue.

E. W. SHEPHERD, B.Sc. ("Post Office Finance—An Outline"), is Deputy Director of Finance in the Post Office. He joined the Accountant General's Department in 1932 as an Executive Officer, returning in 1946 as a Higher Executive Officer, after six years of war service. In 1948 he was promoted Principal, serving in the Overseas Telecommunications (now Radio and Accommodation) Department for a year before being seconded to the Treasury from 1949 to 1952. He came back to the Post Office as an Assistant Accountant General, becoming a Deputy Comptroller and Accountant General in 1953. Mr. Shepherd was appointed to his present position when the post of Director of Finance and Accounts was first created in 1955.

Notes and News

The G.P.O. London Television Centre.—Our picture shows the paraboloid aerial, which is to be used for beaming the I.T.A. programmes to Birmingham and the Midlands, on the roof of the Television Control Centre.

The Post Office Television Control Centre in London came into being when it was decided to extend the B.B.C. Television Service to the provinces. The function of the Centre is to operate and control the complex network of Post Office cables and radio links used to distribute the television programmes.

New equipment is being installed to connect the studios of the Programme Companies, switching centres and the Independent Television Authority transmitters and will be used to link up with the I.T.A. transmitters in the North. The London-Birmingham radio link is being modified to form the first link to the I.T.A. transmitters in the North.

★ ★ ★

P.O. Cable and Wireless.—As the overseas traffic handled by the Leeds Post Office Cable and Wireless Office was insufficient to justify the heavy overheads, the office was closed in January, 1955. The work and some of the staff were transferred to the Leeds Head Post Office where a portion of the counter was fitted with suitable signs and publicity material. A similar arrangement will also be made at Sheffield early this year.

Again, at Newcastle-on-Tyne Head Post Office an overseas telegram and counter position has been fitted. Associated with the counter is a specially built cabinet from which overseas telephone calls can be made.

★ ★ ★

Guide to Broadcasting Stations 1955-56.—Nearly 50 per cent. of the medium wave broadcasting stations in Europe are operating on frequencies not allocated to them under the international plan drawn up at Copenhagen in 1948 says the *Wireless World* in a note sent with its *Guide to Broadcasting Stations*, 1955-56 (Iliffe & Sons: Price 2/6d.). The *Guide* lists geographically, and in order of frequency, all the 650 stations operating on long and medium waves, and some 1,600 operating with a power not less than one kilowatt. Operating details of Europe's 300 or more V.H.F. stations and 130 television transmitters are also included.

★ ★ ★

New Chairman for C. & W. Ltd.—Sir Godfrey Ince, G.C.B., K.B.E., became Chairman of Cable and Wireless Ltd., and its associated companies on February 1. He has been Permanent Secretary of the Ministry of Labour and National Service and retired from the Civil Service in January. He will be part-time Chairman. Mr. Norman Chapling, C.B.E., and Mr. H. H. Eggers, C.M.G., O.B.E., are joint managing directors.

Sir Godfrey succeeds Major-General Sir Leslie Nicholls, K.C.M.G., C.B., C.B.E., M.I.E.E. (formerly Chief Signals Officer to General Eisenhower) who became a director in 1947, becoming Chairman in 1951.

The Company's head office has moved from Electra House, Victoria Embankment, to a new building, Mercury House, Theobald's Road, London, W.C.1. The Post Office Cable and Wireless Telegraph Station at Electra House will be enlarged.

Hungary Introduces New Telephone.—The manufacture of a new style telephone has begun in the Beloiannis Telecommunications factory in Budapest, Hungary.

Its main features are the more modern design, louder and clearer speech, and the placing of the numbers on the outer band instead of the dial to obviate dialling errors.

★ ★ ★

"Museum" Building Extension.—Howland Street Building (London Centre Telephone Area), which includes Museum exchange and Television Control among its offices, is to be extended. Ultimately it will be one of the largest Post Office buildings in the area and will house University Automatic Exchange, a Trunk exchange, a Directory Enquiry Centre, Centralized Observations, and engineering and motor transport stores. The present television mast will be replaced.

★ ★ ★

Television—"In the Air"!—The 32-position C.B.10 P.M.B.X. which for many years served the Air Ministry at "Adastral House", Kingsway, London, has been adapted in two separate sections to provide telephone service initially for the new tenants of the building. They are the Independent Television programme contractors—Associated Rediffusion Ltd. and Associated Broadcasting Co. Ltd.

