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New Branch for New Methods

AFTER 75 YEARS OF INTENSIVE DEVELOPMENT ONE might have thought that the telephone system would be approaching some measure of finality in design. But nothing could be further from the truth. Probably at no time has the future held brighter promise of better and more economic telecommunications. By translating the transatlantic telephone cable from vision to reality we have opened a new vista for international telephony, and a similar prospect is offered in inland telephony by subscriber trunk dialling which technical progress has now brought within our grasp. But the full advantages of mechanization can rarely be attained by adding machines to an existing system; the system must usually be adapted to fit the machine.

Mechanization of the local telephone service required changes in some of our basic procedures. Thus, whereas with a manual system metering occurred at the end of a call, with automatic machinery design was simplified by metering at the start. Also the extension of local dialling has required junction calls to be multi-metered and shown as a bulk total in subscribers' accounts.

It is not surprising, therefore, that the introduction of subscriber trunk dialling should raise operational and administrative problems of fundamental and urgent importance, but it is not easy for staff encumbered with day-to-day work to find time for the basic study necessary to make correct and timely decisions. A new Telephone Mechanization Branch is therefore being formed in the Inland Telecommunications Department to aim at speeding the automization of both the local and trunk services and thus to bring into profitable operation the results of our research and development.

Communications and the Future

Sir Gordon Radley, K.C.B., C.B.E., Ph.D.(Eng.)

Following is part of an address by the Director General of the Post Office to a conference held during the Instruments, Electronics and Automation Exhibition at Olympia in May :

THIS EXHIBITION occurs at an appropriate time in the history of telecommunications; world cable telephony, the extension of the subscriber's dialling range from a group of local exchanges to the entire national network, electronic switching, automatic telex, the transmission of data associated with the mechanization of office processes and the transmission of vision, changing at some future date from monochrome to colour, are all in various stages of implementation. All offer problems, and all present a stimulating prospect of development in the second half of the 20th century far exceeding that which took place during the first half.

The United Kingdom stands second among the countries of the world as regards the total number of its telephones, but ranks below such countries as Sweden, New Zealand, Denmark and Australia in respect of the number of telephones installed per 100 inhabitants. The United States, which heads the list, now has about one telephone to every three members of the population. To a great extent our placing below these countries is due to world wars which, during the first half of this century, retarded the social development of the United Kingdom.

Nevertheless, considerable progress has been made in overtaking the backlog of demand for telephone service. When the seven-millionth telephone was connected last summer the size of the system had been practically doubled since the war. As the telephone is made more readily available to the marginal user the problem of the investment required to give service to each new subscriber becomes an increasing economic problem. Each subscriber still requires a separate pair of wires back to the local exchange, or divides the use of this pair of wires with another subscriber if the service is shared. Even so the load factor is extremely low, the wires often not being in use for more than a few minutes' conversation in each 24 hours. This is the great argument for shared service, which meets all the requirements of the occasional user and is accepted without question by such highly developed countries telephonically as the United States. In that country two-thirds of residential subscribers are sharing, half of them with one other party. In the United Kingdom only about one-third of residential subscribers are sharing lines, none with more than one partner.

Nevertheless, there is a new emphasis throughout the Post Office on providing customers with the kind of service they want at an economic price. Any method of multiplying local voice paths on existing lines, as we now multiply long-distance paths over high-frequency cables and at radio links, would hold tremendous promise for the future. But it must be done without the need to outstation elaborate apparatus away from the exchange. There may be an uncovenanted benefit here from the development of electronic switching.

During the past 25 years the results of scientific research have been more apparent in building up the facilities for long-distance communication. Cables transmitting 600 speech channels within a single coaxial tube have been installed between the main centres of population. This form of cable was first proposed by the Bell Telephone Laboratories in America, but the mathematics of transmission over the coaxial line were largely due to my old teacher, Dr. Alexander Russell, and the first coaxial cable in the world to be brought into service was that between London and Birmingham in 1938. The same line plant, with appropriate repeaters to transmit a slightly wider band of frequencies, is used to provide television links

rented to the broadcasting authorities. With little modification the coaxial cable with repeaters at six-mile intervals could cater for 1,000 telephone channels on each tube.

As traffic demands and opportunity offers, it is proposed to reduce the spacing between repeater stations on some routes to about three miles. Modified in this way existing cables will cater for about 1,000 telephone channels, plus a 405-line television channel on each tube.

Alternatively, the tube can carry 2,000 telephone channels, but it is doubtful whether the risk of losing such a large number because of a single fault would make this arrangement attractive for general adoption. The ability to transmit telephony means that the repeaters must meet stringent requirements in respect of low intermodulation to prevent interference and cross-talk between channels. If television is to be transmitted the governing requirement is in respect of minimum phase distortion, and may be more difficult for colour than for black and white. Nevertheless, no insuperable problem is likely to be encountered in the transmission of colour by line. To design an amplifier meeting both requirements simultaneously or alternatively is not easy. Development, in any case, depends on the use of valves with a performance superior to that of any at present in use in this country.

During the next decade radio relay systems of very large communication capacity are likely to be constructed in this country. The period since the war has seen notable developments in the 1,000 to 10,000 megacycles per second band, which is as yet comparatively unexploited. Microwave radio has characteristics which make it attractive for use in an inland network. It offers the possibility of transmitting a very wide band of frequencies. A radio relay system of this kind has stations at intervals of between 20 and 50 miles, each station having a line of sight to its neighbours. Energy is transmitted between them in a narrow beam by means of aerials in the shape of parabolic "dishes". Automatic gain control is normally provided to counteract the effects of fading.

The first use of the microwave system by the Post Office was for the transmission of television programmes to the Sutton Coldfield station of the B.B.C. in 1949. The Kirk O'Shotts station has been served by a system from Manchester since 1952. This last system operates on a frequency of about 4,000 megacycles per second. These frequencies are beyond the limits of ordinary valves, and the system is noteworthy because it made use of the travelling wave amplifier developed in the Clarendon Laboratory at Oxford. This was the first large scale commercial application of this amplifier anywhere in the world.

It is commonly thought that a system of this kind must have considerable economies over buried coaxial cable. This is not always so in the United Kingdom, because comparative costings of cable and radio systems frequently show an advantage in favour of cable, particularly if a duct line already exists into which the new cable can be drawn. In addition, it is not easy to find sites for new radio stations on the hilltops in rural England.

Nevertheless, radio transmission systems have been developed capable of carrying several hundred telephone channels, and three such systems have recently been installed. A much larger system is planned, extending from south to north through the United Kingdom. When fully loaded this system will carry six independent radio transmissions in each direction, and each transmission will be capable of bearing up to 600 channels of telephony, or one television channel. At terminal and intermediate stations the separate transmission will be handled in independent amplifying equipment. This will make it convenient to lead off transmissions as required by spurs to cities on either side of the route. Valuable economies can, however, be achieved by the use of common aerial and wave-guide systems, and by engineering the project so that spare plant, test facilities, etc., are shared.

It will be a definite policy for future development that all broadband channels should be interchangeable between cable and radio, and usable for telephony or television.

Large numbers of circuits will be required on main trunk routes to cater for the anticipated growth in traffic when subscribers are enabled to dial long-distance calls. The first installation of a new system enabling subscribers to do this will be brought into use in Bristol early in 1959. From the outset subscribers there will be able to dial to most of the large cities in the United Kingdom, as well as to smaller towns nearer Bristol. Similar facilities will then be provided at other towns, and later they will be extended to calls routed indirectly; for example, from Bristol to Dover via Tunbridge Wells. Coin-boxes of new types are to be introduced by means of which call office users will also be enabled to dial trunk calls.

This development should result in very substantial operating economies. Although operators

will be required for normal traffic at many exchanges for a long time to come, ultimately they will only be found at the main switching centres to give assistance to the setting up of calls when requested, and to handle international traffic.

To make nation-wide dialling by subscribers practicable it will be necessary to set up a national numbering scheme which will enable the called number to be obtained by dialling a code which is independent of the place of origin of the call. Thus, if the called subscriber is in Glasgow the same code must be dialled, whether the call originates in Aberdeen or Brighton. The equipment must do the thinking to determine the routing of the call from Aberdeen or Brighton—or anywhere else—to Glasgow, and sometimes it will be very complicated. The national number will not be used for local calls, but in designing the system the Post Office is anticipating 20 million subscribers connected to 8,000 exchanges.

Long-distance switching will be done initially by electro-mechanical equipments of conventional type. Electronic register translators should, however, prove useful for converting the dialled national number into the digits actually required to route the call to the exchange of destination, and to determine the charging according to the duration and distance of the call.

Electronic techniques are likely to revolutionize the art of telephone switching within the foreseeable future. In America it has been announced that a fully electronic exchange will be in public service in 1958. Many telecommunication laboratories are pressing on with the development of systems which will render the present mechanical equipments—cross-bar as well as Strowger — obsolescent, although mechanical systems with an electronic control may be used as an interim measure. So far as is known fully electronic systems are beginning to fall into two broad types. The distinction depends on how the speech paths are actually connected. In one type gas diodes, or some other device, are used in a space arrangement. In the other the appropriate channel is picked out of a time division multiplex system.

The Post Office favours the second of these and a good deal of experimental research at Dollis Hill has resulted in the filing of 50 or 60 patents. These, it is hoped, will form the basis for a useful exchange. One incidental advantage of this type is that it may be possible to extend the time division multiplex system into the local network. Use of a single pair of wires between the exchange and some such outstationed switching unit would effect economies in local cable networks.

During the past year or so agreement has been reached between the Post Office and the principal manufacturers of telecommunications equipment to pool all their research and development resources with the objective of constructing an all-electronic exchange of this type as early as possible. A design has been agreed which exploits time division multiplex techniques to the utmost, is the most promising economically and requires the minimum development time due to the fact that it has already been the subject of prolonged research. It also makes use of components and techniques which are readily available. The objective is to have the electronic equipment made and ready for installation as an exchange forming part of the public network by the end of 1958.

Development of electronic exchanges generally is at an interesting stage. The philosophy of switching has been worked out in terms of broad functional designs. The speed with which ideas can be realized in the form of a cheap and compact exchange depends on the production of apparatus for performing the various functions. In some cases there are alternative methods for doing what is required; for example, cathode ray tubes with thousands of tiny capacitors deposited on the screen, examples of cheap mass-produced ferrite cores and delay lines are three different forms of electronic memory for storing large amounts of information.

It is difficult to forecast the rate at which all-electronic equipment will replace contemporary electro-mechanical equipment in our exchanges. There is a world wide belief that the change to electronic equipment will take place. Because of the work that has been done British industry is well placed to face world competition. This is of national importance, for exports of telecommunication equipment are particularly useful to us. The equipment needs very little in the way of imported materials. The end product is largely the result of scientific research and semi-skilled labour.

