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Telex Advances

DURING THE PAST FIFTEEN MONTHS A CHANGE which the *Financial Times* has described as a minor contemporary revolution has been taking place in business management: the extending use of the teleprinter, particularly for Telex, as a normal means of business communication.

This revolution has been, and is still being, encouraged by the Post Office through the Sales Division of the Inland Telecommunications Department supported by the engineers, public relations officers and the men in the field. During 1955 alone Post Office salesmen made 13,500 calls on prospective users; many articles on Telex appeared in the Press; and the system was displayed at several exhibitions. More recently there has been a special demonstration at the Houses of Parliament.

Today, there are 2,650 subscribers to Telex in this country who are able to exchange printed messages not only with one another but also, through the International Telex Exchange, with some 75,000 subscribers in Europe, the United States and South Africa. Since the end of 1954—when the new, all-telegraph Telex service began operating through its own network of exchanges, and the inland system was integrated with the oversea services—the number of subscribers has increased at the rate of 40 per cent. a year. Contracts are made by Telex, and are valid in law when the offerer receives acceptance by Telex; the system is being used by a wide variety of businesses, from those which need rapid communication between a number of branches in this country to firms engaged in international trade. There is also an installation at Scotland Yard!

The Telex sales staff are to be congratulated on their achievements.

Radio transmitter interference

Controlling Radio Interference in the United Kingdom

D. C. Balaam, B.Sc.

THE YEARS BETWEEN THE TWO WORLD WARS saw rapid developments in the use of radio, and intensification of the problem of keeping radio communications free from interference from each other and from an increasing variety and volume of sources of electrical disturbances. Electrical appliances using small motors were among the leading offenders, and remain so today. The need for some limitation on interference from these and other appliances stimulated early attempts by the Post Office, the Electrical Research Association and industry, to evolve suitable standards to which manufacturers would work.

Two major developments after the 1939-45 war accentuated the need for definite measures of control. The first was the rapid development of television services; the second, the increasing popularity of domestic electric appliances (vacuum cleaners, hair-driers, sewing-machines, refrigerators, drills and so forth), with other technical developments such as the wider use of radio waves for medical and industrial purposes. Ironically enough, television sets are themselves a major source of interference to sound broadcasting, particularly that of the B.B.C. long wave programme. When we add the two recent broadcasting developments—introduction of the B.B.C.'s very high frequency (V.H.F.) sound broadcasting and of the Independent Television Authority's services—and the possibility of the use of radio at even higher frequencies where the effects of electrical interference are yet to be explored, it is easy to understand why nobody, either inside or outside the Post Office, can claim that the problem of eliminating interference is solved or is indeed capable of an easy solution of the once-for-all type.

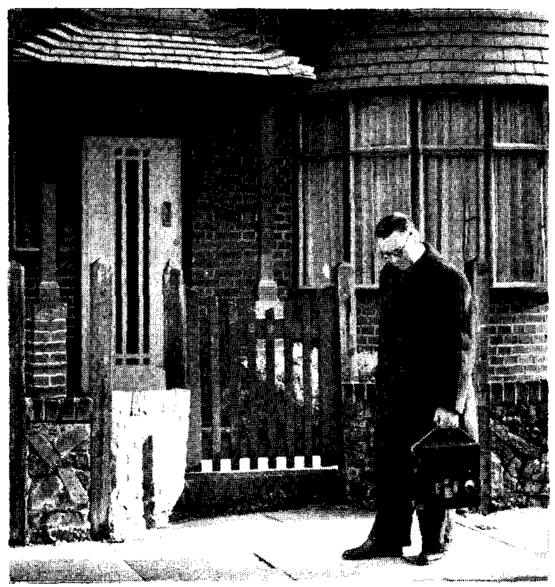
We need to take note of two extremes of opinion. There are those who feel that the matter should be left entirely to the electrical and radio industries acting under the spur of pressure from customers. On the other hand, there are those who favour tighter Government control of all appliances capable of causing interference and of the people who make and use them. The issue was widely debated in Parliament in 1948 and in the event the Government was provided, in the Wireless Telegraphy Act, 1949, with powers sufficiently widely drawn yet carefully circumscribed against arbitrary Government interference with private liberty.

These powers, while they enable the Postmaster General to make regulations about appliances and machinery liable to cause interference, do not automatically impose any legal obligation on manufacturers or users. To illustrate, when the Ministry of Transport and Civil Aviation decided that motor vehicles within certain categories should have rear reflectors, they made regulations to that effect, and it automatically became an offence not to have rear reflectors. The Postmaster General, on the other hand, has no power to prescribe the general fitting of interference suppressors in a similar way. The provisions of his regulations are legally binding only when the Post Office serves a legal notice (against which a right of appeal is provided) on somebody whose appliance is causing interference.

Another interesting feature of the Act which further illustrates the care which Parliament has taken to safeguard the citizen against arbitrary action is that the Postmaster General is specifically required, before making regulations about interference, to consult an Advisory Committee. The members of this Committee have to be selected to represent adequately all interests involved, and the selection is a joint responsibility of the Postmaster General and the President of the Institution of Electrical Engineers.

There are two further important limitations of the Government's freedom of action. The first, which is not as yet widely known, is that except where interference to safety-of-life and other services is concerned, a notice cannot be served on the user of an appliance which is causing interference, until the Post Office is satisfied that the person whose reception is suffering interference has done all that can reasonably be expected of him to ensure that his own receiver, with its aerial and earth, are in good working order. The reason is that a set in poor condition, or with a poor aerial or earth, is often unduly susceptible to interference and can make the task of eliminating the interference more difficult, if not impossible. Again, the Post Office has first to be satisfied that "undue" interference is being caused before exercising its powers. One factor which has specifically to be taken into account is the possible hardship to individuals which might be involved if the suppression of interference was enforced.

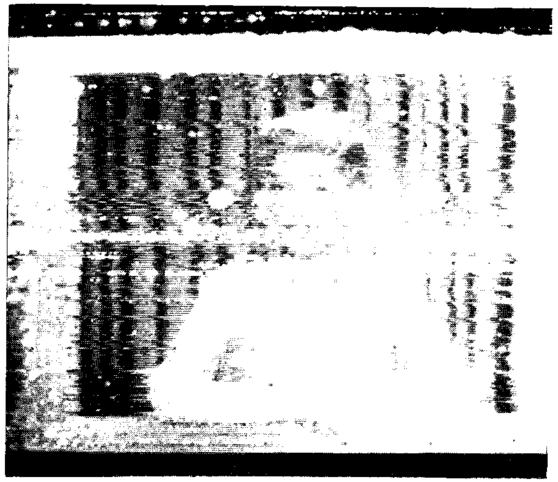
Tracing source of sound interference



Tracing source of television interference

The technical aspects of radio interference could occupy many articles of their own. The various problems involved offer scope for enquiring minds. Of the many co-workers which the Post Office has in this field, the Electrical Research Association, the British Standards Institution and the Institution of Electrical Engineers, must be mentioned, as well as the mathematical and statistical experts whose contributions are by no means exhausted. The considered conclusions of these specialist activities eventually find their way into British Standard Specifications and, when appropriate, into Statutory Regulations and a glance at the Regulations already made is enough to show that the subject is far from simple.

Who pays for tracing interference? Who pays for curing it? The cost of the tracing service is recovered, not by direct payments by individual listeners and viewers, but from receiving licence revenue as a whole. If the receiving apparatus which is being interfered with is in a satisfactory condition, the person who is causing the inter-



Interference from an electric drill motor

ference is normally responsible for the cure unless this would cause undue hardship; this general principle is embodied in the Wireless Telegraphy Act, 1949, and is adopted by the Post Office in handling complaints not yet covered by its Regulations.

Hardship is not the only factor which can dictate modifications to the simple formula that tracing is paid for from receiving licence revenue and curing by the people causing the interference. The seriousness of interference in any particular instance depends on a combination of factors.

The amount of interference generated is the obvious starting point, but its effect on viewing or listening will depend on how far the receiving set is from the appliance and how strong the programme signal is to which the set is tuned, as well as on the condition of the set and of its aerial and earth. If every appliance could be completely and inexpensively suppressed so that no disturbing signals could be produced the problem would be solved. Unfortunately this conception is very largely Utopian; its achievement would, in general, be extremely difficult and costly, if not altogether impossible. It is also quite impracticable to cover the whole country with a strong programme signal, particularly at the very high frequencies now coming into use for both sound and television broadcasting. There will always be some areas where the programme signal is not too strong and where reception is particularly liable to interference.

The problem of evolving a reasonable compromise between the points of view of listeners and viewers, and those of the owners of appliances likely to cause interference has been, and is being, tackled by the Advisory Committees, whose eyes are on the economic as well as the technical and practical aspects of the extent of suppression which they recommend. Any suppression regulations made by the Post Office must always reflect this element of compromise.

The practical effect is that the minimum degree of suppression prescribed can be expected broadly to eliminate interference, over quite a wide area around a broadcast transmitter, to reception on a set of reasonably modern design, in good condition and equipped with a suitable aerial and earth. People living further from a transmitter, or using older sets or inadequate aerial and earth arrangements, cannot normally expect to have all interference to reception eliminated, though often the prescribed standards of suppression will produce worth-while reduction in the effect of the interference. Furthermore, radio waves at very high radio frequencies may be obstructed by topographical features such as high ground, even when the receiver is quite close to the broadcast transmitter; here again, complete suppression is not always practicable. The Post Office Radio Interference Service can undertake investigations only where one of the "local" broadcast programmes is being received. The service does not investigate interference to reception of other home programmes—for example, a listener in Cornwall trying to receive the Scottish Home Service—or to the reception of foreign broadcasting.

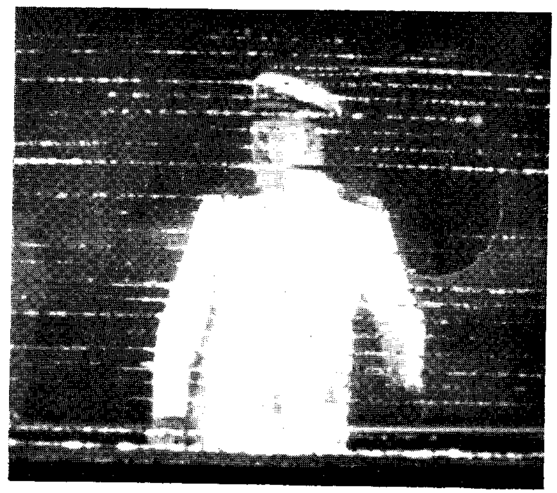
Interference from foreign stations is caused by overcrowding of the medium waveband, and is difficult to cure. Broadcasting in Europe has increased very considerably since the war; even in 1948, when the plan for allocation of wavelengths was drawn up at the European Broadcasting Conference in Copenhagen, there were not enough wavelengths available to satisfy the wishes of each broadcasting authority in Europe. Nearly twice as many stations are now working in Europe as were provided for in that plan. This means that stations are working on wavelengths too close to one another, with consequent mutual interference. Unfortunately, as medium waves range further afield during darkness, this form of interference is especially noticeable during the peak hours of listening.

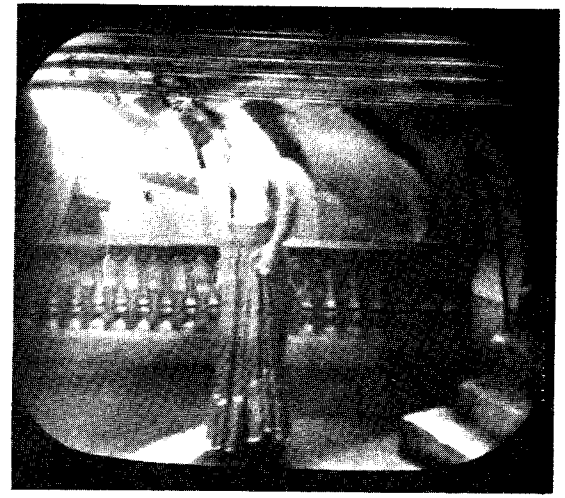
The effect in this country is that nearly all the

B.B.C's Home Services are subject to some degree of interference from abroad—and, of course, we are not by any means the only European country so affected. The Post Office keeps in close touch with the B.B.C. about this kind of interference, and makes representations to the foreign administrations whose stations are causing the trouble; but the only radical cure lies in using, for home broadcasting, other orders of wavelengths which are not subject to interference in this way. As far back as 1946, the Government approved the B.B.C's intention to press ahead with V.H.F. broadcasting as a solution to this problem. The Corporation's plans for the first stage of V.H.F. development, now being implemented by the building of 11 V.H.F. stations, will mean that by the end of 1956 V.H.F. reception, free from interference from foreign broadcasting stations, will be accessible to about 80 per cent. of the population.

Returning to the problem of electrical interference, certain questions are frequently asked by the public, apart from the question of who should pay for suppression. Why not fit suppressors to the wireless receivers instead of to interfering appliances? Why not make manufacturers fit suppressors to all appliances likely to cause trouble? Why not make suppression compulsory on all motor vehicles? Why make a fuss about protecting television reception when television sets themselves cause serious interference to sound broadcasting?

Interference from a hair-drier motor



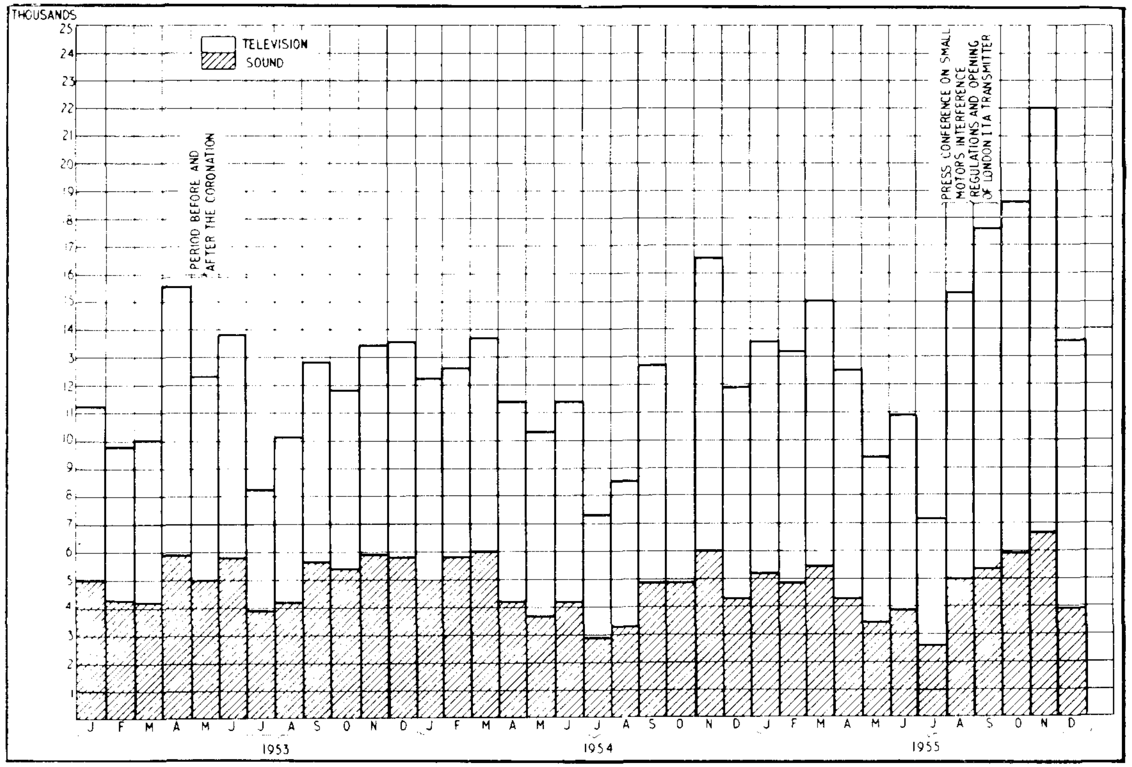


Line (or horizontal) hold control incorrectly adjusted

The first question is fairly easy to answer: there is a technical limit to what can be done to the receiver without spoiling reception. If a baby's crying is interfering with your enjoyment of a piece of music, you can—short of removing the baby—remove the interference by plugging your ears, but this also has the effect of preventing your hearing the music. Much the same is true of electrical interference. Most manufacturers already design their receivers, particularly television, to minimize the effects of external interference, but anything more would spoil reception. The remedy must lie with treating the interference at its source.

The Advisory Committees, which are consulted in connexion with all interference regulations, carefully study the question of treating appliances during manufacture. The case for fitting suppressors to motor cars at the manufacturing stage is quite clear; a car, being mobile, causes interference wherever it goes, and there can generally be no question of tracing interference to a particular vehicle. When it comes to domestic and commercial appliances, however, the problem is rather different. Any one appliance is normally always worked on the same premises, and can be found and dealt with.

Calculations have shown that only a small proportion of the appliances in use actually cause interference and with many of them the interference can be avoided by using them outside broadcasting



Numbers of interference complaints received month by month during 1953, 1954 and 1955

hours. The cost of suppressing increases the retail price of many appliances and there are obvious objections to making every purchaser pay more when usually the suppression would be unnecessary. Apart from motor cars, compulsory suppression by manufacturers has therefore been limited, for the present, to refrigerators, where the cost of suppression makes little or no difference to the retail price and the appliance works 24 hours a day and cannot normally be switched off during programme hours.

However, with the rapid development of television, in geographical coverage and programme hours, the percentage of electrical appliances which need suppression is increasing. Manufacturers are, of course, alive to this, and some are already producing suppressed versions of their products or are making provision for the easy fitting of suppressors if necessary.

Interference from motor car ignition systems, though in its effect more serious with television than with sound broadcasting, is transitory and does not usually cause prolonged disturbance to listening or viewing except when the receiver is close to a main road or is tuned to a weak signal. All cars manufactured since July 1, 1953, have been suppressed where necessary, and the gradual withdrawal of older cars from the roads will eventually lead to the virtual disappearance of this form of interference. Compulsory suppression of old cars could be enforced only by visually inspecting the engines of stationary vehicles, or by setting "suppression traps" by the roadside. Both would involve additional staff and the present view is that the balance of advantage lies with not introducing compulsion.

Many people connect interference suppression solely with television reception. This is a mistake; the Statutory Regulations are designed to protect sound broadcasting as well as television; but the misunderstanding is partly responsible for the resentment felt by some long-established listeners who, for one reason or another, do not go in for television, and who find their listening spoilt by

whistles caused by neighbouring television sets.

Suggestions have been made that the Government should cease "molly-coddling" television viewers and show some interest in the disturbance which they are causing to their "listening" neighbours. This misconception of the position arises from the fact that control of interference caused by receivers—both sound and television—is exercised by licence rather than by Regulations. A person whose set causes interference and who refuses to take reasonable steps to cure it is liable to lose his licence, and this has actually happened. The radio industry and the Post Office have, however, evolved technical standards for television sets which will substantially reduce, and in many instances entirely eliminate, this form of interference. Some radio manufacturers are already producing sets to these technical standards and most of them are very willing to help people whose sets are causing this kind of trouble.

Radio interference cannot be seen in its true perspective without a few statistics. The Post Office Radio Interference staff attend to some 150,000 requests for help annually. In about 35,000 cases, the source of interference proves untraceable because it is transitory. In the remainder, the sources are located in the main groups listed in the table.