(Associated Rediffusion Ltd., one of the I.T.A. programme contractors, was formed by Associated Newspapers Ltd., with Broadcast Relay Services Ltd., and not, as stated in a recent issue, British Relay Services.)

Two new installations, a 500-line P.A.B.X. and an 8-position P.M.B.X1.A. are planned, and work on these is now proceeding in the renamed building—"Television House". Per Ardua Ad Astra and all that!

★ ★ ★

New Network for Sheffield firm.—Globe & Simpson, a Sheffield firm of vehicle electrical and diesel injection service engineers with a nation-wide business, has completed negotiations for a tariff H network of an annual rental value of £9,400.

The firm's area offices up and down the country will be linked to the Sheffield office, where a teleprinter switchboard No. 13 is to be installed. At the Sheffield office there will be two internal teleprinters in addition to the operating machine. The switchboard will afford full inter-communication facilities for all outstations and full or partial broadcast facilities may be arranged from any point. This feature is particularly helpful as the two main area offices, Bristol and Glasgow, have, on occasion, to broadcast information to their branches in other parts of the country.

★ ★ ★

A Career Abroad.—Cable and Wireless Ltd. have issued a revised edition of their recruiting booklet, *A Career Abroad*. The booklet aims to interest young men in training for a career among the 730 British personnel, known as the Foreign Service Staff, who do the administrative and engineering work in the 132 stations in British overseas and foreign territories, supervising approximately 8,000 locally recruited staff of some 57 races. A map of the system, schedules of salary scales, and an application form are included loose in a pocket inside the back cover.

★ ★ ★

"TIM" to Check TV Programmes.—"TIM," the speaking clock, is being fed continuously into Associated Broadcasting Company's Master Control Room on to a tape recording of the programme to be broadcast, to check whether the programme was radiated on time.

The photographs in the article "Training in Telephone Supervision", pp. 39-42, in our last issue were reproduced by courtesy of *The Yorkshire Post*.

North-East Gale Damages Telephone Service

The north-east gale which swept across England on Sunday, January 8, dislocated the telephone services over a wide area. Considerable damage was done on the coastal belt from Tweed to the Wash and inland across the Yorkshire and Lincolnshire wolds.

On January 16, the *Yorkshire Post* reported that it was one of the worse blizzards Lincolnshire had ever experienced and summarised it by saying that "for seven hours a violent north-east gale swept across Lincolnshire. At temperatures below freezing point, heavy snow driving in the wind settled to depths of 14 to 18 inches. In those few hours between 6 a.m. and 1 p.m. roads became impenetrably blocked, telephone wires were torn for mile after mile, poles crashed across country lanes, farm buildings caved in under the weight of snow. More snow fell on Sunday night, the countryside was turned into a 'stricken zone'."

In the triangle Lincoln-Grimsby-Skegness the storm damaged or brought down some 2,500 poles and put 5,000 telephones out of action. Heavy damage was also done to the services between Whitby and Humber.

Post Office engineers set up a Storm Control Centre at Louth, in the middle of the Lincolnshire Wolds, where vehicles were controlled by radio. Engineers, vehicles and plant were drafted in on loan from Leicester, Nottingham and Peterborough.

Boston, Skegness, Mablethorpe, Alford and Spilsby, and the villages between them, were virtually cut off from the rest of the country at the height of the storm—Boston for 26½ hours and the other places for the rest of the week. These towns and villages were also affected by an electricity breakdown caused by the weight of snow bringing down overhead cables. The main power supply to 30 exchanges was interrupted.

Exchanges which lost their power supply were kept going on batteries. The engineers had to drive emergency charging plant along roads almost impassable owing to deep snow. Some of the exchanges' emergency batteries were almost exhausted by the time the plant arrived. In many places telephone service had to be temporarily restricted to essential subscribers. In the Lincolnshire area over 3,000 subscribers' faults were reported. By Wednesday, January 11, ten emergency generators were in use.

The Chief Signals Officer, Eastern Command, and United States Air Force Signals gave valuable assistance.

Publication and Price. This *Journal* is published in November, February, May and August. Price 1/6. The annual postal subscription rate is 6/6 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 4345. Remittances should be made payable to "The Postmaster General" and should be crossed "& Co."