The essential production cost of an electronic exchange is likely to be less than that of the corresponding mechanical equipment. Smaller and cheaper buildings will suffice to house the apparatus and, as already suggested, large incidental savings may be possible on capital investment for local cables, if the cable network can be adapted to the system. The elimination of mechanical equipment requiring precise adjustment should very greatly reduce maintenance costs.

Identifying Wires in Cables and at Distribution Points

S. T. E. Kent, A.M.I.E.E. · *H. C. Nott*

ONE OF THE MAIN PROBLEMS WHICH HAS always faced the telecommunications external staff has been to identify a pair of wires in a cable or at a distribution point. The method used must reduce to a minimum any interference with the service on other wires and cause as little damage as possible to the wires or the paper insulation. Within recent years, the difficulties have been increased, first by the increase in automatic working which makes the identification of individual working circuits more difficult; and second, by the introduction of cables with thinner wires which are very easily damaged. Following a detailed field study of the work of external staff a new method of identification has been developed by the London Telecommunications Region staff in co-operation with the Engineering Department.

Working circuits connected to a manual exchange were identified by breaking into the circuit with a portable telephone and obtaining the number of the subscriber from the operator. Where subscribers were connected to an automatic exchange, one wire of the cable pair was disconnected and the subscriber rung and asked for his number. Where spare pairs were concerned, a battery was connected between both wires of the cable pair and earth and the pair located at the distant end, using a milliammeter. All these methods require a metallic contact with the wire to be identified and an interruption to service of a

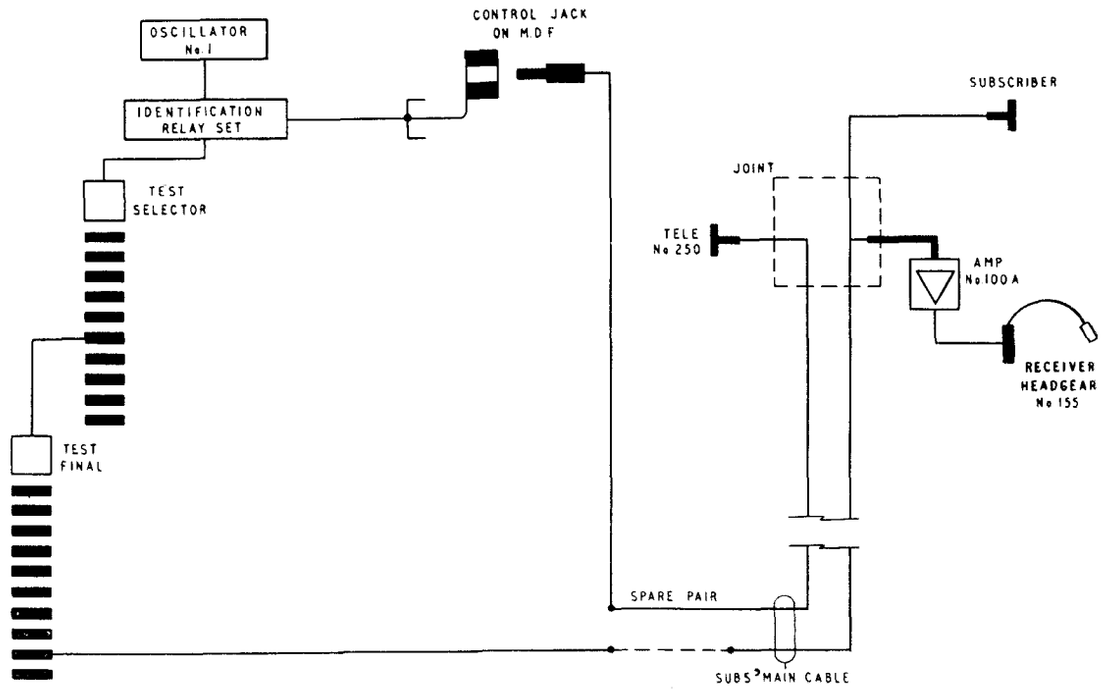


Fig. 1: Identification of working lines using control pair

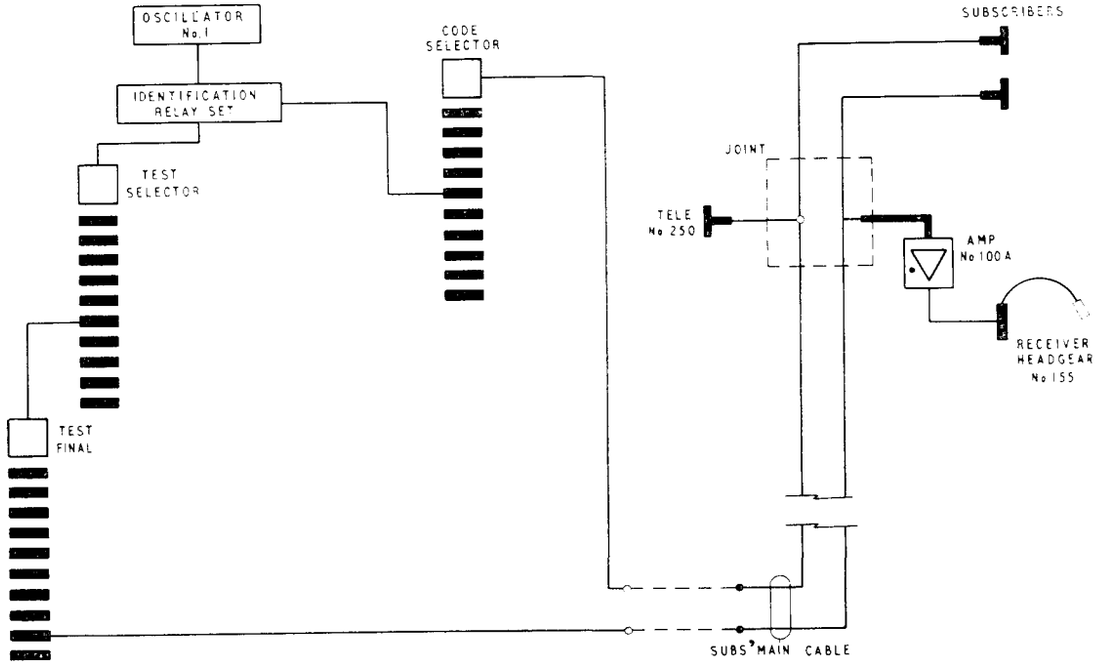


Fig. 2: Identification of working lines using MWJ dialling code

working line. In automatic exchange areas considerable annoyance could be caused to subscribers; also the work obviously could not be done overnight.

Three methods of making contact with the wire were used. First, by sliding back the paper sleeve used for insulating the wire joint and making contact with the twisted wires; second, by penetrating the insulation around the wire using a pointed needle; and third, by cutting through the insulation with a sharp knife. All these methods were very slow and the time to identify a single pair of wires increases very rapidly with cable size. Furthermore, the frequent handling of cable pairs had a bad effect on the insulation. The third method became increasingly tricky as new cables with thinner wires were introduced.

The New Method

The new method is based on the fact that a wire carrying an alternating current is surrounded by alternating electro-magnetic and electro-static fields. These fields can be detected using electronic equipment and thus a wire carrying an alternating current can be identified without physical contact being made with it. In practice, a valve oscillator tuned to 1,000 cycles per second (CPS) is joined to a pair and this is identified at the distant end by means of an electro-static probe coupled to a three valve amplifier and headphone. Also, by using an electro-magnetic probe instead of the electro-static probe, the route of a pair within the cable network can be traced from outside the cable sheath.

The Exchange Apparatus

The exchange apparatus consists of:—

(*a*) A rack-mounted unit having three 1,000 CPS oscillators with outputs as follows:—

(i) 1,000 CPS tone interrupted at approximately five pips of tone per second, cabled to an identification relay set for automatic connexion of the tone to working pairs.

(ii) 1,000 CPS tone interrupted at approximately two pips of tone per second, cabled to multiple jacks on the line side of the Main Distribution Frame (MDF) for connexion of the tone to spare pairs by means of a cord and plugs.

(iii) 1,000 CPS tone, cabled to New Subscribers' Test circuits in such a way that when the circuit is connected to a cable pair uninterrupted tone is applied to line.

(*b*) A rack-mounted identification relay set with an associated test selector to apply tone to working pairs as required. Access to the relay set is obtained by means of a multiple jack on the line side of the MDF for connexion to a cable pair, using a cord and plugs.

Alternative access to the relay set may be gained by dialling a predetermined code (MWJ in the London director area).

(*c*) A rack-mounted speaker relay set terminated on the line side of the MDF is associated with oscillator (ii). This speaker circuit may be extended on any cable pair by means of a cord and plugs; connexion to the speaker circuit in the exchange is made with a headset and breastplate transmitter.

The Apparatus Used

The equipment issued to external staff consists of:—

(*a*) "Amplifier No. 100A". This is operated by dry batteries and is small enough to go into the user's pocket.

(*b*) "Probe No. 4". An electro-magnetic probe tuned to 1,000 CPS, made to fit readily in the hand is used in conjunction with the "Amplifier No. 100A" for tracing cable pairs without opening joints.

(*c*) "Probe No. 5". A pencil shaped electro-static probe used in conjunction with the "Amplifier No. 100A" for identifying cable pairs in a joint or distribution point.

(*d*) "Receiver, Headgear, No. 155". Used in conjunction with "Amplifier No. 100A" or "Oscillator No. 59A".

(*e*) "Oscillator No. 59A". This is a small battery driven 1,000 CPS oscillator with variable control from continuous tone to a slow-speed pulse, used when identifying cable pairs not terminated on the MDF.

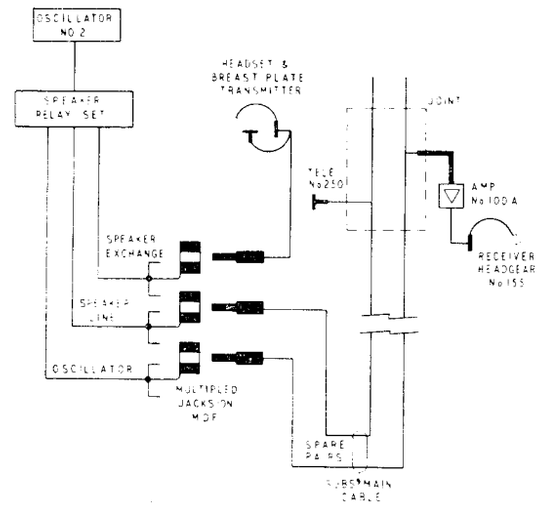


Fig. 3: Identification of spare wires

Identifying Working Cable Pairs

Method I. When a large number of working pairs has to be identified in a joint, the method shown schematically in Fig. 1 is used. A control pair is first established between the joint and the Main Distribution Frame and thence to the identification relay set jack. In the cable joint this pair is terminated by a portable telephone.