The Post Office engineering staff engaged on the work all over the country use a language of their own; they live in a complex world of B.C.I., T.V.I., L.O., T.B., and suchlike obscure entities. Their use of the term "complainants" to describe people who seek Post Office help in tracing and clearing interference is not intended to be in any way derogatory; many of these people are far from being of the complaining type, but the demands of conciseness in speech and departmental correspondence necessitate a "coined" label. The

Source	Interference to: Sound per cent.	Interference to: TV per cent.
Complainant's own set or house wiring	46	19
Electric motors and associated switchgear	19	50
Other radio and television apparatus	16	4
Switchgear not associated with electric motors	8	8
Electric lamps	6	7
Other sources...	5	12

rather obscure designation "Plant Owner", which means the person responsible for the source of interference, is also a "coined" label. Investigating staff usually find that both these categories of people are reasonable and willing to take whatever steps the Post Office recommends to clear the trouble.

Lines of development are being investigated. On the technical side, in addition to the general problem of interference to service in the higher frequency ranges, work is going on to find the most suitable methods of controlling interference from television receivers, from various forms of switches, thermostats and electric lamps, and from two particularly difficult sources of interference—overhead high-voltage electric power lines and high frequency equipment used for industrial and medical purposes. The results may form the basis of future Statutory Regulations which will ensure that appliance owners and manufacturers know where they stand. This should also simplify the task of the investigation staff.

The staff's need for more precise definitions of certain matters, such as what constitutes a "reasonable technical standard" for a broadcast receiving installation, is also being kept in mind. In addition, short leaflets are being produced for distribution to the public, explaining the responsibilities of the Post Office, the Complainant and the Plant Owner.

The form on which requests are made to the Post Office for interference investigations is accompanied by an explanatory leaflet drawing attention to the need to test the set, the aerial and earth, and to make sure that the interference is not caused within the complainant's own home. In spite of this, much time is spent on interference which proves to be untraceable, or which is traced to sources on the complainant's own premises. Ways and means of further reducing such work need to be studied, though the problem is by no means easy.

It would be quite inappropriate to say that radio interference control in the United Kingdom is "flourishing". The ultimate aim of the service must be its own extinction. Although the attainment of this end is still a long way off, considerable progress has been and is being made. There is no reason to doubt that it will continue, with the co-operation of scientist, engineer, manufacturer, retailer and the listening and viewing public, and with the very minimum of recourse to the processes of the law.

Transatlantic Terminal—Oban

J. F. Bampton, B.Sc.(Eng.)Hons., A.M.I.E.E.

The laying of the new transatlantic telephone cable land link in Newfoundland was described in our last issue. In this article Mr. Bampton describes the planning and building of the Oban terminal.

ONE MORNING IN FEBRUARY, 1953, THREE Post Office officials arrived at the Argyllshire coastal resort of Oban, with a special mission—to find a suitable landing point for a transatlantic telephone cable. Nautical considerations, one of which was the need for avoiding the network of some twenty telegraph cables already spanning the Atlantic, had narrowed the search to this area.

The town of Oban itself is built round a busy harbour (Fig. 1) from which small steamers ply to the neighbouring islands, and for this reason was unsuitable for a landing point. The officers, therefore, left the town, driving along the coastal road which, after a few miles, terminated in front of a solitary house built in a gap in the mountains and lying a little way back from the shore. The owner of the surrounding land lived in this house, and after a preliminary talk with her the party started a thorough survey of the small bays which made up the foreshore.

It was soon apparent that any of these small bays was suitable for landing submarine cables, but it was also clear that there would be some difficulty in finding a building site for a large repeater station. In the area under survey such level ground as there was lay on the seaward side of the road and was boggy and uncomfortably near the water's edge. On the landward side the rock face rose sharply, eventually to terminate in the Highland peaks rising in the background. To add to the difficulties, it was apparent that there were no electricity or water mains within several miles. The party left knowing full well that natural obstacles in themselves would prevent the erection of a normal type repeater station and the spoiling of what was undoubtedly a natural beauty spot.

In November, 1953, the announcement that the transatlantic telephone cable was to be laid made it necessary to complete plans immediately for a building at Oban and the decision was made—in view of the difficulties mentioned above—to tunnel horizontally into the rock face to house the repeater station, the accommodation to consist of a large tunnel deep in the rock with access by two small entrance tunnels or adits.

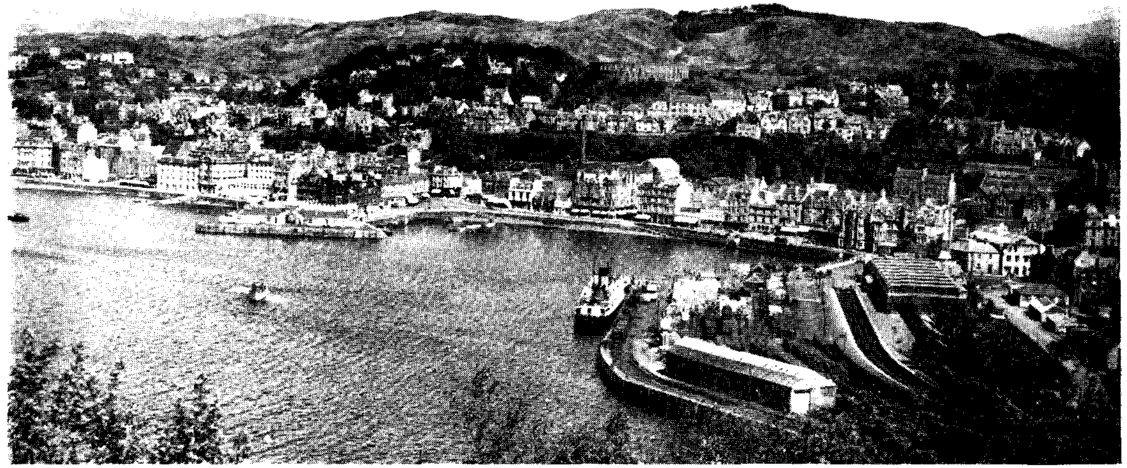


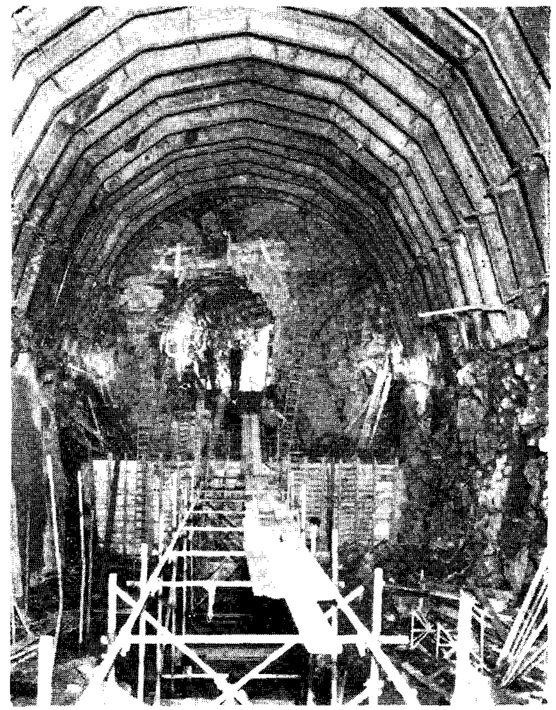
Fig. 1 : Oban—the town and harbour

To provide a high quality transmission path between Oban and London the Glasgow-Oban telephone cable route had to be supplemented by a modern coaxial system, one terminal of which would be at Oban. The new underground repeater station thus had to be big enough to house the terminal equipment necessary for both the transatlantic cable system and the inland coaxial system, with equipment to adapt the signals received over one system to make them suitable for onward transmission over the other. In addition it would have to house its own power plant (to guard against mains failure) and a host of testing gear. The 7,000 square feet of floor space required was to be made by dividing the tunnel into two floors.

All the detailed surveying, planning and preparation was done with the greatest urgency for, to meet the requirements of the overall plan, the building had to be ready for equipment installation within 14 months. John Mowlem and Company Limited were entrusted with the work and shortly an army of construction engineers appeared on the site and the mountains and valleys were soon echoing to the blast of dynamite and the rattle and roar of heavy machinery. Gradually as the summer of 1954 (one of the worst of recent years) wore on, the long horse-shoe sectioned tunnel began to take shape. The impression of vaulted space which the tunnel gave at this stage earned it the nickname of the "Cathedral" (Fig. 2). Progress was good and by the end of the year the final touches were being put to the tunnel; in that time 11,000 cubic yards of rock had been excavated and 90 tons of steel rib and many thousands of tons of concrete had been placed in position.

While the construction work was proceeding,

Fig. 2 : The tunnel under construction—"The Cathedral"



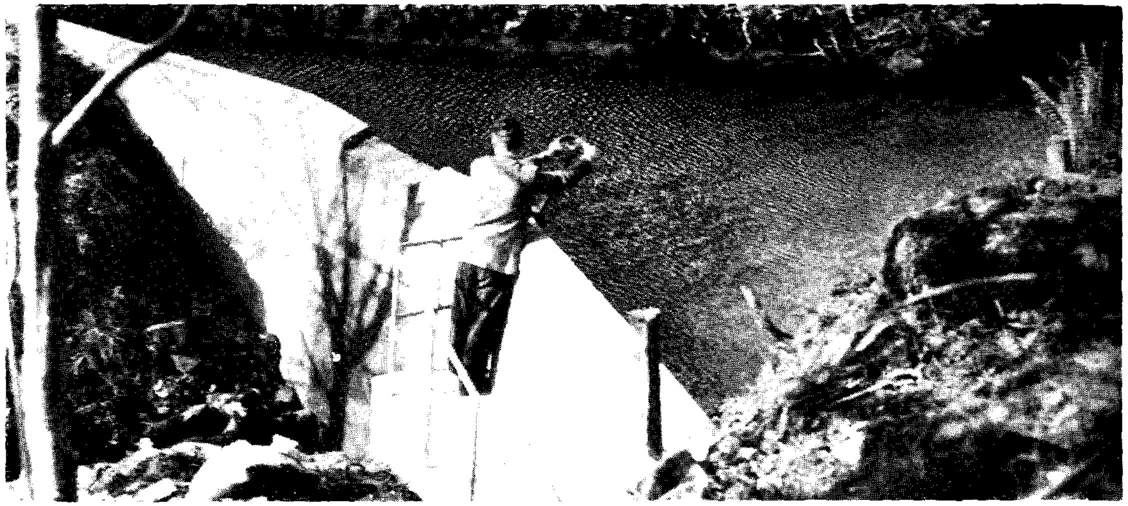
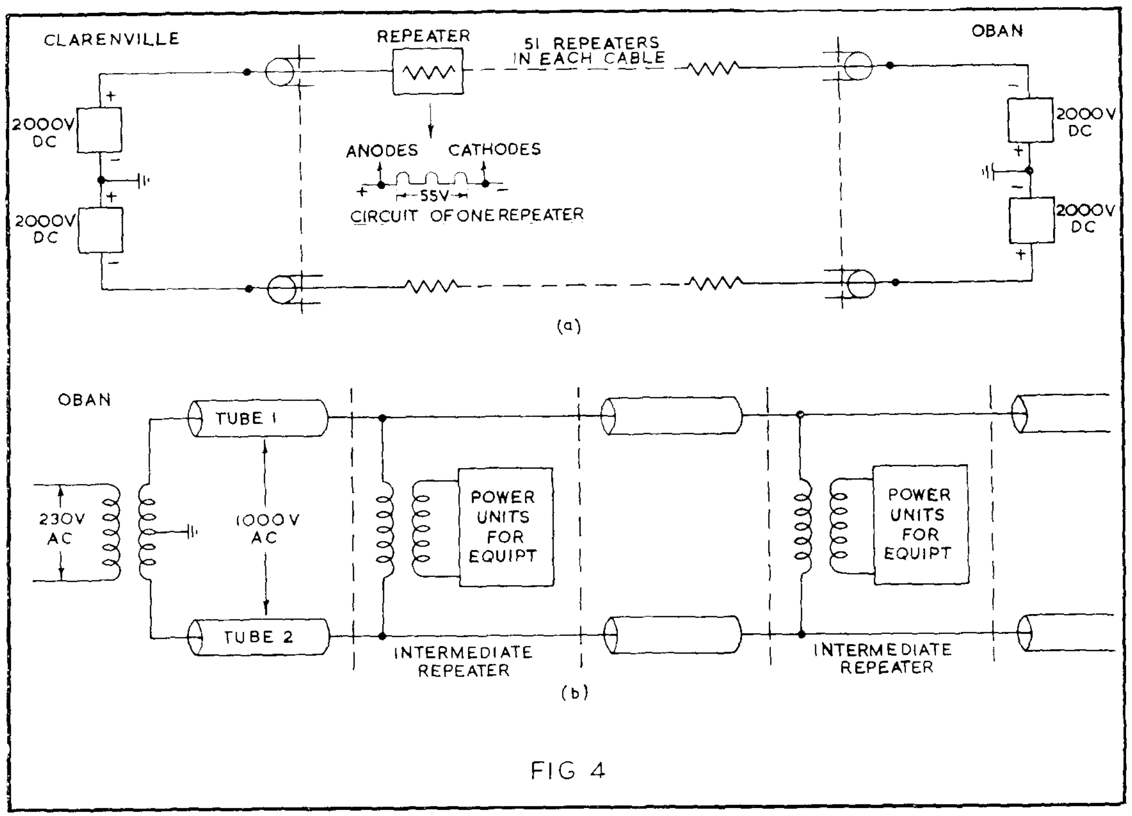


Fig. 3 : The dam—a happy solution to the water problem

Fig. 4 : (a) Power arrangements on Clarenville-Oban cables and (b) power arrangements on Oban-Glasgow cable



electricity supplies were brought over the mountains and the cable route inland from the repeater station was started. As a happy solution to the problem of obtaining fresh water it was found possible to dam a mountain stream above the tunnel, which provided an adequate supply for the whole station (Fig. 3). As soon as the accommodation was ready, installation of the heating, lighting, ventilation and basic power equipment started, and about April, 1954, the repeater room was ready for installing transmission equipment.

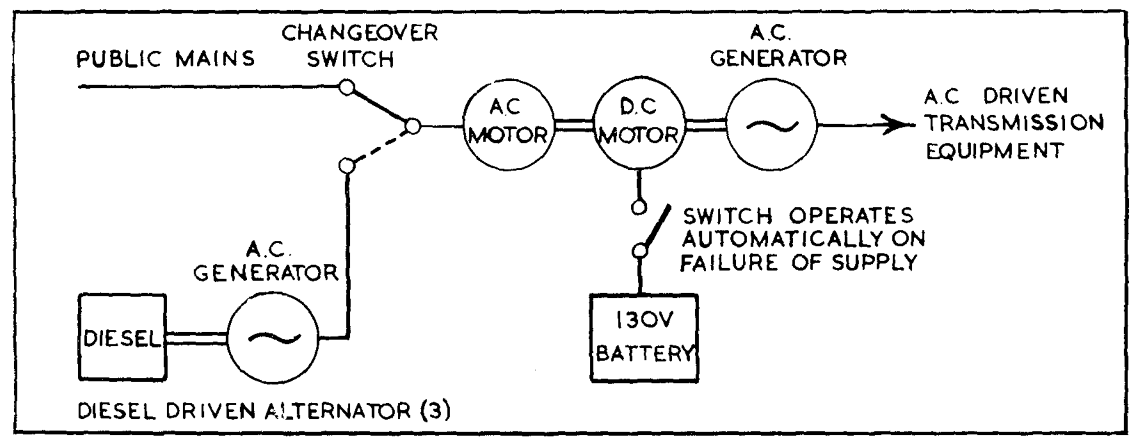
Meanwhile, in the United States the complex equipment for terminating the transatlantic cables had been under manufacture for the American Telephone and Telegraph Company in the factories of the Western Electric Corporation and in April the first shipment, valued at about £60,000, arrived at Glasgow. Post Office staff took charge of the equipment as soon as it arrived and arranged for it to be transported by lorry, under close supervision, through the winding roads of the Highlands to Oban, where British contractors' installation forces were ready to receive it. By July all equipment was ready and awaiting a final check by the American representatives, and so it was that on September 25, 1955, when H.M.T.S. *Monarch* came in sight of the Oban coastline, laying behind it cable which extended back across the Atlantic to Clarenville, 1,940 miles away, everything in the station was ready, and within two hours of the final splice being made between the cable and the short shore end previously laid, signals were received over the cable from Newfoundland.

It was mentioned earlier that Oban would contain equipment for both the submarine cable system and the land cable system. In spite of obvious differences, there are one or two interesting points of similarity between the two systems. For instance, each system transmits a large number of telephone conversations simultaneously over a cable consisting virtually of a single insulated wire (surrounded by a flexible copper tube or "screen"). One such cable is required for each direction of speech, and in the submarine system the two cables are separate and lie on the bottom several miles apart. On these cables armouring wires are added for mechanical strength. On the land system, the "go" and "return" cables are contained in one large composite cable.

There is a further similarity in that both land and sea cables require amplifiers or repeaters at intervals along the cable. Whereas the use of these repeaters on land is well established, not until recently has it been possible to provide repeaters designed to work at the bottom of the Atlantic. These repeaters enable each of the submarine cables to carry 36 one-way speech channels.

To visualize how a single wire can carry a large number of speech channels, it can be compared with the radio broadcast system. We are familiar with the fact that a broadcasting station transmits on its own wavelength or frequency. The ether at any time is full of broadcasts from hundreds of stations, but it is possible to select any one by "tuning in" a radio set to the proper frequency. In the telephone cable, the single wire takes the place of the ether. Each speech channel is transmitted over the wire at a different frequency, all the channels pass along the wire together, and

Fig. 5 : Oban : arrangement to maintain power supply to A.C.-driven equipment



equipment at the far end is tuned into each particular channel and converts it back to normal speech frequencies.

It so happens that the frequencies at which the channels pass over the land cable are in general higher than those used on the submarine cable and the transmission equipment at Oban is provided to make the necessary frequency changes. Equipment is also available for converting channels to speech frequencies if required, but normally this process is carried out only at the main stations, New York, Montreal and London.

In both land and submarine systems, repeaters are run by power which is fed over the cable. With land cables the repeater stations are accessible and power for the repeaters can be supplied at a number of points along the route, but with submarine cables all the power to operate all the repeaters has to be supplied from the ends of the cables. This is achieved, as shown in outline in Fig. 4, by applying to each cable at each terminal station a part of the total voltage required, the applied voltages being arranged so that they assist one another. The power equipment for this purpose has to be designed with special precautions to prevent staff coming into contact with lethal voltages.

It is, of course, essential that the basic power supplies to all this equipment should be absolutely free from interruption such as may arise from a failure of the electricity mains. Three diesel-driven generators are provided in the tunnel to cater for any such interruptions, but to overcome even the short break in supply which would arise while these machines started up, the alternating current supplied to the equipment passes through special rotating machines. Each machine consists of an alternating current motor driving an alternating current generator with a direct current motor mounted on the same shaft. Arrangements are made so that should the supply to the A.C. motor fail, direct current is fed from batteries to the direct current motor and the rotation of the shaft, and hence the output of the A.C. generator, is maintained without interruption. This principle is used on the machines feeding A.C. equipment on both the land and submarine systems (Fig. 5).