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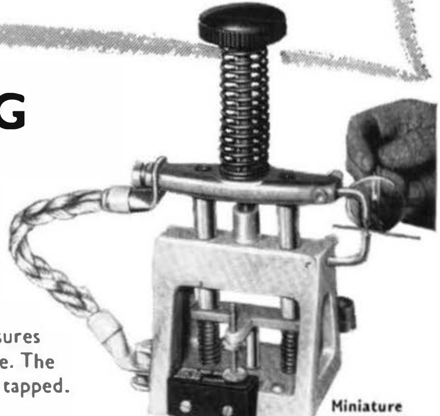
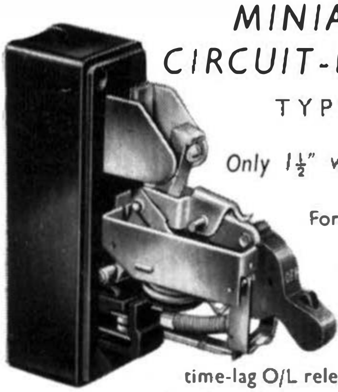
Vertical movement of the upper electrode allows accurate alignment of the work; electrode pressure is variable without increasing foot pressure.
The pilot initiating switch has a micro-adjustment, and the electronic timer ensures accurate, high-speed repeat performance. The large capacity transformer is secondary tapped.



Miniature Spot Welder WPO 5.

AUTOMATIC PROTECTION



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For power and lighting circuits up to 30 amps 250 v. Instantaneous short-circuit and Thermal time-lag O/L releases. Neutral link. Breaking Current capacity 4700 Amps.

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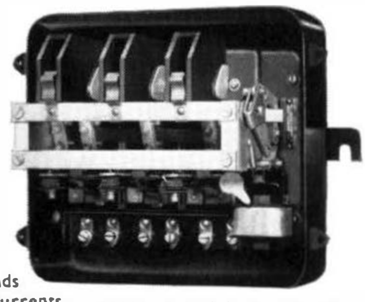

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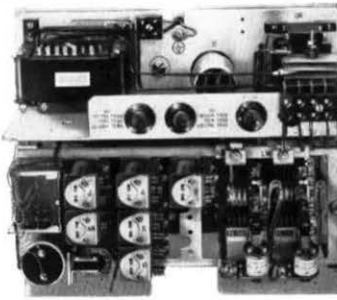
MEMO TO TELEPHONE ENGINEERS

Something here you'll be looking for.

Cut out this page for reference!



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A switchboard for ten lines, with one connecting circuit (allowing one conversation at a time) and built-in mains unit. Wall mounting, strong metal cabinet.

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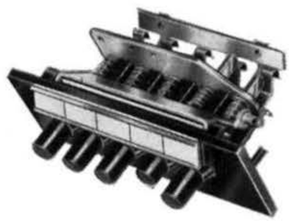
A compact and efficient Buzzer D.C. resistance 10 ohms. Operates from 6 volt supply. Special resistance coils can be wound to suit individual requirements.



PRESS BUTTON UNITS

Interlocking self-releasing units, can be coupled to form banks of 20 buttons.

HAND MICROTELEPHONE

Complete with 3-way flexible cord. Can be supplied with extra sensitive receiver if required.

MAGNETIC RELAYS

Wound to suit your individual requirements.

JUNCTION BOX

Well-designed Bakelite housing for two 20-way terminal strips. Strips can be supplied separately if required.

SEALED JACK

Suitable for P. O. 'A' gauge Plug. Ideal for pressurised and watertight equipment. Auxiliary contacts can be incorporated.