Lifting the receiver of the telephone operates the relay set in the exchange and attenuated 1,000 CPS tone at 5 p.p.s. is returned to the telephone. The number of the subscriber to be identified is then dialled and a test selector and test final selector locate the number under control of the identification relay set. If the subscriber's line is not in use the oscillator tone is connected to the line and the cable pair concerned is located in the joint using the electro-static probe and amplifier. The pair having been found, one wire is earthed: if this is the A wire tone is disconnected from the pair and NU tone is heard on the control pair; if nothing happens it is the B wire. The following safeguards are provided by the identification relay set:—

(*a*) If for any reason NU tone is connected to the pair to be identified the oscillator output is not connected to line and NU tone is returned over the control pair to the portable telephone.

(*b*) If the subscriber is engaged the oscillator output is not extended to line and busy tone is returned to the portable telephone.

(*c*) Should the subscriber enter the circuit while the identification is proceeding, the oscillator output is immediately disconnected and NU tone is returned to the portable telephone. The receiver of the portable telephone must then be replaced to release the identification relay set and enable the subscriber to proceed with the call.

Method II. When the number of working pairs to be identified is small or no spare pair exists be-

tween the exchange and the joint, the method shown in Fig. 2 is used. The telephone is connected to any disengaged working line in the cable and access to the identification relay set obtained by dialling the code MWJ. The number of the line to be identified is then dialled and the operation proceeds as already described in Method I.

Method III. External construction work often requires that a number of spare pairs be identified at a joint or distribution point. For this purpose a second relay set, designated Speaker Relay Set, has been provided. The output of the second oscillator (1,000 CPS interrupted at 2 pips of tone per second) is terminated on multiple jacks on the MDF and interconnected with the Speaker Relay Set to provide for the identification of the A wire of the cable pair. A speaker circuit is set up between the joint and the MDF and the oscillator output is connected to the appropriate cable pairs by a man stationed at the MDF using a cord and plugs. The method is shown schematically in Fig. 3. Identification of the pair at the joint proceeds on similar lines to Method I.

Method IV. To facilitate finding individual cable pairs, normally required by installation and maintenance staff, a modification to the standard New Subscribers' Test Circuit has been introduced. When the modified test circuit is used, the output of the third oscillator (1,000 CPS continuous tone) is connected to the cable pair. When the cable pair has been identified, the test clerk is called by connecting a lineman's telephone to the cable pair. This circuit can also be used by maintenance staff faulting on working circuits. In this application the tone to line is attenuated to prevent acoustic shock if the subscriber should try to make a call.

Method V. External staff often have to identify cable pairs between two joints in the cable network remote from the exchange. For this, a portable pocket size and battery driven 1,000 CPS oscillator with adjustable interruption has been provided (Oscillator 59A). The equipment is used as shown

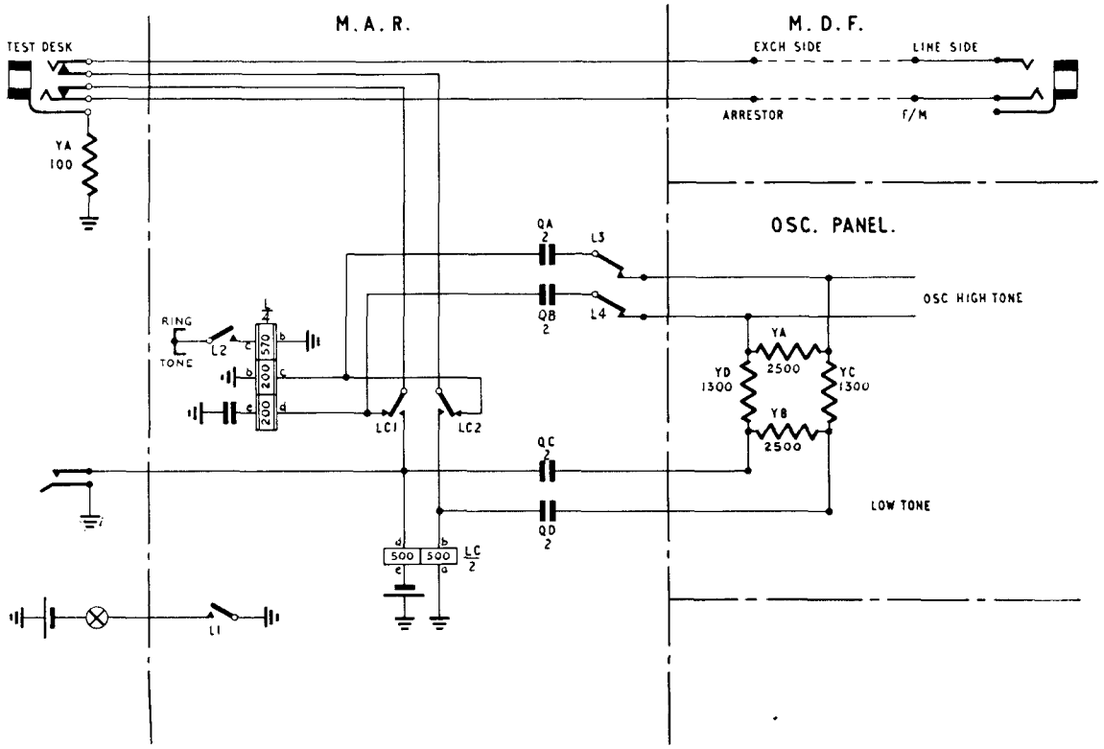


Fig. 4: New subscribers' test circuit modified for 1,000 cycle high and low level tone supply

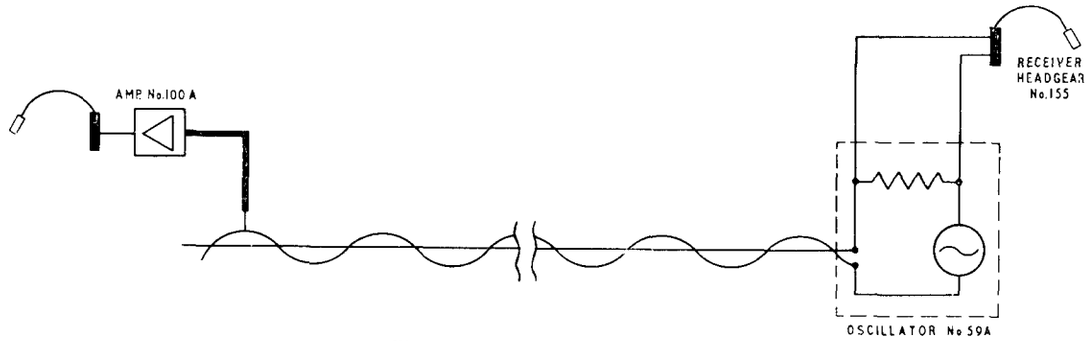


Fig. 5: Identification of local spares

in Fig. 5. When spare pairs are being identified it is useful to be able to indicate to the sending end that the pair has been found and the method adopted for this purpose makes use of a lightweight headphone connected to a monitoring jack on the oscillator. When sending on a cable pair, disconnected at the distant end, tone at a very low level can be heard in the headphone. When the pair has been identified, short circuiting the pair causes a marked rise in level at the sending end.

To assess the advantages of the new methods, field trials were conducted in all London Telecommunication Areas, using portable equipment. Following satisfactory completion of the trials, the decision was taken to equip all the major automatic exchanges in the Region. At the present time permanent equipment has been installed in all the director exchanges and similar equipment is on order for most of the non-director exchanges. In addition, information has been given to provincial regions to enable them to build equipment for local trials. The Engineering Department has taken over the provision of permanent equipment nationally. All external working parties in the Region have been equipped with amplifiers, local oscillators and the associated equipment. The expenditure to date on the whole project is about £35,000.

Some typical examples of the saving in time by using the new methods are:—

(a) Diversion of subscribers' lines from one cable to another involving changes on the MDF: the time was reduced to a quarter of that previously required.

(b) Identification of all the pairs in a large sized cable: only one-fifth of the time previously taken was necessary.

With an annual expenditure on external construction work of approximately £2.3 million, it is confidently expected that all the costs of the changeover will be recovered within two years and current estimates are being adjusted accordingly.

The advantages of the new methods from the subscribers' point of view are that extensive rearrangement schemes can be undertaken without worrying them. Also, as cables are subjected to a smaller amount of handling, faults arising from damaged insulation are reduced.

Book Review

MARCONI INSTRUMENTS 1957: Electronic Measurements; 276 pages, illustrated.

This attractively produced and comprehensive catalogue provides a complete list of electronic measuring equipment produced by the Company.

The descriptions of the individual items of test equipment are laudably complete, and understanding of the operation of the unit is considerably eased by the association of a block schematic diagram of the circuitry of each unit.

Incidentally, this catalogue gives a very interesting glimpse of the wide scope of equipment marketed and produced by Messrs. Marconi, which ranges from large industrial X-ray plant mounted on a trailer to small bottles of tablets for preparing buffer solutions of known pH value for use in electro-chemical analyses.—R.P.F.

Wonderful T.A.T.—A Yorkshire subscriber has written to Middlesbrough Telephone Manager's Office in praise of the Transatlantic Cable: "Perhaps it would interest you to know that we spoke to a son in Calgary whom we had not seen for several years, and his voice was so clear that it was just as though he was in the room with us—a wonderful experience".

Post Office Midland Region

THE MIDLAND REGION OF THE POST OFFICE controls the postal, telegraph and telephone services of more than seven million people living in 18 counties, mainly in the great Central Plain of England but including the Peak of Derbyshire and the southern hills of the Pennine Range. Surrounded by the Wales and Border Counties Directorate and four other Post Office Regions, it is landlocked except for a narrow corridor in southern Lincolnshire through which it reaches to the east coast.

The Central Plain provides much of the raw material—coal, iron, clay, limestone—for England's greatest industries. Its administrative headquarters in Birmingham are in the centre of the dense industrial area which contains the heavy engineering, metal work and jewellery factories of Birmingham itself and the Black Country, with Wolverhampton, Coventry and neighbouring towns; beyond are Crewe, the great railway centre, Worcester and Stoke-on-Trent, notable for the world's finest pottery, Leicester, Northampton and Kettering, centres of the hosiery and footwear trades; Nottingham, home of lace-making, tobacco manufacture and the production of drugs; Derby, noted for locomotives and Rolls-Royce engines, and Burton-on-Trent, the city built on beer. Agriculturally it has the fruit and vegetable gardens of Worcestershire and the rich and fertile fenlands of Boston, Spalding and Wisbech. It has contributed to England's history and legend through Coventry and Lady Godiva, Evesham and Simon de Montfort, Stratford-on-Avon and Shakespeare, Cromwell and Huntingdon.

Because of its central position the Region has its own special problems of through communication. Crewe is one of the most important centres in the Travelling Post Office system which circulates the mails throughout the country. Birmingham itself was an important station in the early days of telegraphy—the first valve used to amplify speech currents was tried out in Birmingham Head Post Office in 1916. The first coaxial cable from London terminated at Birmingham; from this, anticipating television, developed the 1-inch coaxial cable and the London and Birmingham radio link.