This summer, *Monarch*, having completed the cable system between Clarenville, Newfoundland, and Sydney Mines, Nova Scotia, will come again to Oban, this time to make off the end of the cable, which will be paid out westwards in stages, finally reaching Newfoundland. When the final splice is made in this cable all should be ready in Oban, so that after a short testing time overall speech circuits will be available between London and the North American continent.

Even now the gashes torn in the countryside at Oban are beginning to heal, grass is growing again over the disturbed ground, a new road leads up to a neat granite-faced building at the entrance to one of the adits and gradually the other signs of the minor invasion will fade. In fact, those concerned with the provision of these highly reliable communication systems feel that after the exciting events of the current year are over, transatlantic cable telephony will be so uneventful that some of the lost serenity will return to the mountains which shelter "Transatlantic Terminal, Oban".

A Transportable Automatic Traffic Recorder

For many years traffic records on automatic exchange equipment have been taken by rack-mounted automatic traffic recorders which are part of the exchange plant; but lines records at switchboards have been taken manually by operators counting, at frequent intervals, the number of circuits in use.

The growth in the trunk and junction network since the war, and the coming of trunk mechanization and subscriber trunk dialling, has greatly increased the need for lines record information. The present method of manual counting is laborious and a small transportable version of the exchange automatic traffic recorder has been considered. Apart from relieving the tedium of the job, it would make it possible to take more records at switchboards during the important pre-automation years ahead.

A prototype recorder was made by the Engineering Department and has been used experimentally at a number of exchanges of different types, both large and small, and has proved to be a success. The form of a production model of the new recorder has recently been agreed, and its design has started. It will be similar in size and shape to one of the larger cordless P.M.B.X. switchboards, and will operate from A.C. mains supply. The recorder will be connected to the exchange multiple by plugs and cords, and will be able to take records simultaneously on a hundred circuits arranged in groups of ten.

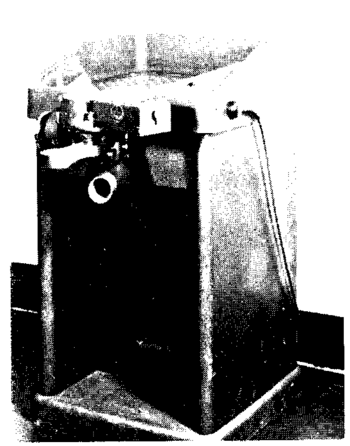


Fig. 1. Coin-counting machine unmodified

Reduction of Acoustic Noise

A. J. Forty, B.A., A.M.I.E.E.

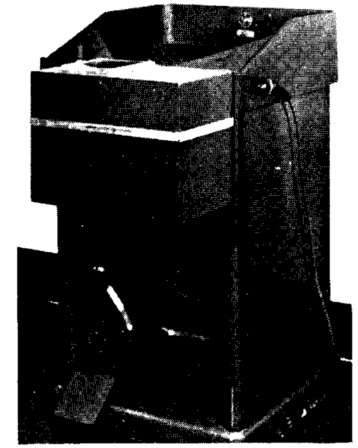


Fig. 2. Modified for noise suppression

"AND THE MORAL OF THAT", SAID THE DUCHESS in *Alice*, "is—take care of the sense and the sounds will take care of themselves". The motto of the telecommunications engineer may well be "Take care of the *sounds* (including the unwanted ones) and the *sense* will take care of itself". Unwanted sounds or signals, whatever their nature, are called "noise" and the ratio of wanted signal level to noise level is one of the most important considerations when intelligence is conveyed over a transmission system. This article, however, is concerned with noise in the narrower, more conventional sense of unwanted sounds heard as vibrations in the air.

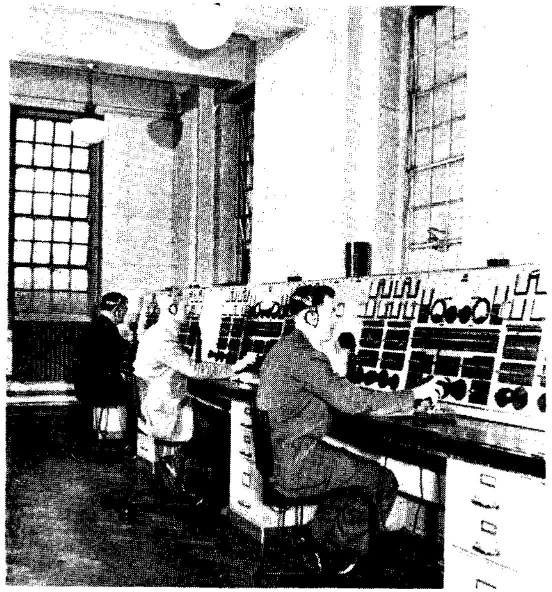
During the summer the B.B.C. often asks listeners not to turn up the volume of their sets and sit in the garden with the windows open, for the concert they hear is merely noise to the neighbours. Similarly the background voices of switchboard operators as heard by their colleagues may cause distraction and impaired efficiency.

Noise may contain components of pitch spread over most of the audible range. The noise from machines usually contains a large number of components of random pitch, but in addition extra loud components will be present with pitches corresponding to the frequencies of rotation or reciprocation of the mechanism. Sometimes in noise investigations only a series of pure tones are met—such as the electric mains frequency and its harmonics—but usually the spectrum of noise is complex and constantly varying.

Complaints received about noise normally arise not only because of the interference with hearing (this can often be overcome by raising the voice) but because of the discomfort experienced by the people who are subjected to it. The important factor of noise from this point of view is thus its "annoyance value". Unfortunately this is almost impossible to measure, or even to define, for it will depend not only on the hearing of the observer but also on his state of mind, his health, his occupation at the moment, his history and a lot of other factors. The next best way to measure the effect of noise is to determine its loudness and to describe its nature, so that other people with some experience can assess its magnitude and violence from the information given.

Loudness, however, is not always a suitable criterion. To return to a previous example, operators in a busy switchroom will perhaps tolerate quite a high level of noise arising from the movements and voices of their colleagues, yet in a quieter switchroom elsewhere complaints might be received about a much lower level of noise caused by a ventilating system or conveyor belting. The normal background of voices may be now accepted: the intruding sound of machinery is distracting.

The measurement of loudness is not simple (as might at first appear). We are used to describing sounds as "loud" or "quiet", or perhaps "sharp", "soft", "sweet" or "brittle" (using adjectives derived from our other sensory impressions), but these give no precise indication of magnitude.



International radio-telephone service control positions at the Radio Telephone Terminal at Brent, where the walls have been treated with acoustic tiles

The normal dimensions with which the engineer deals, such as linear measure, electrical current, mass and so on may easily be expressed quantitatively once the fundamental units of the foot, ampere, and pound have been defined. Similarly the variation of atmospheric pressure of a sound from a loud-speaker can readily be determined with suitable equipment. To measure the *loudness* of that sound, however, a human ear and brain must be used, for the quantity involved is subjective. In other words, a person must listen to the sound and make a decision concerning its loudness.

Now the human mind has no absolute measure of loudness: consequently all it can do is to compare the sensation of loudness created by a sound with that caused by some other sound. This ability to compare sounds does allow an indirect measurement of loudness to be made. The judgment may be made that sound A is *n* times as loud as sound B, or alternatively the level of sound B may be altered until it sounds equally as loud as sound A. The first judgment is difficult to make, especially for any value of *n* greater than 2. Most people will make a fair attempt to decide whether a given noise is twice as loud as another, but who would say when the noise from an approaching train was 7 or 11 or 17 times as loud as it was when the train first came into sight? The second judgment is, generally speaking, easier though difficulty is experienced when comparing noises of widely different character.

To achieve some degree of uniformity of assessment, a standard procedure has been laid down using the second form of judgment described above. Noises are compared in loudness with a standard tone of 1,000 cycles per second (that is, a pitch of about "c" in the musical scale); the unit of loudness is called the "phon". A sound is said to have an "equivalent loudness" of n phons when it sounds as loud as a 1,000 cycle second note which has an energy content of n decibels. This further unit, the decibel (or db in its abbreviated form), has a precise scientific definition which need not concern us here. For our purposes it can be regarded as a unit in terms of which the strength of a tone may be expressed. With a suitable instrument the strength of a tone in decibels can readily be measured just as the magnitude of an electric current can be shown by a meter.

In practice it is found that one phon is approximately the smallest detectable change in loudness, and that the judgment "twice as loud" corresponds approximately to an equivalent loudness difference of 10 phons.

Noise Meters

Attempts have been made, with varying success, to design meters which will objectively measure the loudness of sounds and so remove the difficult and cumbersome technique of human judgment which is required by the definition of the phon. There is a variety of factors which make such a design difficult if not impossible to achieve. First, the human ear is not equally sensitive to sounds at all pitches. Low and high pitched sounds give less stimulation than those in the middle range centred on 1,000 cycles second. The matter is further complicated by the fact that the pitch sensitivity curve of the ear varies with the loudness of the sound that is heard. It is virtually impossible to match these complications in a meter. Most important of all, however, the sensation of loudness of a sound depends quite a lot on its nature. A series of staccato noises will not necessarily produce the same effect, either on the brain or on a meter, as a steady note of the same energy content, and whereas the brain may think the machine gun fire or typewriter type of noise is louder, most meters will almost certainly register it as quieter.

Nevertheless, for measurements in the field some form of objective meter is a necessity. For this

purpose a device known as a Sound Level Meter is used. It consists of a microphone, amplifier and indicating meter and measures the energy content of the sounds or noise to which it is exposed. The pitch response characteristic of the amplifier can be varied by means of a switch to correspond to the variation of sensitivity of the ear for low, medium and high energy sounds. Consequently the reading given by the meter gives some indication of the effect of the noise on a listener although the meter is calibrated in decibels, and the results of a measurement are quoted as a "sound pressure level of x db".

Such a meter is of great value to the acoustics engineer, for with a given noise of a fixed magnitude repeatable results can be obtained by measurement without the variability introduced by human judgment. Also, the effect of work done to reduce a noise can be accurately measured and quoted in decibels, though discretion must be used if noises of different character are to be compared. The following table gives an idea of the orders of magnitude of different noises measured on a Sound Level Meter. The figures shown are averages and may of course vary widely according to the circumstances and location of the measurement; and, indeed, from moment to moment when the measurements are made.

Type of Noise	*Sound Level (db)*
Whisper at 2 feet	20 to 30
Quiet office	40 to 50
Average office	50 to 60
Noisy office	60 to 70
Noisy restaurant	70 to 80

The approach to a problem of reducing noise in a given location can be stated quite briefly; reduce at the source as much as possible and apply acoustic treatment to deal with the noise that remains. Reduction of noise at the source is the most profitable line of attack for a variety of reasons. First, it is more effective: reductions of 10 to 20 db in noise level can often be achieved by relatively simple measures, whereas the reduction by more than 6 db of the noise in an office or switchroom by means of acoustic treatment is difficult with the materials usually permitted. Second, it is less expensive, especially when the source is a small machine or group of machines. Acoustic treatment of a large room with considerable wall and ceiling areas can be very costly. Third, reduction of noise at source is more logical; otherwise, if a noisy machine is moved to a new location the problem of noise suppression will arise again.

Post Office at Rushey Green, Catford: acoustic tiles fixed in the ceiling bays cured reverberance

The problem facing the acoustics engineer is to interrupt the paths by which noise travels from the source to the ear of the listener. This transfer of noise energy may occur in several ways. The most obvious link is the transmission of sound through the air directly from the source; this link can be broken by surrounding the source by a continuous barrier of heavy material. The barrier may be a tightly fitting cover for a teleprinter, or a brick wall to isolate a diesel generating set. It is very important that the barrier should be continuous. More noise will often penetrate the cracks round an ill-fitting door than passes through the door itself. Broadly speaking, the effectiveness of the barrier depends on its weight per square foot. Thus soft-board, which is light and has an open texture, is a good sound absorbent when used as a lining, but is not useful by itself as a barrier.

It is often necessary to brace or deaden the panels of which the containing box or partition is made to prevent them acting as diaphragms and so radiating a considerable amount of sound energy. A form of sound insulating barrier which is sometimes used is the "discontinuous" construction for which two relatively light partitions are employed, each being insulated mechanically from the other; by this means a considerable attenuation of noise can be achieved by the use of relatively light structures. With any sound insulation problem care must be taken to avoid by-passing the barrier by transmission of the vibrations along flanking walls. To avoid this effect it is often necessary to mount the machine causing the noise on resilient supports, taking care that the supports themselves are not by-passed by rigid clamping bolts or other members along which vibrations can pass.

The use of Acoustic Treatment

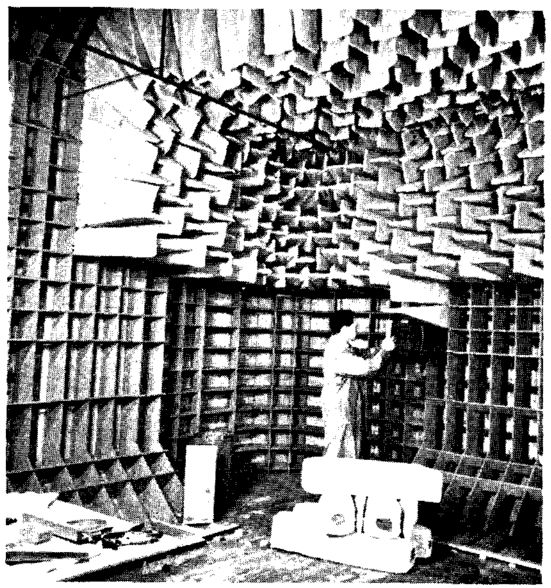
For obvious reasons it is frequently impossible to adopt the measures described above for suppressing the source of noise. In particular the unwanted sound arising from the voices and movement of other occupants of a room cannot be dealt with in this way. In such cases some alleviation of the distress caused by noise can be obtained by covering portions of the walls, ceiling or floor with certain materials which absorb sound. All materials possess this quality in greater or less degree and most of those which are used for building or decoration have been classified in terms of a factor called an "absorption coefficient". With a knowledge of the absorption coefficients of the materials in a room it is possible to calculate the likely effect on the noise level by the introduction of additional treatment.

In general it is not economically possible to achieve a considerable reduction in room noise level by acoustic treatment, but the effect on the comfort of the occupants may be great for a variety of reasons. Most of the materials used for sound treatment absorb high pitched sounds more effectively than low and consequently the "edge" is removed from the sound reflected from the walls and more pleasant conditions result. Furthermore the introduction of acoustic treatment reduces the reverberation time of the room (and so lessens the time taken for a sound to become inaudible). This again results in a more congenial acoustic environment.

Acoustic plasters and tiles, fibreboard, felt, and slagwool or fibreglass covered with perforated board are some of the materials used for acoustic treatment. Curtains, furniture, carpet and even the users of a room all contribute to the absorption —a fact which is at once apparent when a room is stripped for decorating.

In normal circumstances the lower part of a room contains the greatest amount of acoustic absorption in the form of soft furnishings and the occupants and their belongings. Noise which is radiated in an upward direction will be reflected by the walls and ceiling and return. For this reason it is usual to apply acoustic treatment mainly to the upper half of the walls and to the ceiling, an arrangement which has practical advantages since many acoustic materials are soft and porous and unsuited for use where wear will be heavy. It is sometimes possible to segregate noisy machines at one end of a large room. It is then profitable to apply acoustic treatment to the walls and ceiling at the noisy end and so reduce the magnitude of the reflected sound which would otherwise augment the noisy source.

Constructing the acoustically "dead" room at Dollis Hill: the walls, floor and ceiling were lined with 3-ft. fibreglass wedges



Examples of Noise Reduction

Two methods of approach to the problem of noise suppression may be illustrated by the treatment applied to the coin counting machine illustrated in Fig. 1. Machines of this type are used in the larger Post Offices for dealing with counter money and the takings from telephone coin boxes. The machines are normally installed in sorting offices, but their use in situations where quieter conditions prevail, and where the noise level produced by the machines would be unacceptably high has been considered. An investigation was therefore made to see whether the machines could be silenced without undue interference with ease of operation.

In this machine, coins of one denomination only can be counted: other coins contained in a mixed collection are sorted into a reject chute. The coins are loaded on to the top platform and moved by hand towards a chute. They pass into a hopper, the floor of which is a rotating disc driven by an electric motor. The coins fall in turn into holes in the disc, are counted mechanically and delivered to a chute from which they can be removed into bags. As originally supplied the machine was very noisy. In the idling condition with the motor running the disc in the hopper rang continuously, while the side panels of the base structure vibrated under excitation from the motor. The coins made a considerable noise when dropped on the platform, which was of plain sheet metal. By far the greatest clatter, however, came from the hopper where the coins are in constant movement on the disc.

The machine was treated as shown in Fig. 2. The platform and the inside of the collecting chute were covered with $\frac{1}{8}$-inch rubber sheet. All panels were deadened with $\frac{3}{8}$-inch felt sheet. The motor was mounted on rubber suspensions. The hopper and counting mechanism were enclosed in a box with a rubber flap for the entry of the coins. The lower half of the box could be dropped by means of a foot-operated pedal for removal of the coins. The noise level was measured near the machine before and after treatment and a reduction of 13 db was attained. The boxing-in of the hopper was demonstrated to be an essential feature of the treatment, for if the perspex flap above it were lifted the noise rose again to the untreated level.

The reduction of the counting noise by as much as 13 db represented a considerable improvement, and the final level would have been acceptable. Unfortunately, however, the ease of operation of the machine was impaired by the addition of the treatment and so some other solution of the problem had to be found. A machine of this type was therefore installed in the corner of a room and partially screened by a glass partition about 6 feet high. The normal noise level of the office rose by 9 db when the machine was running. When acoustic tiles were fixed to the ceiling and part of the walls of the enclosure, the noise level outside was reduced only by 2 to 3 db: the direct path for the noise over the partition was still giving rise to high readings.

At another office, a similar machine was operated within a specially built cubicle. This enclosure was properly constructed with brick walls containing double-glazed observations windows and provided with a ceiling to prevent upward egress of sound. The upper part of the interior was lined with acoustic tiles. This structure was entirely satisfactory, and reduced the noise measured in the room to a figure only 2 db above that caused by the occupants in the normal course of their work. In fact when the machine was operating only a faint "tinkling" could be heard in the office.

The example quoted gives point, it is hoped, to the fact that noise suppression in common with other engineering processes is a matter of compromise. A simple solution of a problem may be both effective and inexpensive, but if there are conflicting requirements then more elaborate measures must be taken to achieve the same end. In fact frequently the degree of noise reduction achieved is proportional to the length of one's purse.

Colour Television

Colour television on eight United Kingdom manufacturers' sets was demonstrated to 100 members of the Television Study Group of the International Radio Consultative Committee (C.C.I.R.) in London during April—part of a four-nation test for the Committee.

"The sets displayed an almost unlimited variation of colour tones, apparently depending on the whims of their operators, who were probably all skilled engineers," *The Times* commented, adding, "One was left with the thought that the final answer to colour television has yet to be discovered."

The *Manchester Guardian* said that to the layman there was nothing to choose between the quality of the picture and the best colour film at a commercial cinema, but some sets showed a distressing tendency to "wander". The *Guardian* also recorded that the consensus of delegates seemed to be that colour transmissions were not yet as advanced anywhere else outside Britain and the United States, and that the transmissions here showed higher quality, in terms of colour faithfulness and definition, than those in America. In a leader, the *Guardian* hoped that the I.T.U., in August, will decide on a unified system for European colour television.