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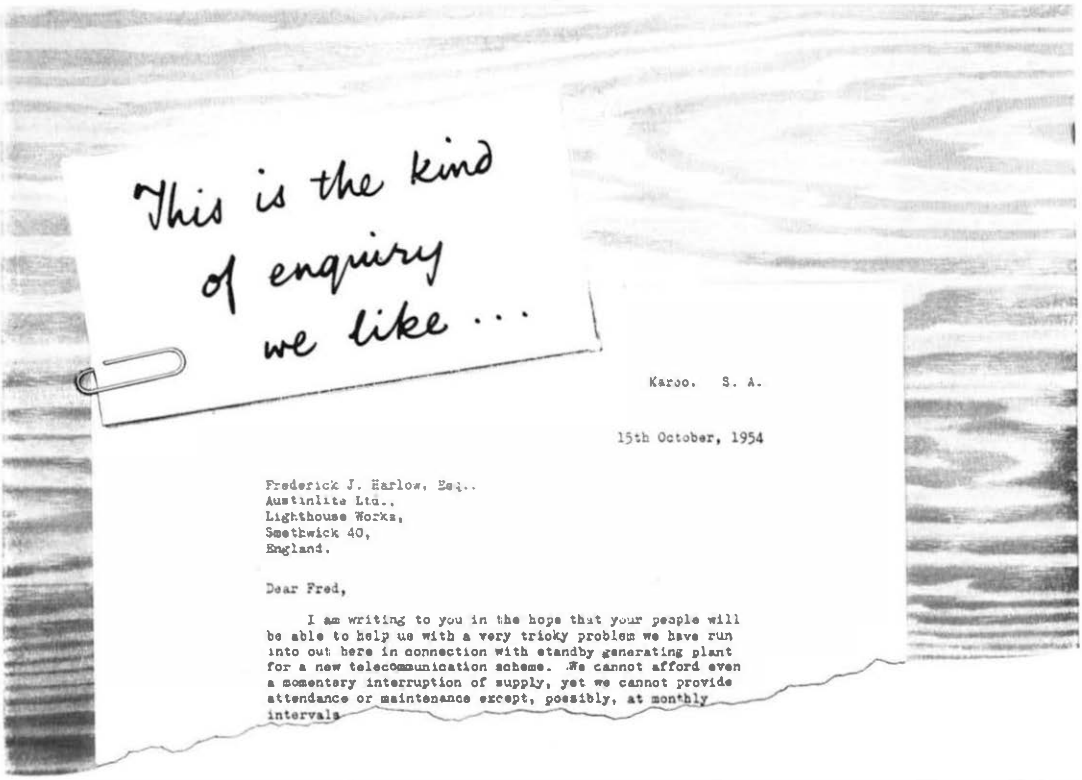

Karoo. S. A.

15th October, 1954

Frederick J. Harlow, Esq..
Austinlite Ltd.,
Lighthouse Works,
Smethwick 40,
England.

Dear Fred,

I am writing to you in the hope that your people will be able to help us with a very tricky problem we have run into out here in connection with standby generating plant for a new telecommunication scheme. We cannot afford even a momentary interruption of supply, yet we cannot provide attendance or maintenance except, possibly, at monthly intervals

The more tricky the problem, the more arduous the conditions under which the equipment must operate, the better we like it. Difficult, unusual generating plant is our metier. It does not matter how long it must run without attention. It does not matter whether there is a mains supply or not. Nor if the supply is erratic and unreliable. Even if the requirements do not come within our standard range Austinlite plant can be designed which will ensure continuous, steady and extremely reliable supply.

During the past 25 years Austinlite plant has been steadily developed, always with the emphasis on quality and dependability. We can now provide automatic generating plant of many types in sizes from 1.4 to 250kVA, for continuous unattended operation or for mains standby work—to the strictest no-break specification where necessary. However difficult a particular problem may be, we have good reason for the confidence with which we affirm that Austinlite can tackle it.

In this country our plant is used by the G.P.O., the Ministry of Civil Aviation and British Railways. It is installed in many parts of the world in lighthouses where reliability is vital. It is in operation in South Africa, Australia, Denmark, the U.S.S.R., Malta, Syria, New Zealand and Norway; as well as a number of tropical countries including Nigeria, Malaya and Borneo.

Austinlite AUTOMATIC GENERATING PLANT tailor-made by STONE-CHANCE LTD.

(The makers of Sumo Pumps and Stone-Chance Lighthouses)

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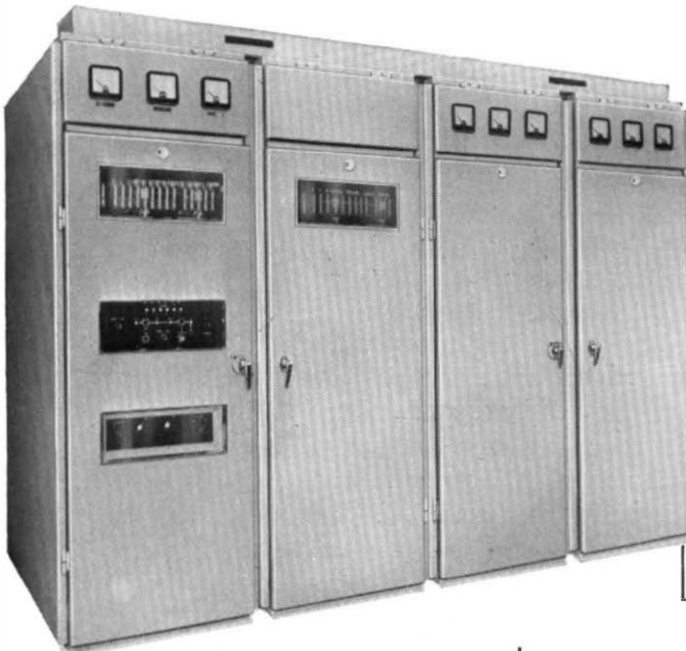
Marconi 6kW HF ISB Transmitters



TYPES
HS 71 AND HS 72

The assembly is enclosed by unit sections, as shown here, with access through front and rear doors. The two left hand bays house the rectifier and power equipment and the right hand bays the low power and auxiliary transmitting circuits and the main output stage.