The Region is divided under seven Telephone Managers' Areas—Birmingham, West Midland, Stoke-on-Trent, Coventry, Nottingham, Leicester and Peterborough with a total of 679 telephone exchanges, all but 89 of which are automatic, and 775,462 telephone stations. In 1956-1957 the telephone services handled 405 million local and $38\frac{3}{4}$ million trunk calls. The City of Birmingham, with a population second only to London among English cities, is responsible for about a quarter of the whole Region's telephone traffic.

The Directorate *(left to right)*: Mr. A. W. LANGFORD, Head Postmaster, Birmingham; Brigadier F. JONES, C.B.E., Telephone Manager, Birmingham; Mr. L. J. GLANFIELD, Telecommunications Controller; Mr. W. H. BLOOMFIELD, O.B.E., Staff Controller; Mr. W. T. GEMMELL, Regional Director; Mr. W. K. MACKENZIE, Deputy Regional Director; Mr. L. L. TOLLEY, Chief Regional Engineer; Mr. F. F. BUCKLE, Finance Officer; Mr. P. J. W. DE GROUCHY, Postal Controller; Mr. A. H. ENDECOTT, Public Relations Officer

Britain's only Municipal Telephone Service

H. V. J. Harris, M.B.E., A.M.I.E.E.

SOONER OR LATER STRANGERS TO KINGSTON-upon-Hull ask how the city managed to keep its own telephone service. The answer is that under an Act of 1899 municipal authorities were empowered to raise capital to introduce their own telephone service, if licensed by the Postmaster General. It is under that statute that the last surviving municipal system in the United Kingdom continues to provide local telephone service to the City and County of Hull, and to the neighbouring towns of Beverley, Hedon, Haltemprice and adjoining places lying within a roughly semi-circular area of the East Riding of Yorkshire, totalling 120 square miles on the north bank of the Humber and having a radius of eight to ten miles from Hull Head Post Office or the Guildhall.

Hull Corporation had previously taken a far-sighted step when granting the National Telephone Company the right to lay underground plant in the city's streets by negotiating an agreement for securing free intercommunication with the Company's subscribers if the Corporation should establish its own telephone system. Nevertheless, from 1904, when the first Corporation magneto exchange was opened, until 1912, many local subscribers considered it necessary to rent lines connected to both the Company's and the Corporation's exchanges. In spite of this, the Corporation won the confidence of subscribers and ratepayers, and their backing in negotiating with the Postmaster General to retain their system when the Company's was transferred to the Post Office on January 1, 1912. The licence was renewed after long negotiation, and the Corporation had purchased the former Company's plant. It was renewed again in 1932 for 30 years.

The administration resembles that of other municipal trading concerns. A 14-man committee of the City Council meets monthly, or more often if necessary, and deals with matters of general policy and so forth which cannot be settled by the officials of the Department. The Telephone Manager is the chief official responsible to the Committee but certain functions affecting the management, such as legal, finance, accounting, purchasing of non-technical supplies, payment of salaries and wages, collection of cash, are vested in other corporation officials—the Town Clerk, City Treasurer and so on.

Fig. 1 gives a general idea of the area served and the local junction network. It will be seen that there is only one manual exchange apart from the central auto-manual assistance board, and that the automatic exchanges are of three types corresponding to different periods in the development of automatic telephony. There are 18,500 exclusive connexions and 16,000 two-party line connexions, with a total of 52,000 stations in service. Hull has a telephone density of 14 stations per 100 population.

There is a waiting list of 3,500, nearly 1,000 of which are in a single exchange area where post-war housing development has been rapid. In spite of an increase in tariffs last year, demand continues unabated.

Finance

The total income (apart from trunk call revenue) for the year ended March 31, 1956, was £427,000; working expenses amounted to £370,000; and at the same date the total capital outlay at original cost, after deduction of appropriate amounts in respect of superseded plant, was £2,100,000. Under the terms of the licence a royalty, a relic of the 1880s, amounting to 10 per cent. of the rental and local call revenue, is payable to the Postmaster General; this now amounts to £40,000 a year.

The Corporation Telephone Department is organized in three divisions: Commercial, under a Chief Clerk; Internal Engineering, under an Executive Engineer; and Lines, under a Senior Executive Engineer who is also Deputy Telephone Manager. The gradings of engineering and non-engineering staff and, indeed, the general conditions of employment, correspond to those of the Post Office telephone service, the City Council having agreed in 1915 to adopt Post Office conditions as standard for all their telephone employees. There is a non-contributory superannuation scheme on Civil Service lines—the standard Local

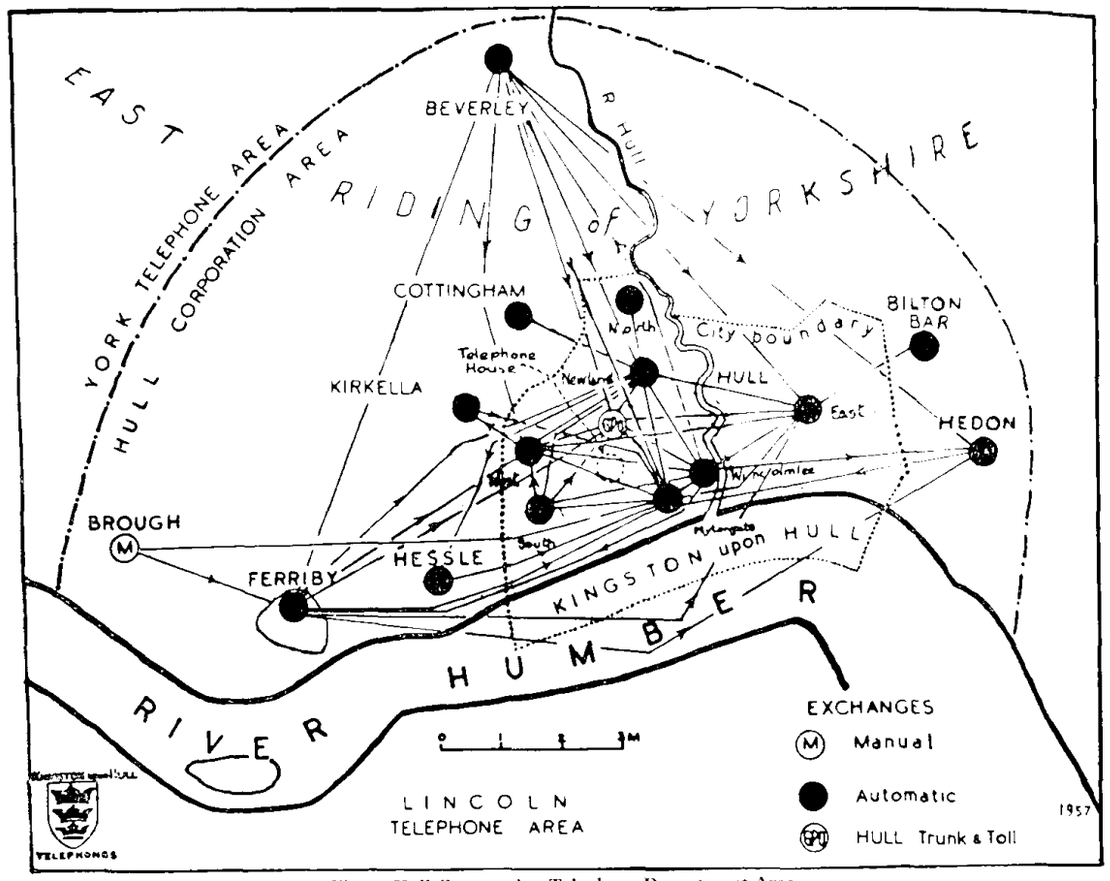


Fig. 1: Hull Corporation Telephone Department Area

Government Superannuation Scheme is contributory. There are nearly 600 employees of all grades, including about 60 telephonists and 60 administrative and clerical staff.

The organization does not include any separate Traffic or Sales Divisions, the Commercial and Internal Engineering Divisions sharing both functions, with the Lines Division providing the long term forecasts of exchange line growth. The City Treasurer's Department bills subscribers' rentals and keeps the Department's account books, while the Department itself bills trunk* calls, and local calls, and keeps stores accounts. The Department is also responsible for purchasing technical supplies and placing contracts for engineering works.

Each year, in common with other local authority departments, a budget is prepared of the expenditure on capital and revenue accounts during the ensuing financial year, based on the works programme prepared by the Department and approved by the Telephones Committee. For capital expenditure, a long term programme is also prepared, as most of the money for this purpose is raised by loans, set up under the authority of a Block Loan Sanction approved by the Minister of Housing and Local Government, usually for two or three years ahead. Receipts normally cover expenditure on revenue account, any surpluses having been (with isolated exceptions) transferred to a Reserve Account and ploughed back into the Undertaking.

The development forecasts prepared by the Lines Division form the basis of studies for drawing up site, accommodation and exchange equipment

* See page 156.

data, ... well as for line plant development schemes. Usual... the City Architect is called on to design new h... dings (Fig. 2) or major alterations to existing p... ses (Fig. 3), and to arrange major building contr... The Department also prepares and publi... an alphabetical and classified telephone direc... printed by a local firm, of which about 50,0... pies are now issued each year.

Th... Department's Transport section looks after about... vehicles of various types, including sever... ost Office Morris Utility one-ton models. The... rnal Engineer looks after this section, the work... s engaged on reconditioning recovered swit... ards and telephone apparatus for return to s... the maintenance of electrical power equi... nt and electronic apparatus. The workshop... o look after such things as public address insta... ons, sound recording apparatus, deaf aid (amp... d telephones and line amplifiers.

Tari... Structure

St... nbers are offered six exchange line tariffs, thre... which are restricted to residence use. The... a flat rate tariff at £24 *per annum*, payable in a... nce, permitting a business subscriber unli... d local calls within the licensed area; the corr... nding rental for a residence line is £12 *per annu*... The measured rate tariff for business lines offer... o calls for an annual rental of £8 10s. with extra... lls charged at 16s. 8d. per 100; there is als... similar two-party line tariff at £1 12s. 6d. a qu... r, including 100 calls. The measured servi... exclusive line for residence subscribers costs... 15s. a quarter, including 50 calls, with extra... lls at 25s. per 100; its two-party line coun... part is £1 2s. 6d. a quarter. A black moul... H.M.T., similar to Post Office types, is inclu... d in the standard rental. A charge of 10s. a ye... s made for coloured telephones in ivory, red ... green. Connexion charges are payable at the ... of £1 10s. *per annum* extra.

A ... ple internal extension in parallel is £1 10s. *per ... um*. Connexion charges are payable at the rate ... £1 10s. for each exclusive line and £1 for each ... rty line subscriber for new work and at abat... ies for installations partly or wholly *in situ*. The ... ntract with subscribers is based on an agreement ... gned when the Department can accept a firm ... er, which reserves to the Corporation the righ... mong others, to revise tariffs on giving one mon... public notice in any newspaper published in t... full area. The licence states maxima and min... for the principal tariffs.