The London Telephone Weather Service

"Argus"

A telephonist making a recording of a new forecast

"*HERE is the London area forecast for nine hours. The night will continue dry with clear skies. Slight frost will occur around dawn in some of the outer suburbs, but in most places the minimum will be about 35 degrees. The morning will be dry and sunny with temperature steadily rising. There will be a rather cold north-west wind.*"

These were the words that greeted a London subscriber who, suffering from insomnia perhaps, had dialled WEA 2211 in the early hours of Monday, March 5, 1956. Within a year of the formal authority being given, the Post Office, with the co-operation of the Air Ministry and the Automatic Telephone and Electric Company, had designed, installed and brought into service the first Telephone Weather Forecast Service in the United Kingdom.

The Meteorological Office of the Air Ministry is responsible for making the forecasts which cover a circle of about 20 mile radius from Oxford Circus. The period for which the forecast applies is stated in the text of the messages and new forecasts are prepared by the Meteorological Office as often as considered necessary. New issues at night will probably be less frequent than those by day.

The forecast messages are called over by telephone to Holborn telephone exchange switch-room where they are written down. A recording telephonist then takes them to a recording room where they are put on a tape recorder. The recording telephonists are all volunteers from the day and night staffs of Holborn exchange and they take it in turns to make the recordings during their normal tour of duty.

The recording equipment consists of three commercial tape recorders with continuous tapes. One revolution of the tape takes 30 seconds and the recorded messages are all phrased to contain approximately 70 words or 35 words. A 70-word message takes about 28 seconds to record and a 35-word message can be read twice in 29 seconds. Normally one recorder is transmitting the current forecast, another is a standby with the same forecast recorded on it and the third is in reserve. If the first machine fails, the second will be automatically switched into use and the third will be made the standby. There is a fourth

machine which is used to replace any of the other three which should happen to be withdrawn for maintenance.

When a new forecast is to be recorded, an engineer erases the old recording from the *standby* machine and resets a clock which is in front of the recording telephonist. When the telephonist is ready to record she presses a button which starts the clock and connects her headset instrument to one of the two free recorders. The clock runs for 30 seconds and then disconnects the operating instrument. The telephonist has to record the forecast without leaving more than a couple of seconds at the beginning or end of this period. (This is because the automatic change-over device is operated by any silent period of more than 5 seconds' duration.) A number of attempts can be made if needed, but when the recording is satisfactory it is repeated on a second machine. The machine carrying the former forecast is then withdrawn from service (becoming the new "standby") and is replaced by one carrying the new forecast.

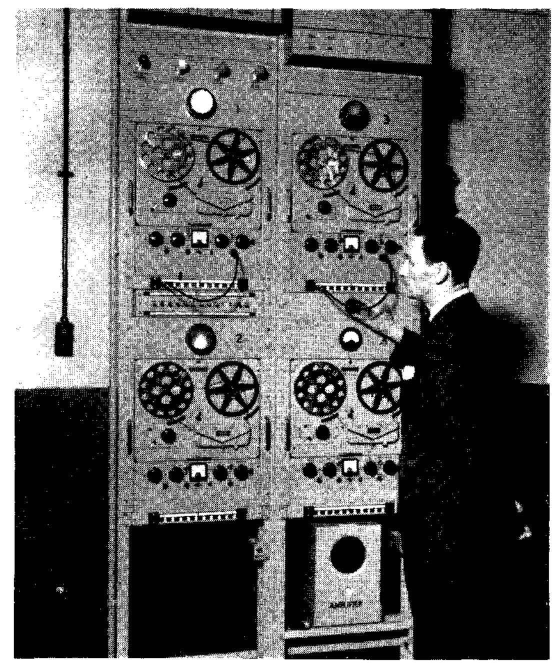
The whole operation of changing the forecast takes very little time; even allowing for the recording telephonist making several attempts before being satisfied a new recording is in use in well under 15 minutes from the time of receiving the message from the Meteorological Office.

The switching equipment is installed in Holborn and Museum tandem exchanges and consists of racks of specially modified final selectors which operate to the first two digits of the numerical number (22). When a selector has been switched its testing circuit is disconnected; up to five selectors on any rack can be switched simultaneously and any number can remain switched to the same outlet. The recording is fed over one channel to Museum tandem switches and over two to Holborn tandem switches; it is distributed over the final selector banks via standard amplifiers, the output impedances of which are low enough to prevent overhearing.

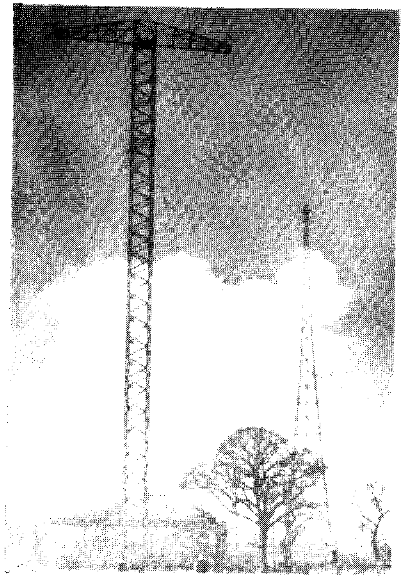
London subscribers in the Director area dial WEA 2211 for the service and the translation of WEA routes their calls via the main tandem network to the final selectors, but the last two digits (11) are inoperative. Subscribers outside the Director area, but within dialling range of central London exchanges, dial a numerical code followed by 2211 and their calls are routed via London Toll B exchange to one of the two tandem exchanges mentioned. Any other subscribers in the country can be connected on demand to the service but it has been necessary, at the outset, for long distance calls to be routed via an intermediate switchboard in London. The charge for a call to the service is the same as that for a call to a subscriber on any exchange in the London 5 mile circle.

This first Telephone Weather Forecast Service has given some relief to the forecast service given direct by the Air Ministry on Holborn 3434 but, of course, a more extensive service is available from the Ministry and forecasts for areas other than London can still be obtained from the Holborn number. Meteorological offices in other parts of the country also provide forecast services obtainable by telephoning the local office.

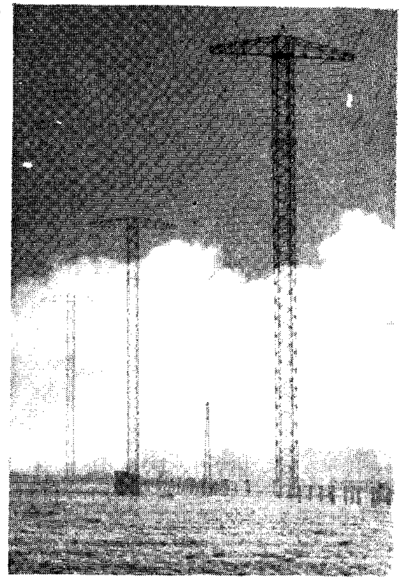
If the London Telephone Weather Service is a success (and there is every indication that it will be) similar weather forecast services could be extended to other parts of the country. The forecasts for other areas could also be made available to subscribers in London from an extension of the present equipment, a number such as WEA 2311 being used.



An engineer at the recording apparatus racks switching a new forecast to the outlets of the final selectors, which have a capacity of a quarter of a million calls per week



Brentwood Radio-Telegraph Receiving Station



H. Beatson, A.M.I.E.E.

BRENTWOOD RADIO STATION, WHICH IS about 20 miles from London, is one of the four large Post Office receiving stations operated by the External Telecommunications Executive for their overseas point-to-point services.

The main function of the station is to receive radio-telegraph signals in the frequency range 3 to 27.5 Mc/s from various places overseas, and to convert them into stable landline signals as free as possible from mutilation and distortion. The received signals are passed over equipment associated with the normal inland telecommunication network to Electra House, the Central Telegraph Station of the Post Office Cable and Wireless Services, described in the Autumn, 1955, *Journal*.

Brentwood is one of the oldest point-to-point receiving stations in the world, having been opened by Marconi's Wireless Telegraph Company in 1922 to receive long and medium wave signals from the Continent and the United States.

Long distance high frequency working has grown since 1926 and long wave or low frequency working has been gradually superseded so that today only a few such services are in operation. The large Bellini-Tosi crossed loops, supported on 200-foot self-supporting towers and used for long and medium wave directional reception, still remain and are now probably the largest in everyday use. Concurrently with the gradual change-over to high frequency propagation, the site has gradually expanded from the original 11 acres in 1922 to 284 acres at the present time.

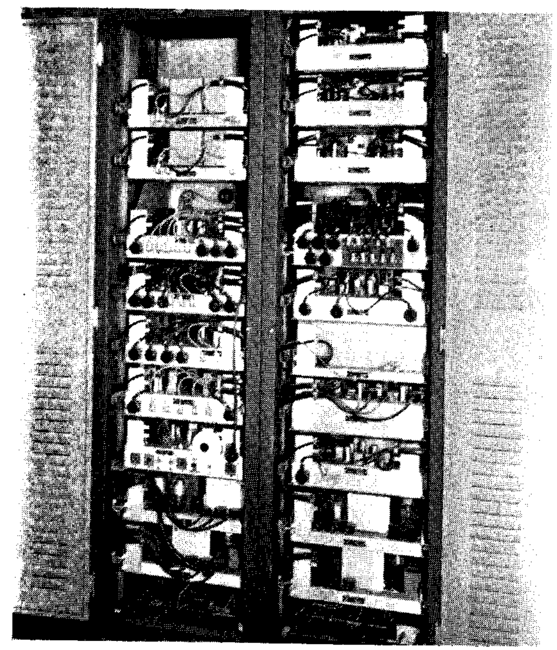
Directional aerials are used to reduce interference both from other stations and from electric storm centres. For reasons of space, among others, the aerials in common use at Brentwood take the form of horizontal arrays of dipoles, but four extremely directional Franklin Beam arrays are used for receiving signals from Nairobi and Salisbury, Rhodesia.

High frequency signals received over long distances are subject to very rapid fluctuations of strength; however, the signals observed at two places separated by as little as a few hundred yards are found to vary in quite different ways and it is possible to combine the two sets of signals in such a manner as to produce a combined signal which is more stable than either separate signal. This method, known as double diversity reception, is extensively employed at Brentwood.

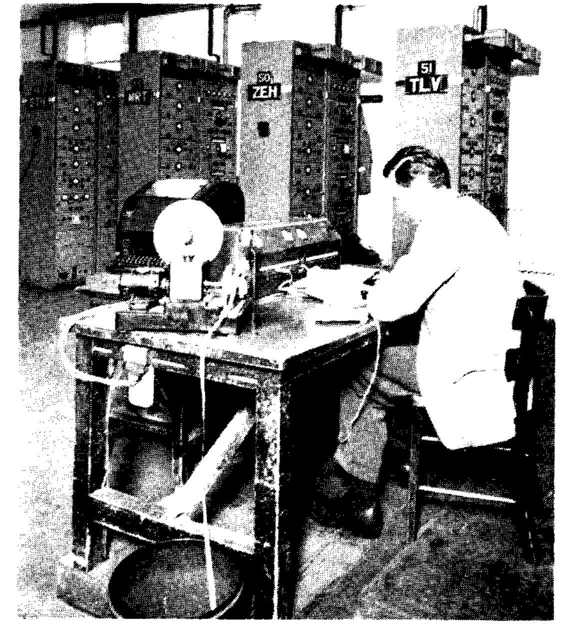
Thirty pairs of aerials are provided for the night and day frequencies on which up to 45 services are received. Several services use the same aerials and signals from places such as Beyrouth, Tel Aviv, Damascus, Bahrain, Amman and Athens, all in the same general direction, are received on one pair of aerials.

The aerials are connected to the buildings by coaxial cables, which are buried, or suspended well above the ground, to allow maximum use of the site for agriculture. Owing to the rather high losses experienced on this type of high frequency cable, concentration of the higher frequency aerials close to the station buildings is necessary. This limitation does not apply to the same extent to frequencies below 10 Mc/s, and some of the lower frequency aerials are connected to the receiving station proper by feeders over 1,000 yards long.

The buildings at Brentwood reflect the expansion in point-to-point radio communication that has taken place over the years, wings having been added or lengthened from time to time as required. The present front entrance dates from 1923 and was originally a battery room. Two large wings contain the high frequency receivers and one wing the 10 remaining long wave receivers. The landline and monitoring equipment is concentrated at the junction of the three wings, while the aerial switching board, with its associated amplifiers, is accommodated in the south or central wing.



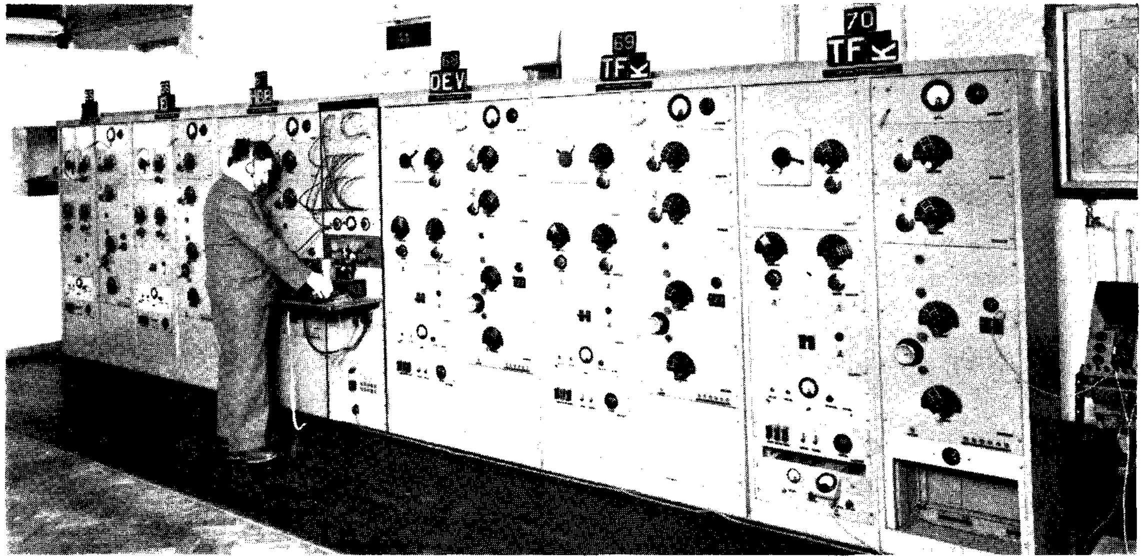
Rear of HR 91 receiver with doors open showing inter-unit cabling and general assembly



West Wing monitoring position showing undulator and teletype. HSR 1 type diversity receivers in background

This aerial coupling and switching installation is very necessary, as over 50 pairs of receivers are fed from 30 pairs of aerials, and at times up to 11 receivers are connected to one aerial. Each aerial is connected to an Aerial Coupling Unit, which consists of an amplifier having six outputs, and it is possible to use additional amplifiers should this be necessary.

Each amplifier is preceded by a filter which ensures that any interference set up in the amplifier by very strong signals from nearby transmitting stations is kept either well below a significant level, or outside the specified frequency range of the unit. This protection is of great value, especially in the reception of telegraphy, as sometimes very weak signals have to be picked up and converted into readable messages. The installation provides 64 amplifiers, the outputs being connected to the main board by lengths of lead-covered coaxial cable of small dimension. Flexible patching cables, with robust plugs and sockets, are used for commutation (altering direction of current) and it is possible to connect any receiver to any aerial.



South Wing showing group of long wave receivers (type Red. 2) and monitoring position

Various types of receiver are required to cover the different systems of transmission. The more commonly used systems are:—

1. *On Off Keying*. In this system the radio signal is switched on and off in accordance with the code in use.

2. *Frequency Shift Keying (F.S.K.)*. In this system the intelligence is conveyed by changing the frequency of the radio signal in accordance with the code in use. The change in frequency ranges from 60 c s on the lower radio frequencies to between 300 and 800 c s in the high frequency band.

3. *Frequency Shift Diplex*. With this method two channels of intelligence are carried on the one radio transmission by changing the frequency in accordance with the four possible conditions:—

		Frequency
Mark on Channel A.	Mark on Channel B.	1
Mark on Channel A.	Space on Channel B.	2
Space on Channel A.	Mark on Channel B.	3
Space on Channel A.	Space on Channel B.	4

The frequency interval between each condition is 400 cycles.

4. *Independent Sideband Voice Frequency Working*. With this system separate telegraphic signals are simultaneously transmitted on a multi-channel basis, at a series of frequencies which may range slightly above or slightly below (but not both) the nominal frequency (wavelength) of the transmission; each of these frequencies is varied in accordance with one of the separate telegraph signals. Such a system is also known as Frequency Division Multiplex. The radiated signals can be collectively received on a single radio-telephone receiver and separated by normal voice frequency telegraphic methods, or they can be received as individual frequency shift transmissions on separate frequency shift receivers.

Receivers

Fifty pairs of high frequency diversity receivers, ten long wave receivers and five general purpose receivers are in use on the station. The high frequency receivers are of four distinct types of various ages. The oldest came into use in 1941, but all are superheterodynes having two or three intermediate frequency amplifiers.

A high speed radio-telegraph receiver must have a high standard of performance, especially in selectivity. The use of a narrow filter to select a weak and variable signal from among a number of adjacent signals, generally much stronger than the wanted signal, also calls for a high degree of frequency stability; this is obtained by using quartz crystal oscillators and automatic frequency

control. The level of the received signal must be limited, and the width of the individual signal elements, lengthened to a variable degree by propagation phenomena, kept constant.

An ordinary general purpose receiver can be used on a high speed circuit if these requirements are to be met only by fitting additional units and complicated circuitry. For this reason, 7-foot high cabinets, 22 inches wide, have to be used to accommodate the complete receiving unit. A typical example of the modified general purpose receiver is the CR 150 2, 14 of which are in use at Brentwood. Another type in use is the recently developed HR 91, which gives outstanding performance. This is a double diversity On Off or Frequency Shift Keying receiver designed for use on main line, 24-hour, heavily loaded circuits using the same frequencies over long periods. A double superheterodyne instrument, it uses 122 valves and is contained in a 7-foot high cabinet. A high degree of frequency stability is obtained by using crystal controlled first oscillators with as an alternative a continuously variable LC oscillator of comparable stability.

An electro-mechanical automatic frequency control unit keeps the receiver very accurately tuned to the incoming radio-telegraph signal.

Three pre-tuned signal frequency ranges are available and the receiver is switched from one frequency to another by a single control.

The receiver, normally set up for a particular circuit, has protecting doors which are kept closed and locked. Only the necessary operational controls, gain, signal bias, frequency selection and automatic frequency control are accessible to the operator. This makes for considerable ease and simplicity in operation and prevents accidental maladjustment of the pre-set controls.

The performance of this receiver is such that under normal conditions it needs no attention apart from the morning and evening frequency changes made to suit propagation conditions.