These transmitters, designed in accordance with the most advanced practice, provide :—

(a) Telegraphy on CW and FSK (A1 and F1)
(b) Independent Sideband Operation (A3b)

The drive equipment is external and provides either ISB modulation or telegraph keying at 3.1 Mc/s and suitable RF oscillator signals for frequency changing in the transmitter. HS 71 is manually operated ; HS 72 provides full automatic tuning and selection of any one of six pre-set frequencies.

FEATURES INCLUDE

- **Tuning over the whole range without change of components.**
- **Air cooling throughout, with dust filtering.**
- **Double screening of power stages to reduce indirect radiation and cooling air noise.**
- **Envelope feed back to reduce distortion.**
- **Compact assembly with good access for servicing and safety interlocking.**

More than 80 countries now have Marconi equipped telegraph and communication services, many of which, completed 20 years ago, still give trouble-free operation.

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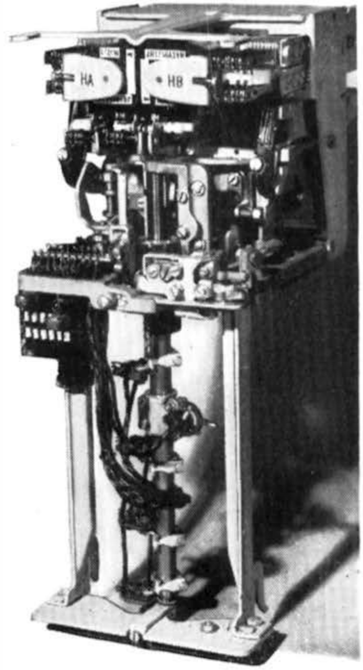
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HERMETICALLY SEALED

"Series 595H" is a hermetically sealed version of our series 595 Relay, which is already well known to the aircraft industry. The armature design reduces the effects of shock, vibration and acceleration; a spring type armature hinge eliminates backlash, friction and risk of displacement.

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In all standard voltages up to 110 V. D.C. Working range between plus 10% and minus 20% of rating.

CONTACT COMBINATIONS: Up to 2 pole changeover.

BASE:
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WEIGHT: 3¼ ozs.

DIMENSIONS:
Diameter—1 11/16" overall.
Height—2⅝" overall.

SERIES 595H

TELEPHONES: NEWMARKET 3181-2-3 TELEGRAMS: MAGNETIC, NEWMARKET

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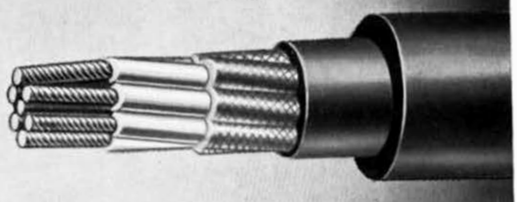

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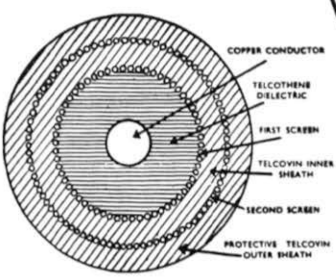

double screened

COAXIAL CABLES

★Wire braid screens, as commonly used on flexible R.F. cables, fail to exhibit an increasing measure of shielding with rise of frequency, the proportion of leakage tending to increase at frequencies higher than, say 1.0 Mc/s. In certain circumstances the effectiveness of a single braid as a screen has been found inadequate, and for such cases a range of double screened cables is offered.

Two types are available, the first having the two screens continuously in contact and the second having the screens separated by a Telcovin insulating layer: in general both types have similar performance as regards screening.

The addition of the second braid may be expected to improve the screening of a cable by a factor which varies from about 6 db at low frequencies to some 30 db at very high frequencies. In all other electrical properties these cables are identical with their normal counterparts.

Available in the following types: (a) with Screens in contact—K.16.YM, PT.1.YM, PT.11.YM. (b) with Screens separated — K.16.MYM, PT.1.MYM, PT.11.MYM. *Further particulars on application.*

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TELCON RF cables

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