Standard A and B Button Multi Coin-Boxes are used in public call offices, adjusted to operate with the present 2d. local call fee. Subscribers may rent a coin-box line at £9 a year, but the Corporation collects all proceeds, an arrangement which works very well and, of course, avoids complaints caused by a subscriber's inability to reconcile his trunk and local call accounts with the amounts collected from the cash boxes.

The Undertaking has the distinction of possessing the only Western Electric Rotary public exchanges remaining in the United Kingdom, although modern versions of this machine-driven register-controlled switching system are to be found on the Continent. The Corporation embarked on automatic telephony with the opening of a 2,000-line sub-exchange (Newland) in 1922, before the Post Office had standardized the use of step-by-step equipment. Unfortunately for the Corporation, the Post Office decision, when it came, meant that the manufacture of the Rotary system ceased in this country, with the result that to extend their Rotary exchanges the Corporation were forced to import equipment from a Belgian factory. World War II caused difficulties but after the liberation the Corporation were offered a consignment of switching equipment which was being made when Belgium was overrun.

During the 1930s it became apparent that it would be advantageous to incorporate British made

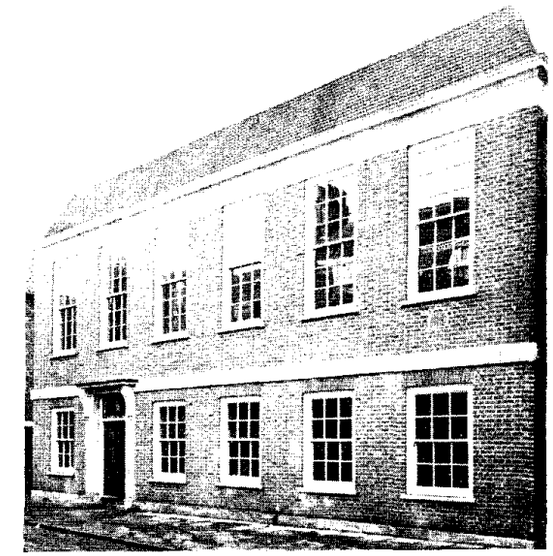


Fig. 2: Beverley Exchange—opened in 1956

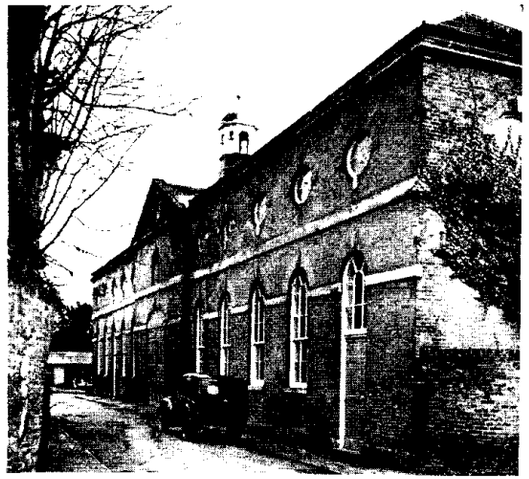


Fig. 3: Ferriby Exchange—premises adapted from stable about 100 years old (Courtesy of *Hull Daily Mail*)

step-by-step equipment in the system, and conversions of four of the remaining manual exchanges during the years 1934–1940 employed pre-2,000 type equipment for sub-exchange working to a Rotary main exchange. After the war the exchange design policy was reviewed and we decided to reduce the amount of Rotary equipment ordered in future. The first step in the long term programme then approved involved replacing one of the Rotary exchanges by a 2,000-type main exchange (West), and re-deploying nearly all the displaced equipment at other Rotary exchanges. A 2,000-type tandem exchange was also opened to provide inter-system working between Rotary and step-by-step and to switch inter-exchange traffic between step-by-step exchanges. Since 1952 when these exchanges were opened, 2,000-type equipment has been installed at most of the remaining exchanges, either as extensions or in complete replacement of existing equipment.

Space does not allow me to describe the Rotary system fully in this article. Its principal feature is that both single-motion and two-motion switches are driven by continuously rotating motor-driven shafting to which they are clutched as required by electro-magnets operating friction drive or flexible gear mechanisms. All operations are controlled by registers, not unlike the directors in the Post Office system. There is a uniform 5-digit numbering scheme, and as the system does not give facilities for code dialling to other exchanges the whole area has been treated as a single 5-digit linked numbering scheme, for which it is fortunately reasonably well adapted, and this has compensating advantages in relieving subscribers of reference to code lists and simplifying directory instructions.

The special service codes are on level 9, as in Post Office non-director exchanges, although as will be observed from the list, the emergency code is "99" and not "999" a little circumstance which arises from the fact that the dialling of an additional digit after the register has completed its work would cause breakdown of the connexion owing to more rapid release which takes place on the Rotary system. The alternative would be to re-design the registers to deal with a 3-digit code, but this would involve modifying or replacing several hundred registers.

Special Service Dialling Codes

"0" Trunk Calls
91 Trunk Enquiries
92 Post Office Official P.B.X.
93 Corporation Telephone Department Official P.B.X.
94 Phonodiary
95 Assistance
96 Speaking Clock
97 Directory Enquiries and Repair Service
98 Reserve for Weather Service
99 Emergency

Within the 5-digit system there has been for the past 20 years a problem of inter-working between Strowger and Rotary equipment. This has been solved, with varying success, in several ways.

A step-by-step exchange can operate as a satellite of a Rotary main exchange; the caller merely waits until a register has been seized over the junction and then dials simultaneously into a disconnecting selector repeater and register; the repeater, after one or two digits, determines in the usual way whether the call is to continue via the main (Rotary) exchange or the satellite (step-by-step) exchange.

In the reverse direction, however, means have to be provided, after the last Rotary switching stage in the call, for the subsequent step-by-step selectors to generate the reverted impulses requisite for operating the Rotary register. This problem has been tackled by special interworking Rotary equipment where association of the interworking equipment with a Rotary exchange was appropriate, or by equipment of step-by-step type where association with a step-by-step exchange was preferred.

To lessen the dependence of the system as a whole on Rotary equipment, a conventional step-by-step non-director system had to be built up with its own main exchanges. This entailed some

means of routing calls when necessary to the remaining Rotary exchanges after the initial one or two digits had already been dialled into the Strowger main exchange. To achieve this the equipment contractors designed a 3-digit register using step-by-step components, but giving facilities similar to a Rotary register for controlling the Rotary switches on the last two switching stages of inter-system calls. This has opened up the possibility of dialling in from Post Office exchanges other than the trunk exchange. We expect that several incoming routes will be working on a dialling in basis within the next twelve months.

We considered that future development did not require more than four main exchanges to take the place of the four Rotary main exchanges in the city area, although remote non-director exchange working has also been adopted at two outlying exchanges, Beverley and Ferriby, recently converted to automatic working. For many years two of the six Rotary exchanges had been full "trombone" satellites. Although these two exchanges had outgrown this form of working, two smaller step-by-step sub-exchanges were opened at North and Bilton Bar in 1955, which have been arranged as satellites of Newland and East respectively. The complicated discriminator scheme for satellite working in 2,000-type areas was considered to be a strong objection to that method of working when these two exchanges were designed.

The table shows in detail the exchanges and types of equipment at present in service, and it will be noted that some exchanges have both Rotary and step-by-step equipment installed in the same premises, the power plant and other common equipment being shared. British Post Office standard tones were introduced in 1955.

Equipped Capacity (Subscribers' Multiple)

Exchange	*Rotary*	*Pre-2,000 Type Step-by-step*	*2,000 Type Step-by-step*	*Manual*
Beverley ...	—	—	2,000	—
Bilton Bar ...	—	—	900	—
Brough ...	—	—	—	380
Nottingham	—	2,000	—	—
East	2,400	—	3,000	—
Ferriby ...	—	—	900	—
Hedon ...	—	680	—	—
Hessle ...	—	2,000	900	—
Kirkella ...	—	2,000	1,000	—
Myton gate ...	4,800	—	Jct. Tandem	Manual Asst. Swbd.
Newland ...	4,000	—	2,000	—
North ...	—	—	2,400	—
South ...	2,000	—	—	—
West	—	—	7,000	—
Wincolmlee	4,000 Jct. Tandem	—	Jct. Tandem	—

The Corporation's two-party line scheme affords discriminating ringing and metering, but no secrecy. The telephone circuit does not require the subscriber to push a button. Apart from the degree of line plant flexibility and economy which party line service affords, it has been the practice to seek the most economical arrangement of exchange equipment, even at the expense of some service disadvantages, such as more frequent number changes and difficulty in intercepting calls. Several circuit arrangements have been used in the different types of exchange, but the Corporation's attitude to this type of service is well illustrated by two relatively recent decisions.

The first affected the design of circuit for party line final selectors which are always segregated. In post-war exchanges a design has been introduced which affords 400 party line outlets by adapting the usual 200 outlet step-by-step switch so that, in addition to a wiper switching relay controlled by the path of access from the preceding rank of switches, there is a ringing reversing relay similarly controlled; two incoming trunks thus give access to "X" subscribers and another two give access to "Y" subscribers. This is really a "single-terminal per line" basis, and so suffers from some of the disadvantages of such arrangements, but it affords useful economy in equipment.

Under the second decision instead of using separate calling equipments for each party and inter-connecting them to give the requisite meter discrimination, or employing a special design of calling circuit with built-in discriminating features, a separately jumpered discriminating relay group or party line "adapter circuit" has recently been used between the uniselector outlets and the first group selectors. In our opinion party line working will, for many years, offer the prospect of cheap and adequate service for many subscribers in our area and we consider that this justifies the design of special exchange equipment.

Hull is one of those cities where the lines engineering staff were made aware of the existence of duplicate distribution systems before the Post Office took over the National Telephone Company's plant in 1912. The two principal exchanges in the central area have, to this day, overlapping areas of service, even to the extent of many distribution poles having cables from both exchanges. Before the war the smallest distribution cable was 10 lb. per mile, a circumstance which has not been without its advantages during post-war

efforts to catch up on demand. There are a few loaded junction cables and some composite junction and subscribers' cables. Since the war a great deal of 6½ lb. per mile and a fair amount of 4 lb. per mile unit type cables have been used, but cabinets and pillars do not yet feature in the Corporation's distribution system. Instead, the mechanical auxiliary joint has given good service as a flexibility device.

Although the Corporation owns large housing estates which have expanded rapidly since the war, it is none the less critical of unsightly overhead plant, but by adopting ring type poles with open wires, it has been possible to plan developments economically and acceptably in most places. Excellent co-operation with the housing section of the City Architect's Department has ensured good provision for telephone plant at the planning stage of several post-war housing projects of the City Council, and by reserving the appropriate access for maintenance purposes from an adjoining highway telephone distribution schemes have been devised on mutually acceptable principles.

For party line working the constant aim is to secure sharing within the same distribution point area to get the maximum line plant economy. This cannot always be achieved, although periodic re-arrangements and number changes for existing party lines are put in hand to correct undue consumption of cable pairs by party line connexions working out of area.