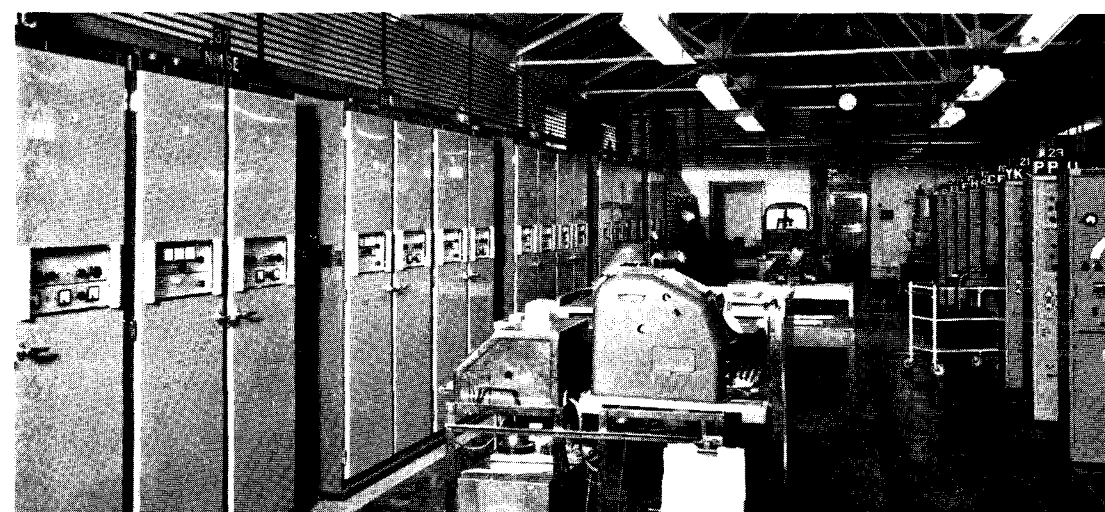
Relay of Signals to Electra House

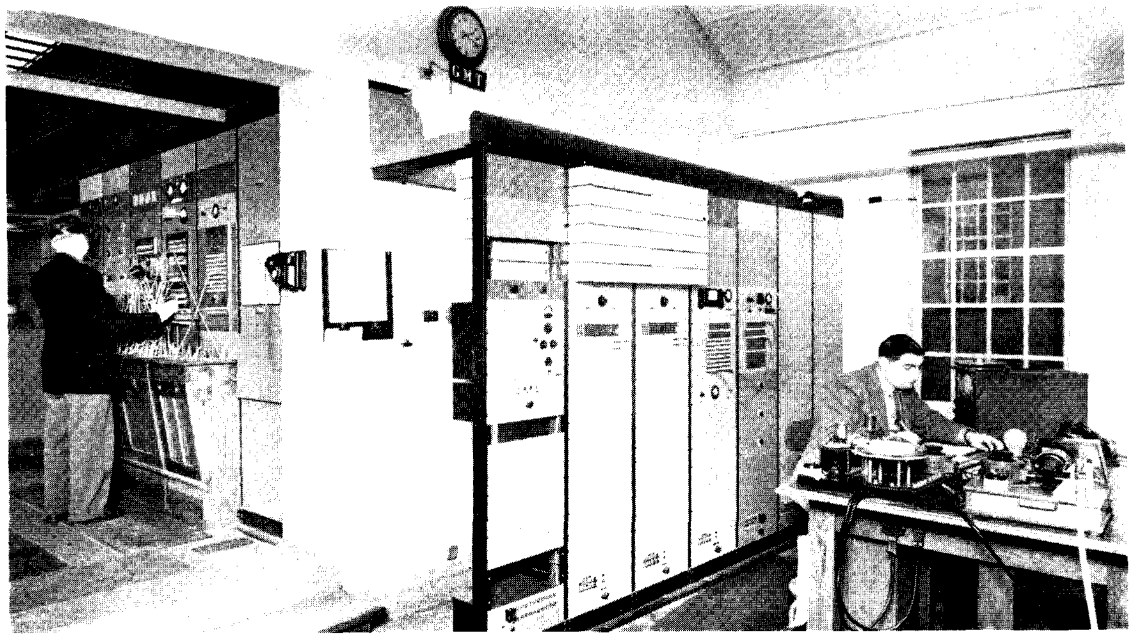
The direct current signals supplied by the receivers operate special Frequency Modulated Voice Frequency channels connected to the Control Room at Electra House. Up to 60 channels in various groupings and systems are available for use as required.

To keep the radio-telegraph circuits functioning efficiently it is necessary to ensure very close liaison with the Control Room staff at Electra House, and telephone, teleprinter and morse order wire circuits are provided. These order wire circuits are in constant use for passing instructions about required frequency changes, complaints regarding faulty transmissions or interference and requests for the supply of additional channels or other facilities to meet operational requirements.

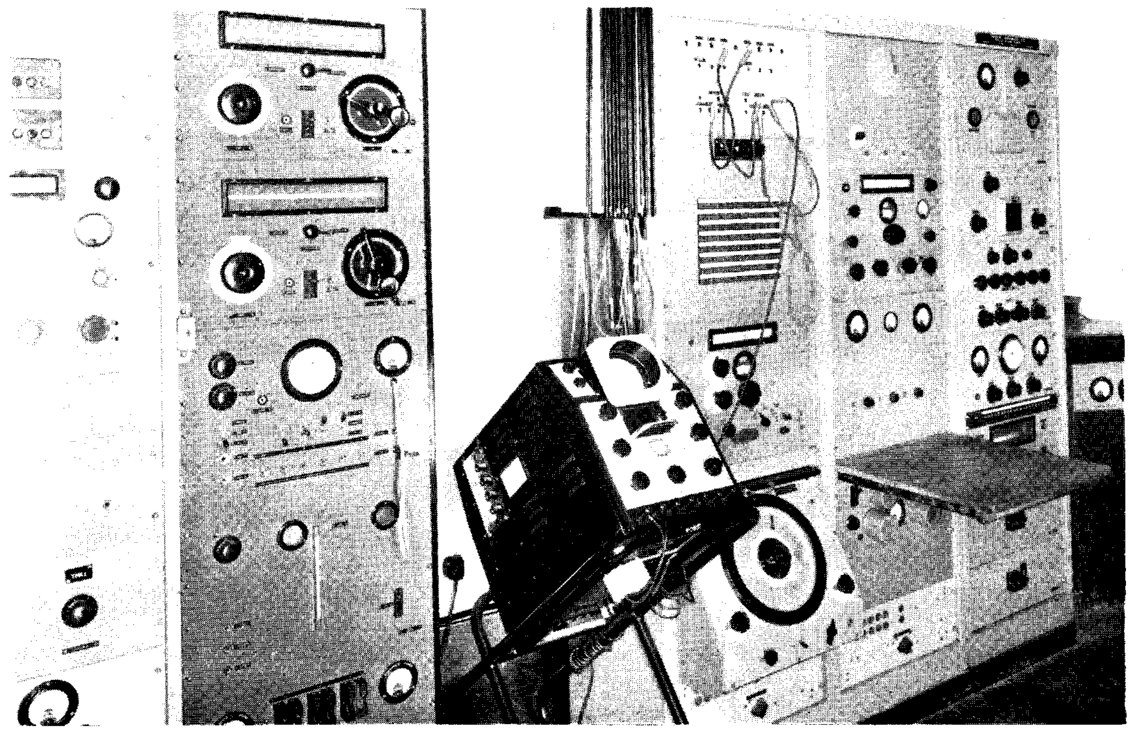
Extensive signal monitoring is required to determine the presence of failures in the received

General view of South Wing showing HR 91 receivers (*left*) monitoring positions and trolley undulators





Above: Landline and Voice Frequency channelling equipment *Below:* Frequency measuring and monitoring equipment



signal, and whether failures are due to faulty transmission, propagation effects, interference or receiver faults.

The simple undulator tape recorder combined with audio monitoring by skilled staff provides the quickest means of detecting failures; for more detailed engineering purposes and for detecting faults in the more complex types of transmission such as Frequency Shift Diplex, oscilloscopes are used. In addition to fixed central monitor positions, undulators mounted on trolleys are also available and can be used alongside the receivers when they are being adjusted.

All radio transmissions are allocated specific frequencies which are registered with and approved by the International Telecommunication Union.

The radio frequency spectrum available for point-to-point working was greatly reduced by the International Telecommunication and Radio Conference at Atlantic City in 1947. Because of increased congestion it is essential that transmitters operate on their assigned frequency; a tolerance of ± 0.003 per cent. is allowed on point-to-point transmissions within the band 4 to 27 Mc/s; that is, ± 300 c/s at 10 Mc/s and ± 600 c/s at 20 Mc/s.

Frequency Monitoring

To avoid mutual interference and to ensure economical use of the frequency spectrum, transmissions are observed and measured by comparison with frequency standards having an accuracy better than ± .00001 per cent. or one in ten million. This work is carried out by monitoring stations at Brentwood and Baldock, both stations being in close touch with the transmitting and receiving stations of the External Telecommunications Executive.

Although the investigation of direct interference between stations operating on or near the same frequency constitutes the largest part of the monitoring stations' work, indirect interference caused by modulation or keying spread, and in some instances, faulty or unwanted spurious emissions, gives rise to many complaints. When interference is confirmed, it is taken up with the administrations concerned, and close liaison is maintained to make the frequency adjustments necessary.

The mechanical and electronic maintenance of a large number of high grade receivers is a problem of some magnitude. A system of minor and major routines carried out by separate maintenance teams of technical officers is necessary if the performance of the receivers is to be kept up to the required standard. A wide range of test equipment is used, including signal generators, ganging oscillators, valve voltmeters and oscilloscopes.

Many small parts and consumable spares have to be carried and the stores organization is of considerable importance. More than 5,000 valves (of 109 different types) are in use and the replacements roughly number 1,000 per annum.

Staffing

A staff of about 80 is needed to ensure that this large radio receiving station is self-reliant and efficiently operated for 24 hours a day every day of the year. The staff work on either shift duty or day duty, in about equal proportions, the day staff being exclusively concerned with administration, equipment maintenance and installation.

Shift duty staff are responsible for the efficient operation of the telegraph circuits and for any first line or emergency technical maintenance; six Technical Officers under a Shift Duty Assistant Engineer are engaged in this work on each shift. The numerous aerial systems and their associated masts and rigging call for the attention of a skilled rigging gang composed of specialists used to working at considerable heights; a gang consisting of a foreman and riggers is continually employed on this work.

Once a small station on the outskirts of a pleasant country town, Brentwood is now a large station surrounded by large municipal housing estates and threatened by major road developments. While this tends to obscure the future, Brentwood can look back with pride on the fact that, as a result of the development work and equipment testing carried out on the station since the day it was first opened, it has played an important part in the great technological and operational improvements that have been made in the field of high speed radio-telegraphy.

Many of the techniques developed and perfected at Brentwood will go a long way towards assisting the External Telecommunications Executive to extend and improve the high standard of service it renders, both directly and indirectly, to its clients and associated organizations at home and overseas.

NORTH-WEST TELEPHONE AREA—LONDON

The Zoological Gardens—commonly known, as the guide books say, as "the Zoo"—Lord's Cricket Ground, home of many Tests, Wembley Stadium where the Cup Final is played, and Harrow School, one of England's oldest and greatest public schools, are among the famous places within the North-West Area of London Telecommunications Region.

Stretching from the north-west postal area, beyond Greater London into the "Green Belt" districts of Middlesex and Hertfordshire, the Area contains probably more of "London's lungs" than any of the other seven metropolitan areas. It includes Regent's Park and Primrose Hill as well as the 280-odd acres of Hampstead Heath. Nevertheless, it is, on the whole, a densely populated Area as well as being, in parts, highly industrialized.

In addition to the older urban districts round Regent's Park, it includes the rapidly growing residential estates of the north-western suburbs, and it contains a garden suburb lying between the metropolitan borough of Hampstead and the Middlesex county boroughs of Hendon and Finchley.

North-West Telephone House

Among industrial districts, the Area includes Park Royal, where Guinness is brewed and the *Radio Times* is printed, and Watford, home of modern colour printing. Elstree, celebrated for film production, gives the name to one of the Area's exchanges.

The Area, which covers about 140 square miles, provides a good illustration of the rapid expansion of the telephone services since the war; during the past 12 years the number of exchange connexions has almost doubled. Today there are 190,000 connexions and 280,000 stations. Nearly 4,000 people serve subscribers in the Area through 32 automatic and six manual exchanges.

★

Left to Right (standing): J. F. CONSTANTINE, Chief Sales Superintendent; D. C. THOMPSON, Chief Clerk; C. A. PRIDE, A.M.I.E.E., Area Engineer; E. PALK, A.M.I.E.E., Area Engineer. (The Chief Telecommunications Superintendent, F. Knowles, was unable to be present.)
Left to Right (seated): E. M. GLEADLE RICHARDS, B.Sc., M.I.E.E., Area Engineer; H. M. de BORDE, Deputy Telephone Manager; A. HUDSON, B.Sc., A.M.I.E.E., Telephone Manager; Miss G. M. STANFORD, Telephone Manager's Secretary; C. F. THOMAS, A.M.I.E.E., Area Engineer.

Transistors and their Uses

T. J. Rowe, B.Sc.

THE WINTER, 1956, ISSUE OF THIS *Journal* contained an article on "Transistor Materials" which described how germanium is prepared for use in transistors, and the way in which free negative electrons and positive holes give rise to its electrical conductivity. This article explains the construction of various types of transistor and presents a simplified explanation of their method of operation. Some account is also given of their immediate and possible application.

The function of a thermionic valve, such as is used in a wireless set, depends on the ability to control the flow of negatively charged current carriers (electrons) across the vacuum which exists within the familiar glass bulb. The carriers are generated by heating a carefully prepared mixture of oxides, which has been partially reduced so that some free metal atoms are present. Some of the electrons which are "bound" to the metal atoms at room temperature become jostled about so violently that they escape and become available for carrying current.

A transistor depends for its action on the existence of two types of current carrier—electrons, which are negatively charged, and "holes", which are positive and behave much as electrons would if they were positive instead of negative. As described in the earlier article on "Transistor Materials", carefully controlled amounts of certain impurities can be added to pure germanium so that it becomes either n-type (that is, when the current carriers within it are predominantly electrons) or p-type (when the current carriers are predominantly holes). An important point to note is that the application of voltages to the electrodes of a transistor results immediately in the flow of current since the necessary current carriers are available at room temperature; consequently, there

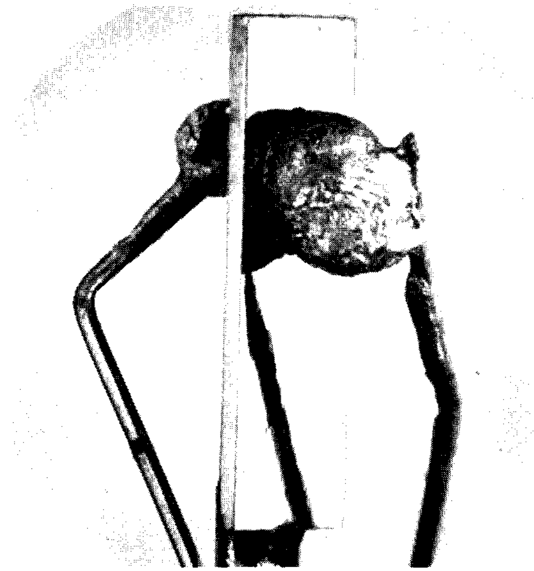


Fig. 3b: A p-n-p alloyed junction transistor—see also diagram 3a

is nothing in a transistor corresponding to the heater of a thermionic valve.

If one section of a germanium crystal is p-type and an adjacent section is n-type, the transition region is termed a "p-n junction". It acts as a rectifier in that electric current can flow through it much more easily in one direction than in the other. Similar rectification occurs at most metal to semi-conductor contacts, and in particular when the point of a thin metal wire (usually called a whisker) is pressed on to a germanium surface. Practically all present transistors consist essentially of two rectifying junctions in series such that their directions of easy current flow oppose one another; thus there exist p-n-p and n-p-n transistors. The p-n-p type, with which this article will be primarily concerned, is by far the commoner.

Construction and Principles of Operation

The first transistors were of the "point-contact" type. They consisted of two metal whiskers pressing on the surface of a piece of n-type germanium and placed within a thousandth of an inch of each other; a soldered contact at the base formed a third electrode (see Fig. 1). The emitter whisker, biased in the easy flow (low resistance) direction, results in a flow of positive holes into the crystal; these flow towards the collector whisker, which is biased in the reverse (high

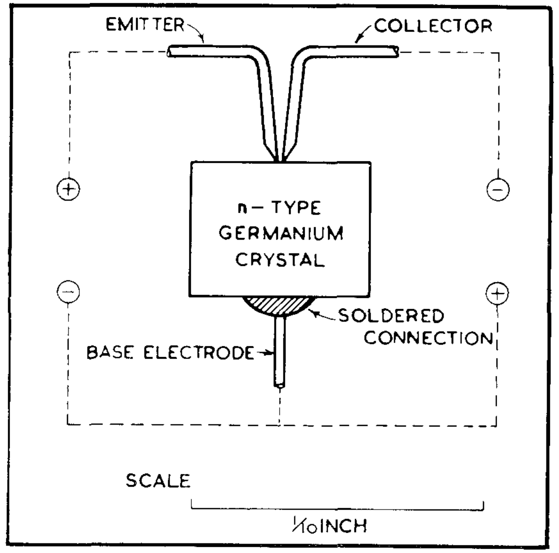


Fig. 1 : A germanium point-contact transistor

resistance) direction, and augment the relatively small current which flows between collector and base. The changes which thus occur in the collector current may, however, be three or more times the size of those which occurred in the emitter current, so that, in addition to the considerable power gain which is a feature of all transistors, a current gain occurs also in the point-contact type.

Such a delicate device, depending so critically on the spacing of the whiskers, was found in practice to be less reliable than was first envisaged. A device of more rugged design, and having several other desirable properties, is the junction transistor. One form consists of a miniature bar of germanium (80 × 20 × 20 mils†) both ends of which are the same type, but having between them a thin (2 mil) central region of material of the opposite type (see Fig. 2). Current carriers "injected" at the emitter junction diffuse across the thin central region, known as the base, and give rise to changes in the collector current. The power gain for junction transistors (typically 1,000) is even larger than for point contact types. The current gain between emitter and collector is always less than unity, however, because some small fraction (normally one or two per cent.) of the injected carriers are annihilated in the bulk material of the central region, at imperfections in

† 1 *mil* = 1 1,000*th inch.*

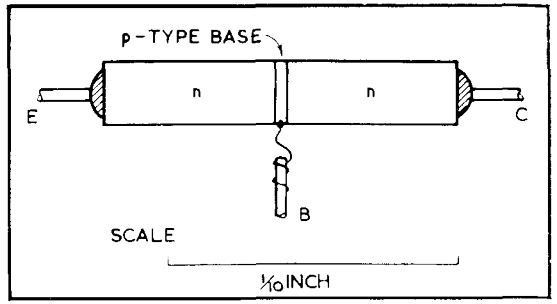


Fig. 2 : An n-p-n grown junction transistor

the crystal, and especially at contaminated areas on its surface.

Careful preparation of the germanium surface and scrupulous cleanliness are essential in the fabrication of transistors. A newly-made unit in good condition can be dipped into perfectly clean water, and when dried will show no deterioration in properties. But similar immersion in a solution containing only about one grain of some chemicals in a thousand gallons of otherwise clean water, followed by drying, may result in a completely ruined transistor. Moisture, even in the absence of accompanying contaminants, can have very undesirable effects. Such a sensitive structure naturally has to be sealed into a perfectly gas-tight enclosure if its originally good properties are to be maintained; many early failures of transistors were due to the infiltration of water vapour through imperfect seals.

The alloyed junction transistor (now the most common form) is made by accurately placing two tiny pellets of indium (a p-type forming impurity) on opposite sides of a thin wafer of n-type germanium, and then heating the combination to about 550°C. Some germanium dissolves in the indium, and subsequent controlled cooling results in the crystallization of two p-type regions with n-type material sandwiched between them (see Figs. 3a, 3b). Connexion is then made to each of the indium pellets and to the germanium, the result being a p-n-p transistor.

Discussion so far has been concerned with units in which changes of collector current are the direct result of carriers being injected from the emitter electrode. Carriers are also produced, however, when light falls on a crystal of germanium, so that if light is directed at the emitter side of a transistor, the changes which occur in the collector current are a direct indication of the changes in illumination occurring at the emitter. Devices which depend on this type of action are called photodiodes and phototransistors.

Applications

The first large scale application of transistors has been in hearing-aids where they enable lighter units to be made than was possible with valves, and much reduce battery consumption. Almost without exception hearing-aids now made in America use transistors.

Samples of two-types of audio-frequency transistor line amplifiers, designed by the Post Office, have been placed on field trial; a larger trial, involving about fifty equipments, is planned to begin shortly. These units are about one-third of the size of corresponding valve types, and consume only about one-eighth of the power. Reliability can be proved only by lengthy tests, but failures have so far been infrequent.

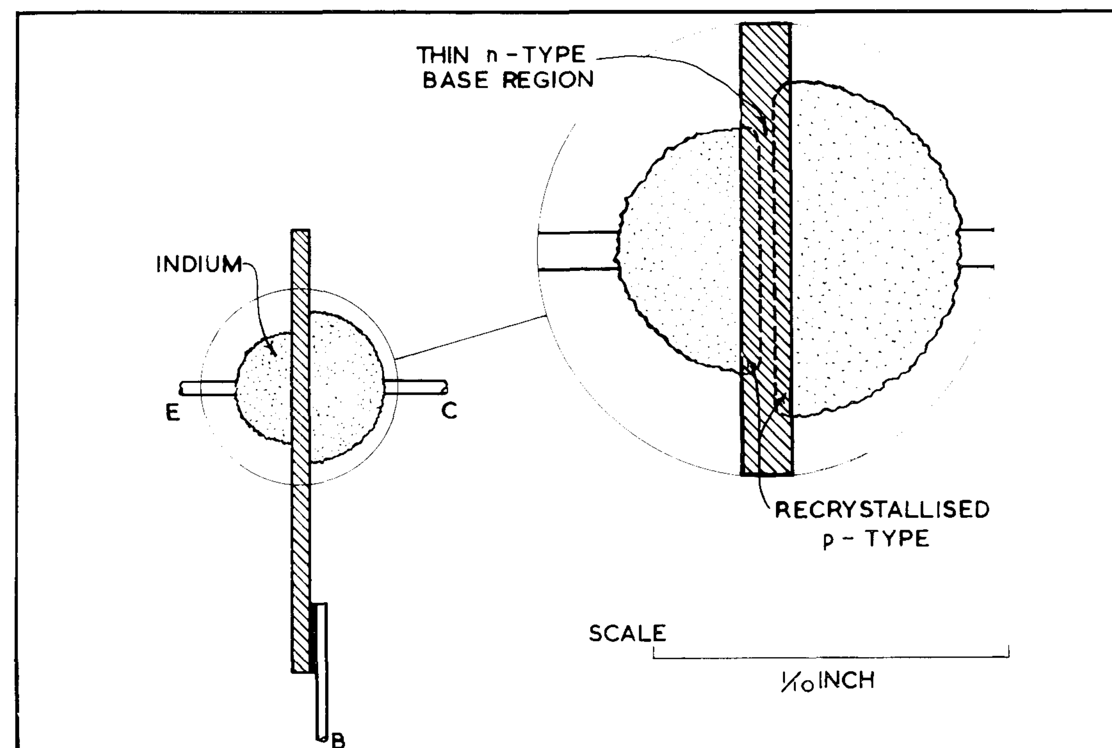
Interest in the transistor as a telecommunications component lies not only in its own small size, but also because accompanying equipment, particularly the power supply, is much less bulky than that required to drive thermionic valves. Technically, very much of the Post Office requirements in the audio and telegraph fields can be met by the use of transistors. The transistor seems particularly suitable in some new switching systems which are under development in Britain, Europe and the United States. Although present junction transistors are capable of switching at only one-tenth of the speed of valves, they are still sufficiently fast for many purposes.

Photodiodes and phototransistors may be useful in punched card systems; they have already been used in the card translator—a call routing machine which forms part of the Bell 4A Crossbar System for long distance dialling of telephone calls.

Limitations

The number of current carriers (electrons and holes) normally present in a transistor increases very rapidly with rise of temperature. Such an

Fig. 3a : A p-n-p alloyed junction transistor



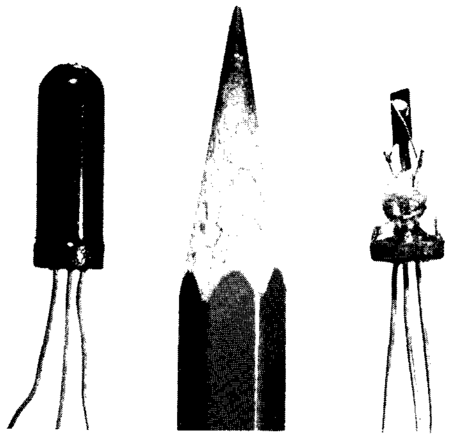


Fig. 4: Comparison of a completed and an unencapsulated transistor with a pencil point

increase in the concentration of carriers results in relatively high parasitic currents and consequent wastage of power which appears as heat. This in turn can result in a further increase in temperature, even higher currents, until finally the excessive heat produced is sufficient to destroy the transistor. For this reason germanium transistors are unsuitable for use at temperatures above about 60 C. Silicon, which has proved to be much more difficult to purify than germanium, is much less seriously affected by changes of temperature, and grown silicon n-p-n transistors, which are suitable for use up to 150 C., are now available in the United States of America.

The range of frequencies over which a transistor can be used is limited because the gain falls when the repetition time (that is, $\frac{1}{\text{frequency}}$) of an incoming signal becomes comparable with the time that it takes the injected carriers to travel from emitter to collector. In the point-contact transistor the holes are actually swept towards the collector in much the same way as a pile of marbles dropped into a gutter would be swept along by a stream of water. In a junction transistor, on the other hand, the holes travel across the base region by diffusion only; that is, in a manner similar to that in which a small leak of gas (issuing from a gas-stove for example) will flow out through an open door even in the absence of any draught. Thus although the distance between the whiskers of a point-contact transistor is about the same as the width of the base region of most junction types, the point-contact transistor is often suitable as an amplifier up to tens of megacycles per second, whereas the common junction type is confined to use below about one megacycle per second. However, recent improvements in design and methods of manufacture have enabled new junction units to operate at frequencies comparable with the limit of the point-contact type, so that the junction may be expected to challenge the point-contact for applications in which the latter is at present the better.

Soon after the discovery of transistor action in 1948, it was suggested that thermionic valves would ultimately be replaced by these tiny devices, but certainly it is still too early to make such a generalization. The outstanding advantages of the transistor are its ability to operate at low voltages and the absence of heaters. At low power the transistor is a very efficient device, and it is reasonable to suppose that in applications to which the transistor is especially suited, its substitution for the thermionic valve will eventually be made.

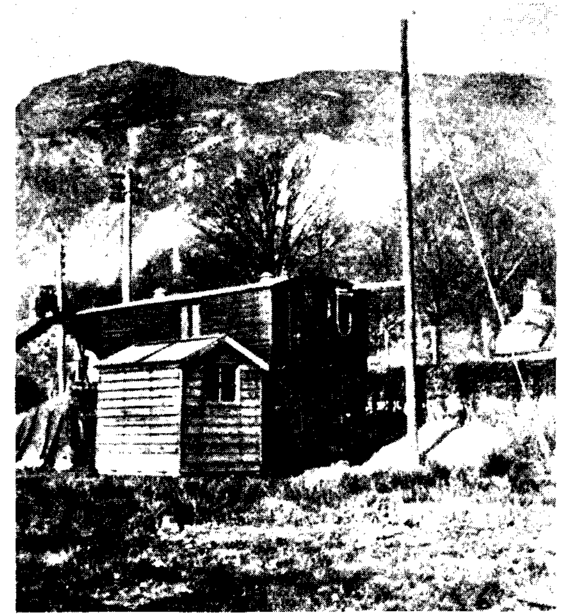
Rather than as a competitor to the valve, the transistor should be regarded as an additional and far-reaching tool in the hands of the electronic engineer.

Awards for Technical Writing

Mr. A. W. M. Coombs, of the Post Office Engineering Department, was awarded one of the 25-guinea premiums given by the Radio Industry Council for articles published in the public technical press in 1955; his article was on "'Memory' Systems in Electronic Computers", published in *British Communications and Electronics*. Mr. I. A. Ravenscroft, Mr. R. W. White and Mr. J. S. Whyte, also of the Post Office Engineering Department, were awarded jointly two premiums for three articles in the *Post Office Electrical Engineers' Journal*. The articles were: "A Frequency Modulator for Broad-Band Radio Relay Systems" (Ravenscroft and White), "Equipment for Measurement of Inter-Channel Crosstalk and Noise on Broad-Band Multi-Channel Telephone Systems" (White and Whyte) and "An Instrument for the Measurement and Display of V.H.F. Network Characteristics" (Whyte). We congratulate our more technical contemporary and the writers on gaining awards out of 62 articles submitted.

Mobile Automatic Exchanges

J. Atkinson, M.I.E.E.



The caravan under the quarried face of Craigmore, Scotland

BEFORE 1929, WHEN THE CONVERSION OF THE telephone system from manual to automatic working had been in progress for some years, efforts had been concentrated mainly in the cities and industrial towns. Substantially all the rural exchanges were manual. In general, the revenue from the manual exchange areas was very small, and in a large number of places the traffic did not warrant the provision of a full-time telephonist. Many of the switchboards were installed in sub-post offices, convenient shops or houses, arrangements being made with the occupier for part-time switchboard attendance. Even where full-time telephonists were justified, a considerable proportion of the small rural exchanges were housed in rented accommodation with little or no security of tenure.

It was widely recognized from the inception of automatic telephony that this new method of switching offered particular economic and service advantages in rural and other sparsely telephoned areas. In 1929, a start was made by installing several smaller rural automatic exchanges by purchasing and installing several types of rural automatic equipment designed by the telephone manufacturers.

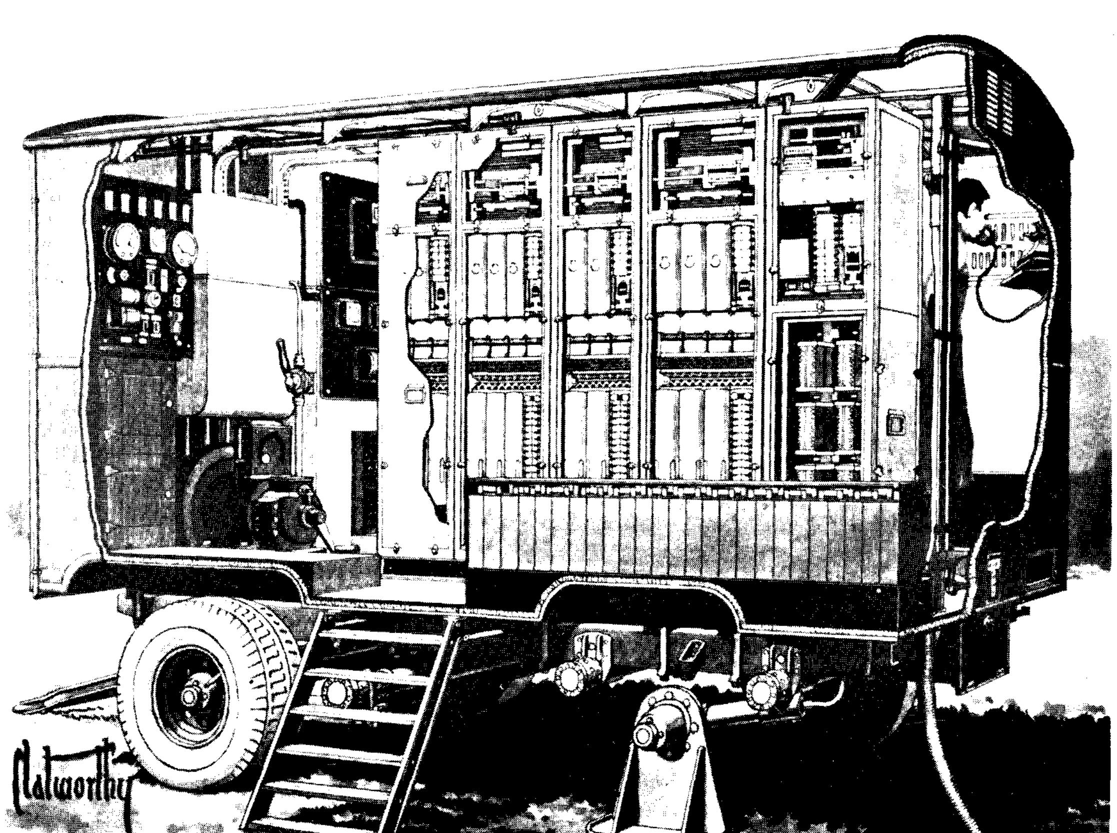
By 1938 a total of some 2,000 rural automatic exchanges had been opened for service. Although the automatic system had expanded to this extent, no fewer than 1,700 small manual exchanges of under 100 lines were still in service. The problems of maintaining continuity of service in the face of resignations, illness or death of caretaker operators and sub-postmasters were not diminishing. The rapid expansion of service in the mid-1930s had resulted in many of the exchanges becoming exhausted, or, where provision could be made for increasing the capacity, the operating load was beyond the capabilities of the part-time sub-postmasters or caretaker operators. However, the Post Office had by this time standardized new types of equipment which gave improved facilities over the earlier non-standard rural automatic exchanges, and it was desirable that the obsolescent non-standard exchanges should be replaced as opportunity occurred.

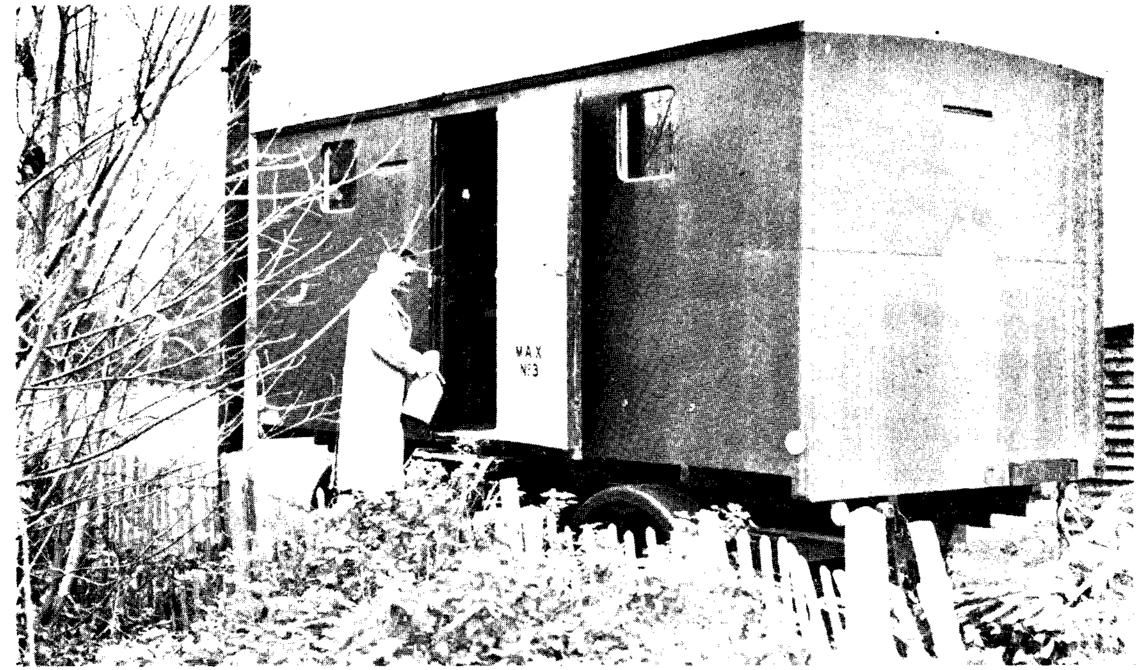
During this phase it became necessary to replace the existing manual exchange at Aberfoyle, Perthshire, in Scotland West Telephone Area. A site had already been acquired for the proposed new automatic exchange, but conversion to automatic working could not await the erection of the building and the installation of the automatic equipment. It so happened that a caravan, originally provided for housing engineering staff when employed in the remoter parts of west Scotland, was in the vicinity, and was not at that time being used for its original purpose. On the initiative of the then Telephone Manager, Mr. F. I. Ray (now Director, London Telecommunications Region), arrangements were made to install standard U.A.X. No. 12 equipment in the caravan to provide quick service at Aberfoyle. This expedient proved highly successful, and the "caravan exchange" was used in the following years to provide quick service at a number of places throughout Scotland. (Its last use was at Tyndrum. The equipment was recovered and, so far as is known, the caravan still remains in the same field—but the clatter of selectors is now replaced by the cackle of hens!)

The success of the Scotland West experiment resulted in widespread demand for mobile automatic equipment which could be used to provide service at short notice in small exchange areas. It was therefore decided that mobile automatic exchanges of more durable and standardized design should be provided nationally. The first of these was brought into service in 1940, and since that date a fleet of 29 mobile exchanges of this type has been built up. These mobile automatic exchanges use the normal standard U.A.X. No. 12 equipment, and have accordingly been designated M.A.X. No. 12. The equipment consists of one C unit, two A units and two B units, and provides for a maximum of 90 subscribers with 10 junctions to the parent or other adjacent exchanges.

The equipment is installed in a specially constructed van type body fitted to a four-wheel trailer. The trailer is of very substantial construction, and was adapted from an original design to meet a fighting Service requirement. Independent springing of each wheel is obtained by a rugged system of torsion bars, which ensure the smoothest possible riding over rough roads. The bodywork consists of an outer and inner shell, fabricated of sheet steel, with welded joints and suitable stiffening members. The space between the two shells is filled with 1-inch thick cork for thermal insulation. When the mobile exchange is installed on a temporary site, the

Artist's impression of the original M.A.X., inaugurated December 7, 1938





Peasmarsh, Sussex

pneumatic-tyred wheels are removed and replaced by specially designed heavy steel feet, which are bolted to the axles in place of the wheels. The design includes a "mechanical joint" in which the wires of the external cables can be jointed to the exchange cabling without plumbing operations.