All trenching, duct laying, joint box construction and manhole building are performed by direct labour. Junction cables are laid, jointed, balanced and loaded by the Department's staff. Mobile radio, with which a number of the Department's vehicles are equipped, as well as affording a most useful aid for line maintenance in particular, has proved valuable to other Corporation departments, such as Transport, Street Lighting and Cleansing, since it is arranged for inter-working with the local exchange network. These communal wireless facilities for a group of local authority departments are believed to be unique in this country.

The maintenance of automatic exchanges is much facilitated by using automatic traffic equipment or, as we know them, "automatic subscribers", for sending a programme of calls continuously through the equipment. This practice has been proved by many years of experience and the latest arrangement combines such testers with an automatic traffic recorder. Automatic routiners for testing components of the system, such as group selectors, final selectors, have not been employed, although manual routiners for this purpose are, of course, used.

Subscribers' apparatus follows Post Office practice for the most part; indeed it must do, for it is one of the obligations of the licence that the Corporation shall conform with certain minimum specifications for its plant, but features of interest to Post Office readers may be encountered.

I have already mentioned the buttonless party line telephone. The conventional cordless P.M.B.X. will usually possess self-restoring exchange line indicators, which operate in synchronism with the ringing cadence. For many of the smaller offices served by P.A.B.Xs of up to 12 lines we have the subscriber attended scheme, without separate switchboard or attendant's cabinet, whereby any extension user within earshot can answer an incoming call and transfer it to the required person using the button operated automatic transfer facility similar to that found on the P.A.B.X. No. 2 scheme.

At the other extreme the recently installed cordless switchboard at the Guildhall serving the Law Courts and several large Corporation departments, has nearly 300 extensions with full recall, refer back, and automatic transfer facilities, with an interesting electronic memory as an operating aid. This shows, on an illuminated display visible at the top of the panel in Fig. 4, the number of the extension calling when any previously established incoming exchange line call is reverted to the operator for any reason—for example, delay in answering, number engaged, or for assistance.

Another large cordless P.A.B.X. serving new headquarters for the City Police, opened in May this year, has two manual positions on different floors; one deals with traffic for headquarters departments of the Police Force and the other with traffic for the Central Police Division, although all extensions share the same automatic equipment with facilities for enquiry calls and automatic transfer without operator assistance. By throwing a switch the whole of the traffic on the headquarters switchboard can be switched to the divisional switchboard, which then functions as a night service switchboard for the headquarters departments; either switchboard can, in fact, handle at short notice the other's traffic in an emergency with very slight loss of facilities.

No account of the Hull municipal telephone undertaking would be complete without reference to Santa Claus on the telephone. This recording

Fig. 4: Cordless switchboard, Hull Guildhall (Courtesy of *Hull Daily Mail*)

of a Christmas story for children on an endless magnetic tape and playing it back to subscribers who dial a special number was introduced in 1952 at less than a week's notice. Certain temporarily spare Rotary automatic switches were available at that time. The connecting circuit and associated first group selector contain the transmission bridge in this system and the registers possess certain limited translation facilities. This allowed the engineers to evolve very quickly a scheme for connecting nearly 300 outlets, although nothing like that number was actually provided for the first day.

Scripts have been written by members of the staff, sometimes with help from other departments, such as the City libraries. Commercial tape recorders were used, but a special machine was constructed in the Department's workshops when we decided to run the equipment permanently for such purposes as local entertainment guide (Phonodiary), daily recipe hint (Telechef) and playing popular gramophone records (Teledisc). Specially developed commercial machines are now undergoing trials.

Having embarked on this type of service, the Corporation naturally wished to take advantage of

the Test match information service, which has since become an established feature of the Post Office system. For this the Post Office supplies a feed from the nearest point on the trunk network, as for Hull's speaking clock service, which is also derived from the Post Office clock. But Hull, having its own brand of weather, is naturally seeking to obtain its very own forecasts.

With the co-operation of the local Rediffusion Company, the Corporation have made available a distribution network for Hull City Football Club to enable voluntary commentators to give commentaries on local matches to hospital patients. Eleven hospitals are connected. The same network was used, it is believed for the first time for such a purpose, to relay the opening of a new wing for the Royal Infirmary by the Princess Royal two years ago, and, more recently, to give a commentary on the Royal visit to Hull before the State visit to Denmark, when the hospital commentary was also given through public loud speakers to crowds waiting at vantage points along the processional route.

It is naturally necessary for a small organization such as the Hull Corporation Telephone Department to rely heavily on the achievements of the engineers and scientists of the Post Office and the telephone industry. Even a small operating concern, however, has much scope for exercising its ingenuity to the advantage of its customers, although this may often present a hard tussle with "standardization". Just now the Corporation must pay particular attention to its future course, since subscriber trunk dialling is clearly the next major development to be reckoned with in its present planning.

It so happens that, within the next few years, the two principal Rotary exchanges serving the centre of the city will have to be replaced. A site has already been obtained and preliminary building plans for "Telephone House" drawn up. By happy coincidence, the site is on the opposite side of the street to that recently chosen by the Post Office for their second Trunk Control centre for Hull, and not much farther from the present Post Office trunk repeater station. The local staffs of the Post Office and Corporation telephone services will continue to have much common ground—almost indeed, in the literal sense—as they plan their respective new projects, both destined, in different ways, to serve better the telephone needs of this Yorkshire city and port.

Post Office Operates Hull Toll and Trunk

J. E. Young, O.B.E., E.R.D.

IN SPITE OF—OR PERHAPS BECAUSE OF—HULL'S Corporation telephone system, a Post Office trunk and toll exchange is necessary in the city. This exchange, a standard sleeve control switchboard of some 150 positions, is in the Head Post Office and operated by a staff of about 200, with 70 night staff, and looked after by about a dozen Post Office engineers.

Most of the traffic comes from Hull Corporation subscribers. Hull, being Britain's third largest general seaport and first fishing port, a maritime flavour permeates the general atmosphere of the traffic handled. Much of the country's imports of timber, oilseed, grain, cocoa, fish, molasses and a large part of its fruit and vegetables enter at Hull, while coal and manufactured goods (including large quantities of new cars) are exported, with a few passengers, stowaways, smugglers and other minor additions to the general interest (and occasional amusement) of the port's shipping interest.

All this activity leads to a solid backbone of commercial and country-wide business long distance traffic, with a very peaky and troublesome daily superposition of fish and (particularly in early summer) fruit traffic; also, dependent on tides and seasons, an occasional spate of passenger traffic. The trunk part of the Trunk Toll Exchange is kept pretty busy handling a daily total of about 6,000–7,000 long distance calls which range through the whole country.

The fish traffic through the exchange starts sharp at 7.20 in the morning. Fish Market Research gives a very busy quarter of an hour with about 100 wide ranging long distance calls. At 9.30 the business traffic starts and at 10.20, superimposed on the business busy hour, the fish traffic comes along with 500 to 1,000 or so long distance calls which the originators all require instantaneously and simultaneously. On a busy day some 20 or 30 subscribers will book batches of 20 or more follow-on calls at once; in Holy Week, our busiest period, even more. The better trained fish salesmen book their batch specially before the busy hour (thereby avoiding the wait of a few seconds at 10.20) to ensure getting in first with customers at the other

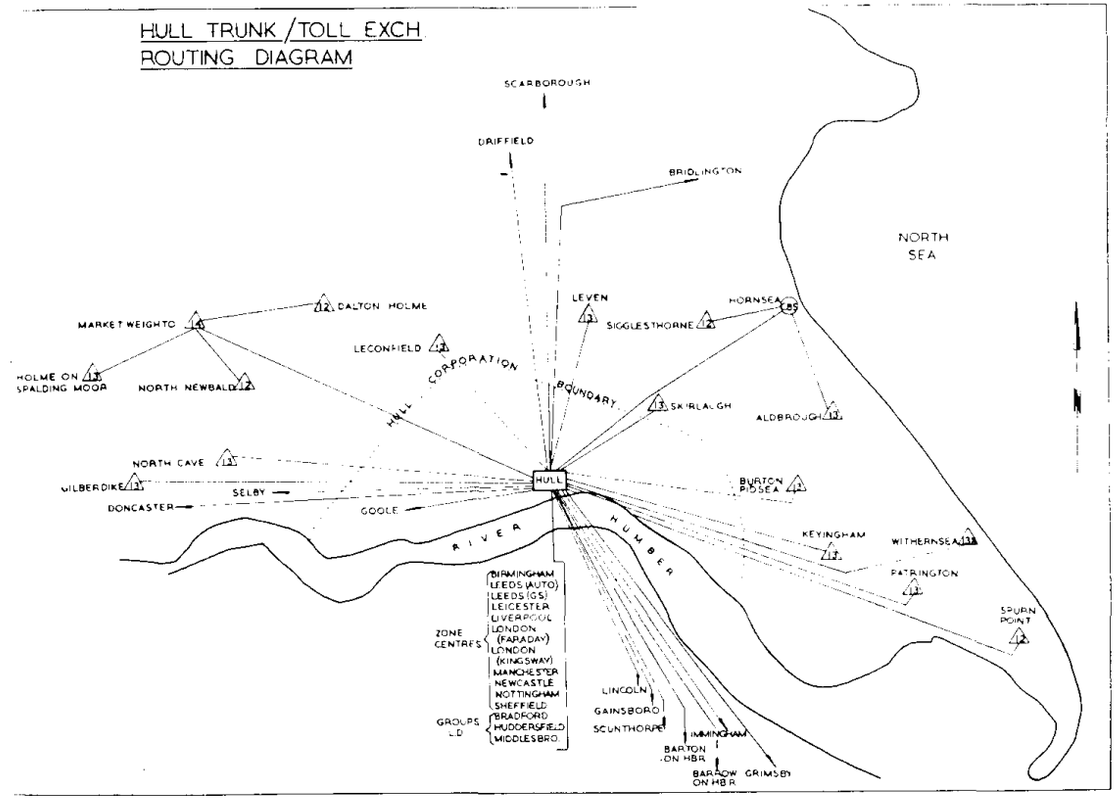
nds of the country. Competition is fierce; in the ish trade the art of reaching the customer before he other merchant is often the difference between flourishing business and a rapid and spectacular ankruptcy. Thus there is no question of patient ubscribers agreeably tolerating any shortcomings n telephone service.

The redeeming feature of the fish traffic is that he callers are just as anxious as we are that the ervice shall be extremely quick and efficient and heir co-operation in all matters to achieve this esirable state of affairs has to be experienced to be elieved. Durations are generally short and in the lays when paid time records were maintained 60 minutes paid time an hour was regarded as very oor return on a long distance circuit.

With trade in other perishables—fruit and egetables—we do not have the same problems as few years ago. Much greengrocery, particularly alad stuff, is either imported at, or grown near to Hull. The docks are tidal and the unloading of a hipload of tomatoes at 2.0 p.m. and the efforts of all the wholesalers to place them in the markets at one time gave frequent, unexpected and unpleasant rushes at unwelcome times. The fruit trade nowadays seems to have got itself rather differently organized and a private teleprinter network and telex appear to have taken many of the rough corners off our traffic.