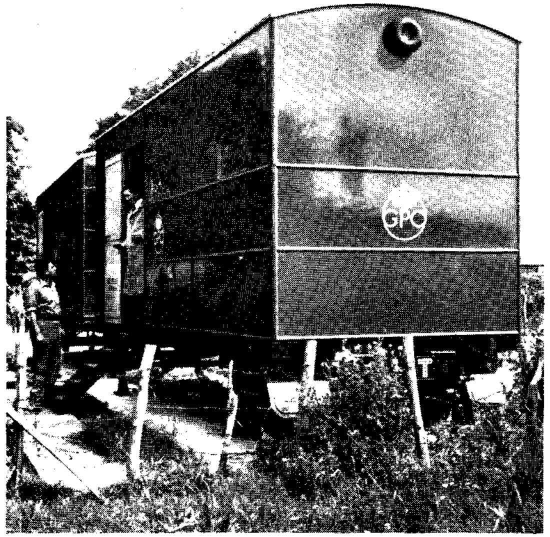
To economize in space as much as possible, traction type batteries are used in the mobile exchange, housed in a system of lockers so placed that the load is as evenly distributed as possible while keeping the centre of gravity low. To meet Ministry of Transport regulations the vehicle is provided with a brakeman's cabin and a system of hydraulically operated brakes for use in transit. The M.A.X. No. 12 includes an engine-driven generator set for use when the unit is in a place where no mains supply is available. An alternative rectifier equipment is also provided for use when it is convenient to provide a mains supply. The whole mobile exchange is some 16 feet long by 7 feet wide, and the weight of the complete vehicle (including equipment) is nearly six tons.

The fleet of mobile exchanges proved their worth time and again during the war years when they were available to provide service at short notice to meet urgent demands or unanticipated growth. On two occasions, M.A.Xs were used to maintain service when permanent U.A.Xs were damaged by enemy action.

With the end of the war, the demand for telephone service increased rapidly, and telephone managers were faced with large numbers of deferred requests from sub-postmasters and caretaker operators to relieve them of the ever-growing load of exchange attendance. The original mobile exchanges have therefore been used considerably since the war.

It has been evident, however, for some time that the character of the demand is gradually changing. The size of many of the small pre-war manual exchanges has now doubled; hence there are progressively fewer and fewer places where the capacity of the original mobile exchange is adequate to provide temporary service in times of difficulty.

To meet these changed conditions, a larger type of mobile exchange was introduced in 1948, and there is now a fleet of 11. The larger M.A.X. is based on the use of standard U.A.X. No. 13



Mobile Telephone Exchange, West Kingsdown, Kent

type equipment, and is capable of providing service to a maximum of 200 subscribers' lines with provision for a fairly extensive junction system.

This M.A.X. No. 13, as the larger type is designated, consists of two vehicles. The first contains the main distribution frame and intermediate distribution frame, and four standard A type units, with the line-finders, group selectors and final selectors of the main switching train. The second vehicle accommodates the junction units and the power plant.

Each section of the exchange has an overall weight of approximately eight tons. Unlike the M.A.X. No. 12, the 200-line M.A.X. does not include a prime mover generating set since, in most places where it is used, a mains power supply will be available. Apart from its increased subscribers' capacity, the M.A.X. No. 13 can be used at a tandem switching point in the automatic network—a facility which is not available with the earlier No. 12 type equipment.

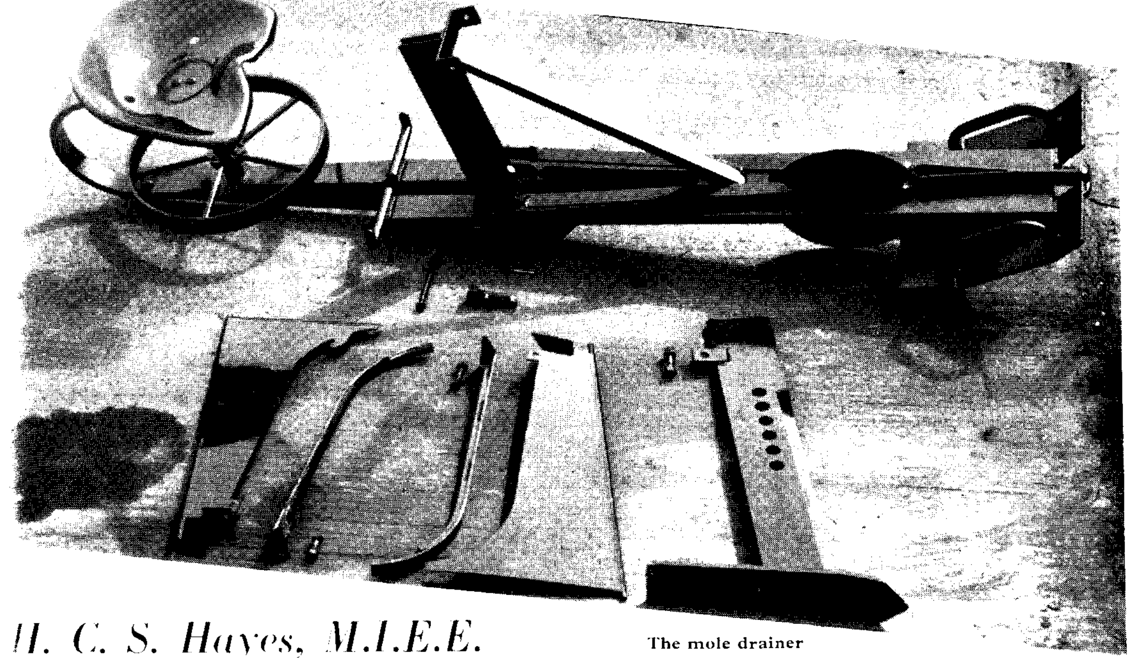
The difficult conditions since the war have still further enhanced the value of mobile exchanges. Almost every other week there is a demand for a mobile automatic exchange to provide service where the normal permanent provision, for some reason, is not possible. Probably the greatest use is to fill the gaps which result from difficulties in obtaining suitable sites, delays in provision of buildings, and sudden emergencies. In 1954 mobile exchanges were demanded on some 23 occasions. Of these, 11 resulted from the resignation or death of a sub-postmaster or caretaker operator; one to bridge the gap between the notice to quit leased premises and the erection of a permanent building; in six places to provide service while the equipment in an existing U.A.X. No. 12 building was recovered and replaced by No. 13 type equipment with its greater capacity for growth; in four places to meet unforeseen developments; and once for temporary replacement due to flood damage of the permanent exchange. Since their introduction, mobile exchanges of the smaller type have been used 95 times, and the larger type 21.

While it is clear that the continued process of conversion of rural exchanges to automatic working will gradually reduce the need for mobile automatic equipment, there is little doubt that good use will be made of the existing fleet for many years to come. (There are still over 700 manual exchanges of fewer than 200 lines.) Even when the conversion is complete, a number of mobile exchanges will be needed to provide service quickly at times of unforeseen demand, flood or other damage, and to permit the re-arrangement of equipment in existing buildings.

Behind the factual history of the M.A.X., there must be many untold human stories. There was, for example, the exchange attendant in a small Scottish village who was a well-known character and a friend of everyone in the district. She gave all the subscribers a very personal service and, although she was getting rather frail and her eyesight was getting very dim, the telephone manager felt that it would be a blow to her to have the exchange taken away by the conversion to automatic working. Nevertheless, a site was obtained and a building was erected. But before the equipment could be installed, the exchange attendant one day collapsed at the switchboard—causing yet another demand for a mobile exchange.

Engineering staff can no doubt recall many stories of the difficulties encountered in transporting the heavy mobile exchanges over rough, unmade roads, sometimes in very bad weather; of the difficulties of manœuvring the vehicles into position over soft and muddy ground; and even of the occasion when the tyres had to be partly deflated to allow the vehicle to pass under a particularly low-arched bridge!

Mechanical Aids



The mole drainer

H. C. S. Hayes, M.I.E.E.

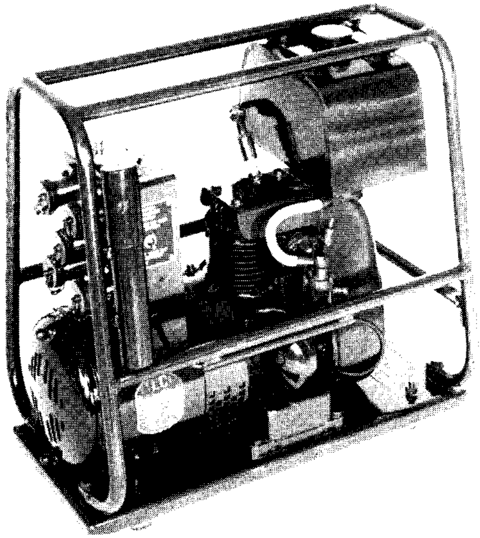
War-damaged buildings are rapidly being reconstructed, or demolished and replaced, in London and other cities and we are all aware of the great part mechanical aids—crawler tractors, diggers, loading shovels, bulldozers, concrete mixers, cranes and so on—are playing in speeding the work. The aim of all in the Post Office who take part in its engineering work is to use mechanical aids to the full to economize, to lighten labour and to increase production. The increasing use of mechanical aids for engineering work is evident from the fact that some 7,000 are now in service, with a capital value of nearly £700,000, or about twice the number and value in 1951.

All appliances such as crowbars, pulleys, or tools, which assist and increase the effort a man can exert with his own hands, are, of course, mechanical aids, but the term is now usually applied to the larger and more complicated devices. The Engineering Department employs about 60 of these; some, such as trench excavators, mobile cranes, air compressors, tractors, bulldozers, fork lift trucks, pumps and road breakers, are standard commercial items, while others, such as cable drum trailers, cable winches, desiccators, mole drainers, turn-table ladders and portable generators, are developed to meet the Post Office's special needs. It is not possible in a short article to describe all the different types employed, but several have been selected as being typical and of general interest. The equipments are not necessarily all exactly the same as those illustrated but they are of the same general type.

Possibly the mechanical aids most used are the portable generating set, the portable pump, the road breaker, the power rammer and the trailer motor winch. These are so widespread that readers will almost certainly have seen some in service on Post Office works in progress in the streets.

Portable Generating Set

Before 1946, portable acetylene lamps were generally used for lighting underground jointing chambers. Their brilliant white light was particularly suitable for identifying the various coloured markings on the paper-insulated wires in cables, but they were less convenient than electric lamps and, moreover, involved that small



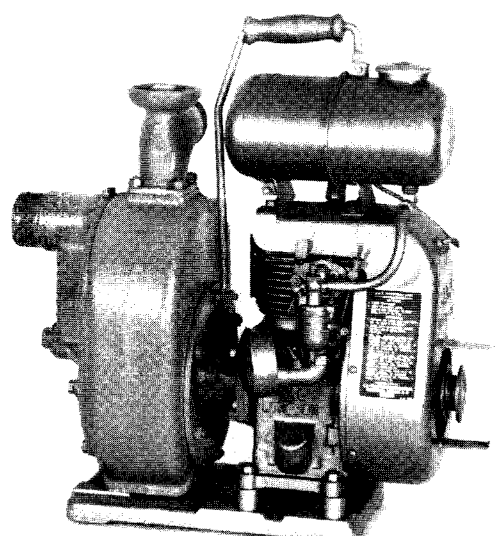
Portable generating set

The power rammer

additional risk which must always be present where a naked flame is used in a manhole. For these reasons it is natural that acetylene lamps should have been almost entirely superseded, and electric lamps with 25-volt 40-watt pearl bulbs powered from portable petrol-engine-driven generating sets are now used.

The portable generating set has a 98 c.c. four-stroke petrol engine directly driving a 500-watt generator. Although it costs rather more initially, a four-stroke engine is generally better suited to Post Office conditions than a two-stroke, largely because it can be more effectively silenced; this is most important particularly for night

Portable engine-driven pump



The road breaker

working in residential areas. A four-stroke also is rather more efficient and runs more evenly at slow speeds. With the generating set is associated a 24-volt battery which can be charged at the same time as lamps are alight. The battery maintains the lighting when the generator is shut down in much the same way as in a motor car lighting system. The generating set is a maid-of-all-work; it heats soldering irons, it lights the portable red and green traffic control signals used when work has to be done on congested roads, and it operates cable driers which produce a stream of hot air for removing moisture from paper insulation in cable joints.

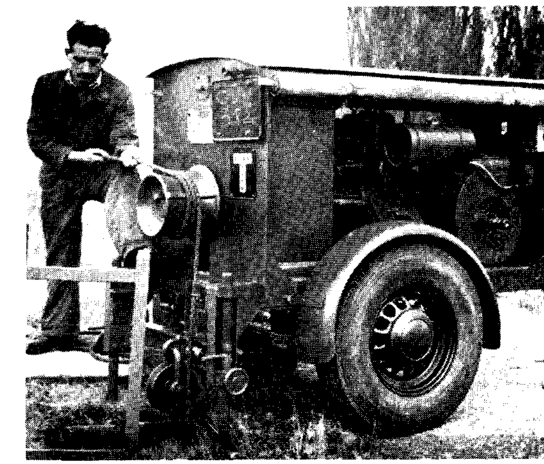
The Portable Pump

Underground cable jointing chambers are subject to flooding and only a few years ago it was common to see men laboriously working the handles of pumps to remove water. This heavy and time-consuming labour has now been eliminated by the general use of the 98 c.c. four-stroke petrol-engine-driven pump. This is centrifugal and can lift about 3,000 gallons of water an hour from a manhole some 14 feet deep. The latest models can run at slow speed and thus can deal economically with any seepage from the duct-ways into the jointing chamber after the main volume of water has been removed.

A 34-foot column of water produces a pressure at its base approximately equal to that of the atmosphere and it is theoretically possible to lift water by suction through a vertical distance just slightly less than this. In working a pump, however, other factors have to be taken into account, which limit the lift of the type illustrated to about 25 feet. For deeper manholes, to 50 feet or so, a submersible pump driven by compressed air is lowered into the flooded structure and this is capable of rapidly forcing the water to ground level to be dispersed in the street drainage system.

Road Breaker

The road breaker is self-contained and is intended for breaking up short stretches of light road surface where large air-compressor equipment with pneumatic road breakers is not justified. It is driven by a special 249 c.c. two-stroke petrol engine in which the cylinder points downwards. In place of the usual cylinder head there is a specially shaped second piston, called the hammer piston, which works in a special cylinder. The explosion takes place between the two pistons



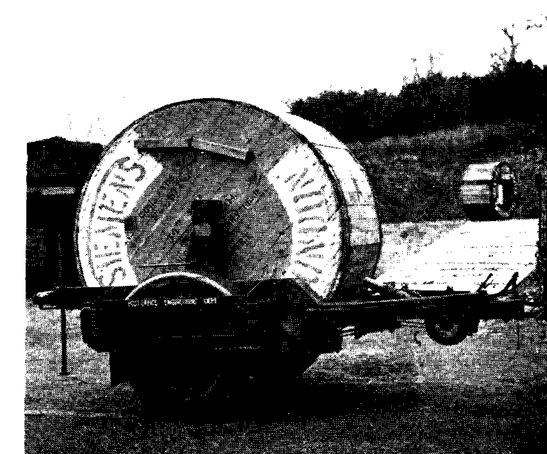
The motor trailer winch

and the lower one, the hammer piston, is driven down to strike the road-breaking tool of steel. The more conventional upper part of the engine maintains the cycle of operations and repeated blows are delivered to the drill steel.

Power Rammer

Hand punning to consolidate soil when a trench is being re-filled after the installation of a pipe or cable calls for much effort and the work is eased and accelerated by use of the power rammer. It is powered by a petrol-driven two-stroke engine of special design. The circular steel foot

Cable drum trailer



The thrust borer

at the base of the rammer is connected directly to the piston within the engine and by an arrangement of two cushioning springs the energy of the exploding petrol-air mixture is made to impart an up and down jumping movement to the whole machine which is held loosely in the operator's guiding hands.

Motor Trailer Winch

The motor trailer winch is almost indispensable for drawing cable into and out of underground duct-ways. It is driven by a 1,000 c.c. four-stroke twin-cylinder petrol engine. The photograph shows a drawing-in operation in progress. The engineer is applying a light pull to the free end of the rope which passes twice around the winch capstan. Depending on the degree of pull he applies, the coils of the rope either slide on or grip the driven capstan, and he is thus able to exert a fine control over the main drawing-in tension. There is a pulley block anchored in the manhole which converts the vertical pull into a horizontal one to haul the cable along the duct. The pull necessary to draw-in a length of cable varies considerably with the conditions, but as a rough guide it may be taken as about half as much as the weight of the cable. As cable lengths weigh up to 4 tons it will be seen that pulling-in tensions of 2 tons and sometimes more have to be expected.

Cable Drum Trailer

The cable drum trailer is coming into general use and is a very valuable aid for transporting cable. The drum is placed within the open framework of the trailer, where it can be raised ready for transport by two screw jacks. The load is carried by two high-pressure pneumatic-tyred wheels, a retractable castor wheel at the front facilitating manual manœuvring on site. The trailer's low unladen weight permits it being used legally when empty or lightly loaded with spring-operated overrun brakes only; vacuum brakes are embodied, however, for use when it is drawn by a heavy vehicle equipped with this class of braking, when loads up to 4 tons can be safely handled. Cable can be readily drawn off a drum which is in position on a trailer.

It is estimated that each trailer can save some £600 a year in labour, compared with other methods of mounting, transporting and placing cable drums, and this is so popular that the aim is to more than double the number now in service.

Trench Excavator

Most of the Engineering Department's pipes for carrying cables are laid by contractors, but occasional pipe-laying works fall to Post Office engineers and a few machines of the type shown are held for use where the terrain is suitable. The particular machine shown is diesel-engine driven, 27 feet long and weighs about 7 tons. It can dig a trench up to 6 feet deep and 18 inches wide. The diesel engine powers the caterpillar road tracks, drives the main digging boom with its series of buckets which excavate the soil, and lifts the boom up and down, as required, by hydraulic rams. The soil is tipped from the buckets on to a transverse conveyor belt which deposits it to either side of the machine.

Another smaller type of trench excavator is sometimes used for digging trenches up to 3 feet 6 inches deep. This excavator hauls itself along by winding up a steel rope on a winch barrel. The free end of the rope is anchored to the ground some distance ahead of the excavator, which carries the winch.

Thrust Borer

In telephone engineering practice a pipe is very often required beneath a road surface for connecting cable on one side of the road with that on the other. Trenching a road to place such a pipe can be costly and inconvenient, particularly if the road is busy, and it is natural that a good deal of thought should have been directed to developing a mechanical aid which will allow the installation of a cable without disturbance of the road surface. The aid shown operates from a hole prepared to take it on one side of the road and it thrusts a pilot rod to an excavation on the other. The thrust is derived from a hydraulic pump which, in some models, has a long handle and can be worked by two men; in others it is driven by a small petrol engine. Oil under high pressure from the pump enters a pair of horizontal rams which, by the use of suitable extension rod pieces, force forward the boring head under the road. When the initial bore has been established it can be enlarged as necessary and lined with lengths of pipe to receive the cable. Road crossings up to about 20 yards can often be laid in this way. Naturally, care is necessary to avoid damage to other services.

Mole Drainer

In agriculture the mole drainer is used to make small underground tunnels in the soil similar to the tunnels made by moles. It consists essentially of a steel cutting blade or coulter some 18 or more inches long attached to a framework which can be hauled along by a tractor or other means. At the bottom of the coulter is a shaped cylinder or "mole" held horizontally, and as the whole contrivance moves forward the coulter cuts a narrow slot in the earth which soon fills in, but the "mole" displaces the earth and leaves a neat circular tunnel or drain which lasts for some years. The Post Office has developed a mechanical aid illustrated in the photograph which follows the general lines of the agricultural appliance, but which can lay a cable in the formed tunnel. The mole to the right in the foreground of the picture is not made circular, as it is desirable when the cable has been placed that the tunnel should collapse rather than become a runway for moles of the natural variety and for other rodents who may nibble and damage the cable. The operation is performed by laying the cable overground along the route to be followed and then, starting at one end, feeding it into a guide behind the coulter as the mole drainer is hauled forward by a tractor or winch. The result is that the cable is transferred below ground to the requisite depth of 18 inches. Two different sizes of cable guide are shown in the middle and left foreground of the picture.

Kiosk Trailer

It is clearly very attractive to be able to transport a complete kiosk, already painted and glazed, to a prepared site and then to erect it as a whole in a few minutes. This in fact is what the kiosk trailer does. Facilities are provided on the trailer for gripping the kiosk approximately about its centre of gravity when it is standing vertically and then lifting it bodily into the horizontal position. The trailer with its load is then towed

The trench excavator

to the erecting site, detached from the towing vehicle and man-handled into the correct position. By manipulating the winding gear the kiosk can be deposited in the vertical position exactly where required for use.

Turn-table ladder

A device which shows considerable promise is the turn-table extending ladder mounted on the top of a 2-ton stores-carrying vehicle; it is intended to have one of these in each Telephone Area within two years.

The photograph shows an aerial cable being attended to at an awkward road corner. It will be observed that work is being carried out in this difficult position without any appreciable obstruction of the road traffic. The extended length of the ladder is 20 feet and it can be rotated through a full circle and elevated from the horizontal through any angle up to 80 degrees. A point of design has been to leave the interior of the vehicle clear of obstruction when the ladder is not in use. The aid will undoubtedly be very useful for general overhead work, particularly tree cutting.

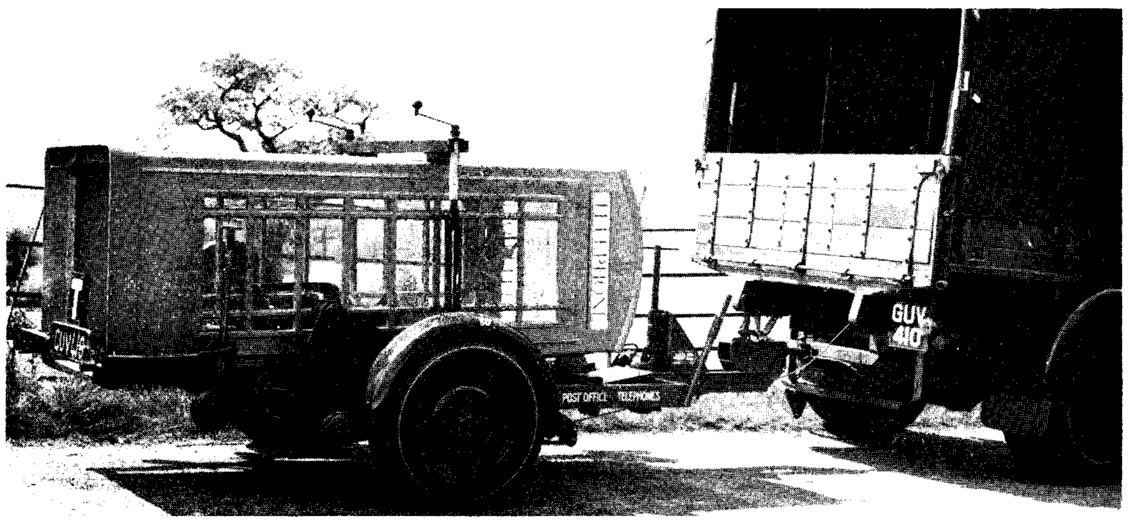
Lifting Devices

Much lifting of heavy loads is associated with engineering work in the field and with the shifting of stores at depots, and there is everything to be gained by handling these loads mechanically.

The turn-table mounted ladder

There are some 50 self-mobile cranes and, of course, a far larger number of non-mobile cranes and hoists are in daily use. Some of the self-mobile cranes are without road springs and are limited to a road speed of 5 miles per hour; this means in practice that they are tied to one depot and are

The kiosk trailer



A self-mobile crane

not generally available for field work. The crane shown is of this type.

Then there is another crane with a maximum road speed of 20 miles per hour which makes it suitable for use both at depot and for such field work as pole erection or recovery. This crane lacks slewing facilities but nevertheless it is a valuable aid. The jib is raised and lowered by hydraulic rams driven by the vehicle petrol engine and operated from the driving cab. The maximum load which can be lifted is 2 tons, with an outreach beyond the front of the vehicle of some 7 feet.

Another most valuable lifting device is the fork lift truck. One of these of the electrically operated type has now been in use at Norwich Engineering Depot for about twelve months and its versatility can be judged from the illustration showing it handling a medium pole, and it can also handle a cable drum and a load of line stores on a pallet; the truck is fitted with the attachments appropriate to the particular use. The reports of its behaviour and general utility are so favourable that trucks have been placed on order for other depots in the course of construction.

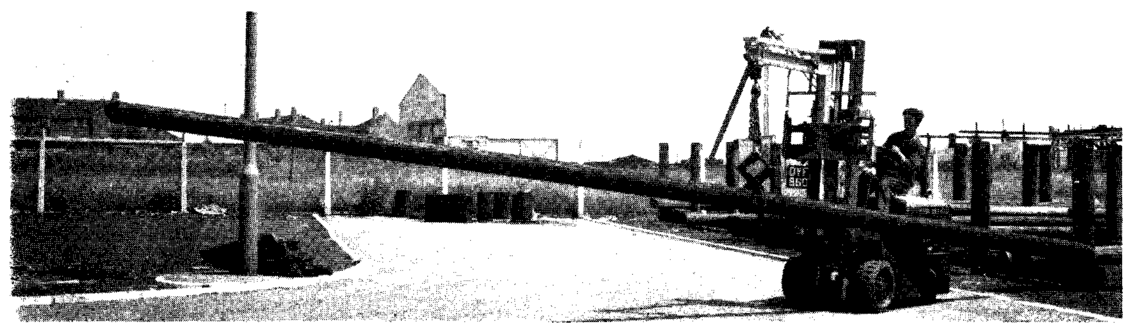
Justification for Mechanical Aids

Whenever there is a project for providing a mechanical aid the question naturally arises whether it can be justified economically or, failing this, whether there is some overriding consideration such as safety or welfare of staff which makes the provision highly desirable or essential. The Post Office pays great attention to safety, and no difficulty in justifying provision on this or similar grounds is likely to arise. It is, of course, necessary to weigh the savings, generally wholly in man-power, against the annual charges for the machine, which include interest on capital, depreciation, cost of fuel, operators' wages and maintenance costs. However, experience shows that it is generally easy to "prove-in" a mechanical aid on economic grounds and that the full realization of substantial savings, particularly with a large aid, is dependent only on proper planning to keep the machine fully employed and on its effective maintenance.

Maintenance

Mechanical aids are liable to much wear and tear and if they are to maintain their efficiency there must be proper organization for day-to-day maintenance, including cleaning, lubrication and

Fork lift truck—carrying pole



minor running repairs; for periodic inspection and routine testing; and for major repairs and complete overhauls. The procedure adopted to achieve this varies to some extent with the conditions in the different Regions and with the nature of the appliances, but the maintenance arrangements are usually on the following lines:—

(1) The user carries out cleaning, lubrication and minor repairs.

(2) There is in the Telephone Area a "Mechanical Aids Centre" staffed by skilled officers familiar with all aspects of mechanical aids operation and maintenance. From this centre aids are issued to gangs and working parties and it is here that equipment is held in reserve to meet break-down and other urgent needs. From the centre a specialist officer can always be ready to travel to any mechanical aid which is giving trouble in the field (assuming the issue of a replacement is not preferred). The centre's staff carry out periodical inspection and routine testing, and effect such repairs as are possible with the tools and workshop appliances at their command.

(3) Major repairs and complete overhauls are carried out at a Post Office Motor Transport Workshop where special facilities and appliances are available.

Our Contributors

J. A. ATKINSON ("Mobile Automatic Exchanges") is a member of the Institution of Electrical Engineers and is an Assistant Staff Engineer in the Equipment Branch of the Engineering Department. Apart from some nine years as Area Engineer, Edinburgh, his career has been mainly concerned with the design and provision of automatic exchange equipment. He is at present responsible for exchange equipment standards, economics, acceptance testing and the overall planning of exchange equipment programmes. Mr. Atkinson is the author of the textbooks on Telephone Switching (*Telephony*, Vols. 1 and 2) which have become standard works of reference.

D. C. BALAAM ("Controlling Radio Interference in the United Kingdom") is a B.Sc. in Mathematics and Physics and a former graduate, Institution of Electrical Engineers. Now a Principal in the Radio and Accommodation Department of the Post Office (with administrative responsibility for the Interference Service), he has worked in various Headquarter departments including the External Telecommunications Executive. As Principal responsible for overseas telegraph services he was largely concerned in 1950-51 with integrating the Cable & Wireless services in the United Kingdom with those of the Post Office. In the Royal Signals during the war, he was a Radio Instructor at the Army School of Signals and later a G.S.O. in the Directorate of Signals at the War Office.

J. F. BAMPTON ("Transatlantic Terminal—Oban") has a B.Sc.(Eng.) honours degree and is an Associate Member of the Institution of Electrical Engineers. A Senior Executive Engineer, he has been engaged since 1953 on the Transatlantic Cable project. After early years at the Post Office Research Station and in the London Telecommunications Region, he joined the Engineer-in-Chief's Office, Lines Branch, in 1942, where he was concerned with the development of military communications equipment. In 1944 he was lent to the Indian Government as Telecommunications Engineer to the railways of Southern India. Returning to the Lines Branch in 1946, he worked on carrier systems on submarine cables and, in particular, was responsible for equipping the Channel Islands and Dublin cables with submerged repeaters.

H. BEATSON ("Brentwood Radio Telegraph Receiving Station") has been Manager Engineer at Brentwood since 1951. He began his career with the Marconi International Marine Communication Company in 1920, transferring to Marconi's Wireless Telegraph Company in 1927, when he joined the staff at Brentwood Radio Station where he has remained under Cable & Wireless Ltd. and the Post Office. During his many years at Brentwood with Cable & Wireless Ltd. he was closely associated with the continual programme of equipment design and development carried out at the radio stations under the direction of Mr. J. A. Smale, now the Company's Engineer-in-Chief.

A. J. FORTY ("Reduction of Acoustic Noise") is a Senior Executive Engineer in charge of the Electro-Acoustic Applications group of the Post Office Research Branch. He was born in Oxford in 1915, educated at the City of Oxford School and at Queen's College, Oxford, where he obtained a first class honours degree in engineering. He joined the Post Office as a Probationary Assistant Engineer in 1938.

H. C. S. HAYES ("Mechanical Aids") is a Member of the Institution of Electrical Engineers and an Assistant Staff Engineer in the Post Office Engineering Department, Construction Branch. He entered the Engineering Department as a Youth-in-Training at Gloucester in 1924, and was transferred in 1927 to the Research Branch at Dollis Hill, later serving at Preston and Manchester. He returned to the Research Branch in 1936, joined the Lines Branch in 1937 and was promoted Assistant Staff Engineer in 1948.

T. J. ROWE ("Transistors and their uses") is a B.Sc. and a graduate of the Institute of Physics and the Institution of Electrical Engineers. He entered the Post Office Engineering Department (Research Branch) in 1953 as a Scientific Officer and is at present investigating the behaviour of bare transistors when subjected to various gaseous environments.

Notes and News

New Charges.—Telephone subscribers' fees for local calls will be increased from 2d. to 2½d. per stage (the 100 free calls will remain), and call office fees beyond the minimum will become 6d., 9d. and 1s. from July 1. The call office minimum fee will go up from 3d. to 4d. from January 1; this date will allow time for the engineers to alter some 130,000 coin boxes. From July 1 charges for evening trunk calls will be generally two-thirds of the day rate.

The Postmaster General announced these changes on April 11, as a contribution towards meeting the £20 million added to Post Office expenditure by wage increases announced on March 31, and rises in other costs.

★ ★ ★

New Coin Box.—A new coin box is being designed for public call offices which, with the development of subscriber dialling of trunk calls, will enable callers to dial their own trunk calls. This was foreshadowed in the White Paper on Post Office Development discussed in our Winter issue.

The final design of the new coin box is not yet settled and it will probably be three to four years before it can be introduced for general use. Modern improvements and techniques will be embodied in the new box; it will have a slot for threepenny pieces; and the Post Office hopes to do away with the A and B buttons, thereby making it simpler to make calls. All calls from the new box will be timed, and it will be possible for a caller to extend his call by inserting additional money on the receipt of an automatic warning signal from the exchange.

Meanwhile, to meet rising costs the Post Office is engaged in modifying existing coin boxes to provide for the increase in the local call fee from 3d. to 4d. next January.

Canadian appointment.—Mr. Frederick Gordon Nixon has been appointed Controller of Telecommunications of the Canadian Department of Transport. In 1945 Mr. Nixon attended the Commonwealth and Empire Conference on Radio for Civil Aviation and has been Assistant Controller of Telecommunications since 1951.

★ ★ ★

Farewell to " Ally Pally ".—The B.B.C. television transmitting station at Alexandra Palace, London—known to millions of Londoners, including television men, as " Ally Pally"—closed down in March after 20 years' service. Programmes were taken over on March 28 by the new station at Crystal Palace.

★ ★ ★

Devoted Service.—Two Chief Supervisors of telephone exchanges—Miss D. Williams, Manchester, and Miss E. Turnage, Ealing, were among six Post Office people whom the Postmaster General invested in March with the British Empire Medals conferred on them in the New Year Honours. Miss Williams, who was cited as having giving "selfless and distinguished service", retired last year. She rose from being a learner with the National Telephone Company in Manchester Exchange, before the Post Office took it over in

1912. Miss Turnage, still at work, has spent 43 years in the telephone service and received the Medal largely for her "gift of infusing zeal and enthusiasm into the staff".

Mr. E. C. Wilson, now Assistant Superintendent (Counter and Writing) at Paddington Post Office, but formerly instructor in telegraphy at Buckingham Palace and the Foreign Office, also received the B.E.M. Another recipient was Mr. W. T. J. B. Sauer, who has been in charge of the Post Office Engineering Department's Circuit Laboratory Construction Shop since 1939.

★ ★ ★

Post Office Switches to Nylon.—Nylon-braided cords are being installed in the 70,000 Post Office public telephone kiosks as the older cotton type wear out. The average life of a cotton-braided cord is nine months. Tests have shown that the new cords will last longer.

★ ★ ★

More Automation.—The "Keysender" system has been installed between London and Amsterdam, enabling operators in Amsterdam and the Continental exchange in London to set up calls without the assistance of their opposite numbers. In London the system works for calls to subscribers on automatic exchanges within 12½ miles of Oxford Circus; in Holland, for calls to subscribers in Amsterdam and many other places. The operator uses a set of push-button type keys instead of a dial, and can connect calls more quickly than by dialling. (Mr. Petche's article "International Trunk Mechanization" in our Autumn, 1955, *Journal* refers to this system.)

★ ★ ★

100,000th Telephone in Northern Ireland.—Northern Ireland's 100,000th telephone was installed in March. Dr. Charles Hill, Postmaster General, flew over to Belfast to present it to the subscribers—a couple who had just returned from their honeymoon.

★ ★ ★

Telephone Cheer.—Mr. I. Matheson, Edinburgh Telephone Manager, had a telephone extension fixed by an old lady's bed to enable her to talk to her daughter in Nova Scotia. "It is pleasant to think of a whole lot of G.P.O. officials working together to bring happiness to one sick old lady", commented the *Scotsman*.

★ ★ ★

London Hotel Telex Subscriber.—Kensington Palace Hotel, London, has become the first hotel in the United Kingdom to install Telex to enable other subscribers to reserve rooms. Several German and American hotels are Telex subscribers.

★ ★ ★

Transatlantic Telephone Cable. — Between April 29 and May 7 H.M.T.S. *Monarch* will lay the Sydney Mines-Terrenceville (Newfoundland) cable. After laying 475 nautical miles of the second Oban-Newfoundland cable from Oban in June, she will lay the 1,300 nautical miles deep-water

Inland Telecommunications Statistics

	Quarter ended 31st Dec., 1955	*Quarter ended 30th Sept., 1955*	*Quarter ended 31st Dec., 1954*
Telephone Service			
Gross demand	107,793	128,810	118,750
Connexions supplied	111,469	105,195	114,692
Outstanding applications	359,201	383,949	358,181
Total working connexions	4,208,232	4,141,393	3,937,111
Shared service connexions	1,053,014	1,009,213	864,784
Traffic			
Total inland trunk calls	81,800,000	87,313,000	77,374,000
Cheap rate	20,511,000	24,052,000	18,881,000
Inland telegrams (excluding Railway and Press)	4,442,000	5,653,000	5,303,000
Greetings telegrams	939,000	1,179,000	1,014,000
Staff			
Number of telephonists	48,824	48,195	46,458
Number of telegraphists	6,965	7,104	7,875
Number of engineering workmen	61,671	60,793	57,451

section in July, and complete cabling operations in August, laying the Clarenville shore end and making the final splice.

★ ★ ★

Television Licences.—There were 5,400,083 television licences in force in the United Kingdom on December 31, 1955; 4,800,747 of them were held in England, 320,073 in Scotland, 243,553 in Wales and Monmouthshire, and 35,710 in Northern Ireland.

★ ★ ★

Mobile Van for Cricket Telegrams.—The Postmaster General gave a "send-off" on April 26 to a new mobile telegraph office which will be used this summer to expedite Press reports during the Australian cricket tour.

The van will attend matches and telegrams will be transmitted by high-speed automatic circuits, or teleprinters connected to the automatic switching network, to the Central Telegraph Station, where they will be received as perforated tape which will be fed into the automatic transmitters connected to the oversea circuits.

Built on a Commer chassis, the office was designed by the Telegraph and Engineering branches of the Post Office External Telecommunications Executive and the Engineering Department. Engineers of the Telephone Manager's staff at Brighton installed the wiring in the works (Harrington's of Hove) where the van was built. The vehicle is 27 ft. 6 in. long and weighs six tons. The aluminium coach body is finished in Post Office red with gold anodised metal fittings and gold lettering.

★ ★ ★

Post Office Dots and Dashes.—With the removal of the morse telegraph instruments at Stornoway, Long Island, and Lochmaddy, South Uist, the last Post Office inland morse telegraph has been dismantled. Many years ago, when the fishing fleets were flourishing, and before the telephone was introduced in 1938, some 400 to 500 messages a day were passed over this circuit.

★ ★ ★

Bailey Bridge Solves Problem.—A 40-foot Bailey bridge was built in March to enable traffic to continue over a busy bus route in Shrewsbury, while Post Office engineers were building a concrete chamber for cables running into the new exchange. The chamber is 15 feet square and 14 feet deep, and took six weeks to construct. This is the first time the Post Office has had a Bailey bridge for such a purpose.

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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."

GPO