We have no evening difficulties. A circuit provision which meets our day requirements is more than adequate for evening traffic, and, apart from some minor automatic plant congestion in the evenings in localized residential areas, now rapidly disappearing, there is nothing exceptional to deal with. Traffic is mildly seasonal because Hull is near so much holiday country.

The toll part of the exchange is somewhat troublesome because, as the Corporation operates within a radius of some seven or eight miles of the exchange, the U.A.X.s for which Hull is parent are all either just within or outside 15 miles. Thus interdialling and multimetering are almost unknown and Hull (which in any other circumstance



would almost certainly be a tandem auto-switching centre for everything within 15 miles) has to connect all this cross-country traffic manually—and to look up a reference file almost every time to see whether it's timed or untimed!

To dispose of all this traffic we have 14 outlets (a total of 210 outgoing and bothway trunks) direct to most zone centres and all adjacent groups. The long distance circuits, apart from those to Kingsway, Faraday and Manchester, are all generator signalling trunks: the remaining three have recently been brought up to date and have materially improved operating facilities, particularly for the quick-fire fish traffic that can be routed over them. The toll traffic (if it can be specifically segregated as such, these days) is all disposed of by means of the usual ether signal or, where available, S.D. D.I. facilities over 14 routes of 130 outgoing and bothway junctions in all. There are also 14 U.A.X.s for which Hull acts as parent manual exchange.

The main cable outlets go via Leeds, with subsidiary outlets via York, Bridlington (and parts north) and under the Humber to Lincolnshire and East Anglia. A large repeater station (Post Office) attends to these circuits; there are also, of course, a Fault Control Centre, Trunk Test, and Maintenance Control in Hull, with about a dozen engineers. The main trunk outlets are via carrier cable to meet the main co-axial arteries in Leeds. The cables going in other directions are modern loaded and amplified installations.

Contact with Corporation

Contact between the Post Office and Hull Corporation is provided (at Corporation expense, under the terms of its licence) by some 250 junctions outgoing from the Post Office to the main Rotary and 100 "1st selector" routes to tandems and satellites. There are about 170 circuits for Corporation subscribers' access to '0' and '91' and a separate provision for phonograms, telephone telegrams, telex and private wires. There are also some 30 Post Office trunk subscribers and a series of odds and ends, such as rediffusion services picture transmission and B.B.C. "ends", routed over Post Office wires and terminating in the Corporation area. All these appear on our main frame as do about 1,000 pairs in Corporation-owned cable.

So far as Hull Corporation subscribers are concerned the trunk exchange deals with their traffic in exactly the same way as if they were Post Office subscribers, and calls are booked, recorded and connected in exactly the same way as anywhere else. They dial 0 to get the trunk exchange and 95 to get the Corporation assistance (manual) board. After the tickets are priced, however, a daily account is presented to the Corporation, and at the end of the month the Corporation have to settle a bill to the tune of some £40,000 or so. As this is a lot of money to find, the Corporation then sort out the tickets (presented to them—in price order—with the account), find which of their subscribers have involved them, and present them all with their respective accounts. Thus Hull Corporation subscribers get a monthly trunk account which they pay over the same counter at the Guildhall as they pay their rates, electricity bills and other such domestic outgoings.

All the (green painted) Corporation kiosks now have trunk facilities. Access to the trunk exchange is by dialling 0, which gets the Corporation operator, who then offers the call to the trunk operator over a red-lamped junction, and the call is completed in the usual way. When the ticket is priced, however, 2d. is knocked off the charge to the Corporation as the coin box fee is adjudged to belong to them. There are a few Post Office call offices at our counters. There is also an attended call office at the Post Office Cable and Wireless branch for oversea calls.

Incoming traffic is all manually handled at the trunk exchange. Because of differences in equipment dialling-in has only recently become technically possible, so for some time to come it is likely that all incoming traffic to Hull Corporation subscribers will be manually handled at Hull trunk exchange.

Traffic amounts to some 16,000 originating calls a day (about 10,000 or so from the Corporation) with a busy hour of about 2,800, and incoming and through (*all* manually completed) traffic of about 18,000 calls per day.

Apart from a little friendly deprecation of their system, and barefaced criticism of their equipment in personal discussion, the Post Office staff in Hull secretly admire the very energetic way in which the Corporation tackle their problems (and public comment), which are remarkably similar to those that face us in our own Areas. We get on extremely well together, and both heartily respect each other. Both Corporation and Post Office engineers are members of the Institution of Post Office Electrical Engineers and the Post Office Training School at Stone is as well known to the Corporation as to the Post Office. Our services fit in very well together.

Old Poles for the New World

Following the brief note—"U.S. Buys Old P.O. Poles"—in our Spring issue, we have received a fuller account of the transaction from Mr. J. Gaukroger of the Engineering Department.

ON SEPTEMBER 14, 1956, MEMBERS OF THE Supplies and Engineering departments met to discuss with a representative of one of the largest firms of wood preservers in this country a most unusual and novel request. This firm had been asked by Koppers of Pittsburgh, U.S.A., whether they could purchase on their behalf from the British Post Office several poles which had been in service for a very long period.

We learned that Koppers, who are one of the largest firms of wood preservers in the United States, are most anxious to increase the use of creosote as a wood preservative, and that approximately 100,000 tons of British creosote are exported annually to the U.S.A., so that any drive to increase the use of creosote in America would ultimately have a beneficial effect on this country's dollar situation. That the Americans should want old British poles still appeared puzzling, but further questioning revealed that their interest stemmed from the fact that the long service life of our telephone poles was the result of their having been pressure creosoted, a process that has been in widespread use in this country since 1870, but was not widely used in the United States until after 1900. An article in a British timber magazine a few years ago had first brought our antique poles to Koppers' attention. A statement in it that more than 8,000 pressure creosoted poles, installed well before the turn of the century, were still in service had intrigued Mr. Holmes, their Vice-President.

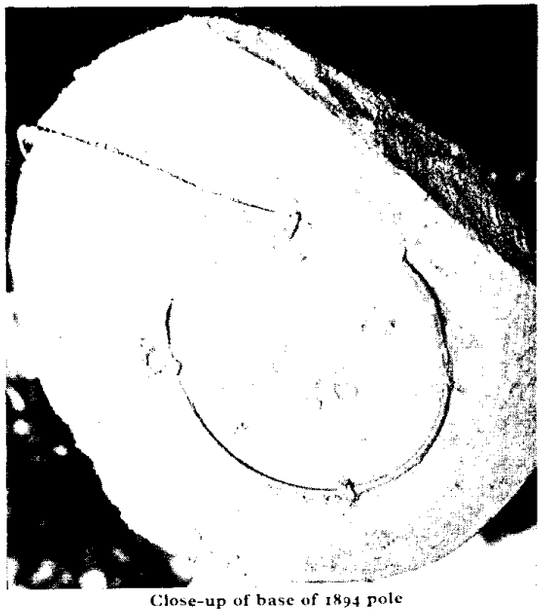
We explained at the meeting that if Koppers wanted poles the age of which could be positively authenticated, those dated 1890 and later would have to be accepted, as it was not until 1890 that the Post Office began branding the year of preservative treatment on its poles; the Post Office also decided that all its standing poles should be similarly branded, the actual date branded being

An old pole begins its journey

obtained from the knowledge of the local linemen. It was considered therefore that although the linemen of the period would probably be correct for most of the poles, the best that could be done would be to certify that the selected poles had been creosoted and erected before 1890. In the circumstances it was agreed that poles dated 1890 or a few years later would be acceptable.

As a result of the meeting the Engineering Department undertook to find suitable poles within a reasonable distance of London which could be recovered in October, 1956, when a representative of Koppers would be present to witness the operation. Owing to the distance qualification the search was restricted to the Home Counties Region. Fortunately, some short time ago the Engineering Department were collecting statistics on both *in situ* and recovered poles, to determine the life of a pole in one position for cost comparison purposes, and the Regional officer concerned recalled that he had been impressed by the number of old poles in certain parts of Oxford Telephone Area and directed the search accordingly.

Two sites, where the poles were dated 1893 and 1894, were selected in the quaint old village of Dorchester some 12 miles from Oxford. At one time, before the days of the motor car, Dorchester



Close-up of base of 1894 pole

used to be on the main road from Oxford via Henley; hence it is not surprising to find old poles now serving the local distribution network which formerly formed part of the old overhead trunk network.

A preliminary visit with the photographer was made to Dorchester on October 12 to take pictures of the site before starting operations. The opportunity was also taken of making arrangements for the visit of Koppers' representative. The Area Engineer agreed that replacement poles would be in position and all wires and aerial cable transferred so that on the day all that would remain to be done would be the actual recovery of the selected poles.

When all the interested parties arrived on site on October 22 a gang had already excavated the strutted pole. A mobile crane was available for removing the poles and the whole operation of recovery and stacking pending transport to the docks was conducted in a very efficient manner, earning the praise of all present. A photographer made a complete record of the operation.

When the poles had been hauled out of the ground the butts were examined for signs of decay but none was found. The markings were still legible: being B.H. & Co., three crowns and the numerals 36. The Supplies Department established that the B.H. & Co. marking is a trade mark used by Blakstad, Holta & Co. of Skien, Norway, who have supplied poles to the Post Office for more than 70 years. The three crowns are still a standard marking for identifying poles in the stout class. The numerals 36 indicate the length of the pole in feet. Actually the length of the poles had been reduced to 30 feet, probably when they ceased to carry trunk circuits and became part of the local network.

The poles were later transported to Long Reach petroleum pier on the Thames where they were loaded on to M.T. *Evina* and shipped to Norfolk, Virginia, their final destination being Koppers' Research Laboratories, Verona, Pennsylvania, a distance of 4,000 miles. Koppers proposed to determine how much creosote still remains in the poles after their long and successful battle against the ravages of time, the elements and other enemies of wood. Later they proposed to use sections in a permanent exhibition demonstrating the long lasting preservative qualities of creosote.

The fact that these poles were free of decay after more than 60 years' service is proof positive of the efficacy of creosote as a timber preservative.

£19 Million More from Telephone Service.—Announcing in the House of Commons increased postal, telephone and overseas telegram charges, consequent on increased expenditure necessitating £42 million a year extra revenue (after £3 million a year economies) from October 1 over the financial years 1957 1959, the Postmaster General stated that £19 million must be raised from the telephone services.

Telephone rentals are to be standardized throughout the country at £14 for business and £12 for residential subscribers, with £2 concession for shared services, and free call allowances are to be abolished. Charges for private branch exchanges, connexions and removals are also to be increased. The ordinary local call charge will be increased to 3d., but from January 1 (under group charging) the local call range will be extended. Oversea telegram rates (except the Commonwealth Penny Press rate) will be increased by about 40 per cent.

At a subsequent Press Conference, Mr. Marples showed that, compared with 1951, 1,500 fewer operators are handling 25 per cent. more telephone calls, and that 3,000 fewer men are doing more engineering maintenance work.

He added that the telephone rental in Paris is £15 12s. 0d. a year, and in New York £33 4s. 0d., including £16 17s. 6d. worth of free calls.

Telecommunications in Australia

P. F. Connell

THE TASK OF EXTENDING TELECOMMUNICATIONS throughout a country the size of Australia is naturally attended by difficulties not encountered in the more closely settled countries of the Old World. With a recorded population of 9,427,000 and an area of over 2,900,000 square miles, Australia is but sparsely populated and yet its two major capital cities—Sydney and Melbourne—can boast of being the third and fifth largest cities in the British Commonwealth. The picture then is one of concentrated settlement around the eastern, south eastern and south western seaboards, with vast areas of relatively uninhabited territory to the north and north west and in the centre of the continent.

In terms of administration and control, the various forms of telecommunications are, perhaps, more closely integrated in Australia than in many other countries, the Post Office having the sole responsibility for the provision, operation and maintenance of the inland telephone and telegraph systems, the licensing of radiocommunication services and the provision and maintenance of the broadcast transmitter stations and equipment operated by the Australian Broadcasting Commission, which conducts the nationally owned broadcasting service. Privately owned broadcasting organizations are, of course, autonomous in this regard but are subject to a measure of regulatory control by the Australian Broadcasting Control Board which, in turn, is responsible to the Postmaster General.

For administrative purposes, the Australian Post Office is divided into well-defined functional groups. The Engineering Division constructs and maintains telecommunications facilities, while planning, and the standards to be prescribed and observed, are the joint responsibility of that Division and of the Telecommunications Division which is also responsible for all traffic, licensing, contracts, revenue and expenditure. Ancillary services are provided by the Accounting, Personnel, Buildings, Stores and Contracts, and Finance and Public Relations Branches.

Within the Engineering and Telecommunications Divisions, the organizations are based on a three-tiered system of decentralization and delegation of authority; that is, a central administration to formulate and direct policy, procedure and research, State administrations to provide and maintain services along the general lines of Headquarters' policy, and district organizations to take care of field operations.

Historical

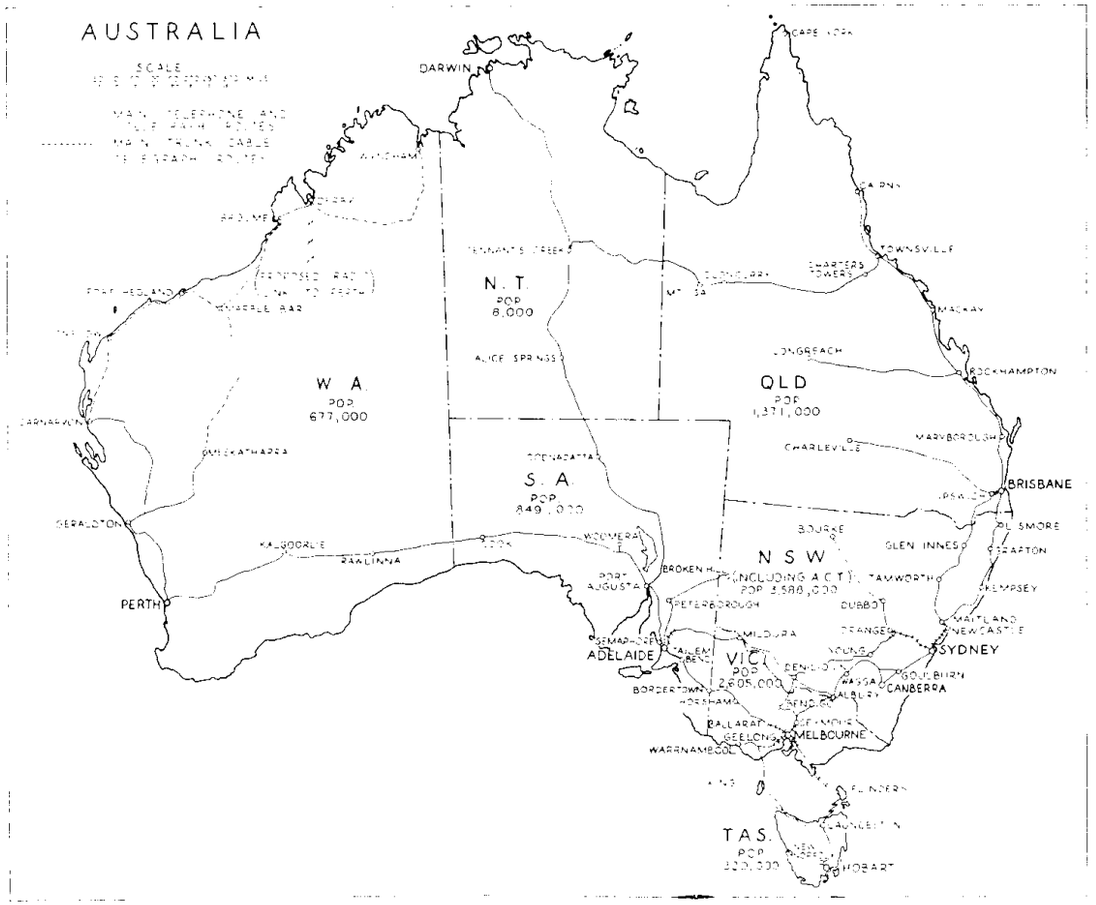
Before proceeding to examine the contemporary scene, it would be as well to mention a number of milestones in the history of Australian telecommunications.

The first long distance call in Australia took place in 1878, only two years after the invention of the telephone by Alexander Graham Bell, and was between Semaphore and Port Augusta, in South Australia, a distance of 240 miles. The establishment of telephone exchanges in Brisbane and Melbourne followed some two years later and, in 1888, the first telephone trunk line was erected between Hobart and New Norfolk in Tasmania. By 1901, the year of federation, the number of telephone subscribers had grown to 32,800; they had reached 100,000 in 1911.

During that decade, 1901–1911, central battery exchange working was introduced in most capital cities and, in 1912, automatic exchanges were established in Perth (Western Australia) and at Geelong (Victoria). Inter-capital city trunk lines were established in 1907 between Sydney and Melbourne and from Melbourne to Adelaide in 1914 and, in this year also, a main trunk exchange was brought into service in Sydney. Other "firsts" included successful trials of direct dialling over trunk lines in 1924, a simultaneous broadcast over trunk lines connecting Sydney, Melbourne, Brisbane and Adelaide in 1925, and the expansion of automatic telephony to rural areas in 1926.

The paragutta-insulated submarine telephone cable opened for traffic in 1936 between Tasmania and the mainland created a great deal of interest in the technical field.

The first telegraph channel in Australia was



opened in 1854 and inter-State communication between Melbourne and Adelaide was established four years later. In 1859, a submarine telegraph cable was laid between the mainland and Tasmania and, by 1871, 23,000 miles of wire had been added to the telegraph system. It was in this period that the famed Darwin to Adelaide overland circuit was erected: this line, which took 23 months to erect, spanned the continent from north to south, a distance of over 1,800 miles across some extremely arid and desolate stretches of country. By federation in 1901, the network had expanded to 100,000 miles of wire and the following years saw the extensive development of phantom working.

By 1912, the Wheatstone system was in operation on all routes and a year later Creed reperforators and printers were installed for the first time. In 1927, the first carrier telegraph system was installed between Sydney and Melbourne and this type of system later gave way to improved voice frequency systems, the first of which was installed in 1935.

More Recent Developments

During the 1939–45 war, particularly after the entry of Japan into the war in 1941, the Australian Post Office was placed on a war footing and the demands of the fighting forces for services and manpower were met only by abandoning normal development projects and by utilizing to the full all reserves of plant and equipment. The position facing the administration in the immediate post-war years was not, of course, peculiar to this country alone: indeed, Australia was more fortunate than many other countries in that little of its equipment suffered damage from enemy action.

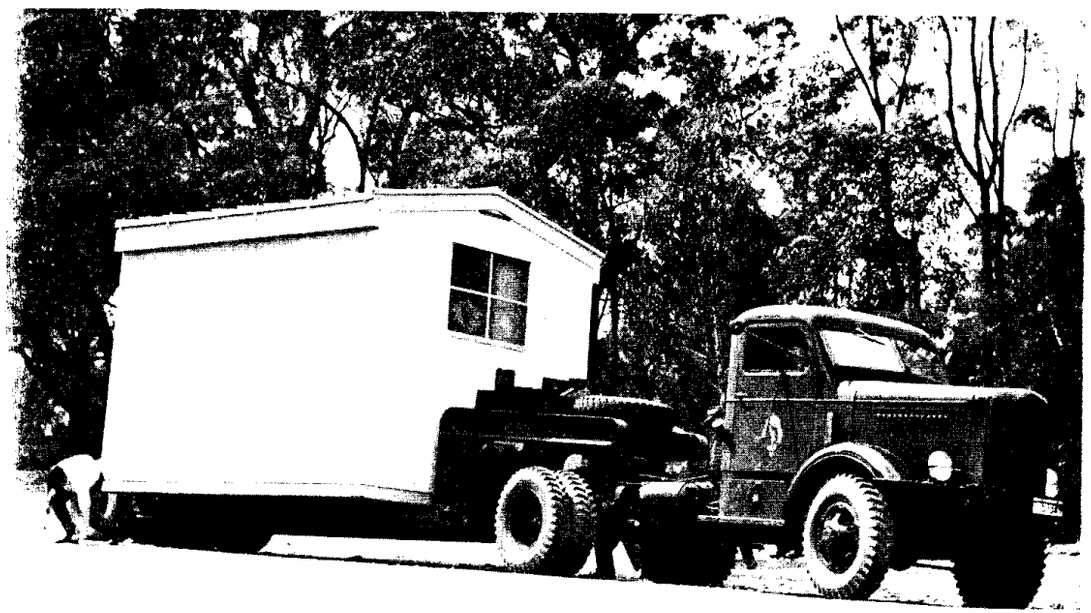
On the other hand, it must be remembered that, before the war, the Australian Post Office relied on imported plant and equipment for up to 75 per cent. of its requirements and, for many years after the end of the war, it was possible to obtain only a very small percentage of its needs from overseas sources. It was necessary, therefore, to foster the development of local production, especially of automatic telephone equipment and cable plant and, nowadays, over 80 per cent. of requirements are being supplied locally.

In recent years, the Australian scene has been characterized by an unprecedented industrial expansion and the Post Office is proud of the role it has played in keeping pace with this development and, at the same time, in providing communication services for a rapidly increasing population. For instance, since 1939, the number of telephone exchange lines in operation has grown from 388,000 to 1,200,000 and the trunk line and local call traffic handled has increased from 41 and 596 million to 99 and 1,186 million calls respectively. Some further indication of the extent of telecommunication facilities provided within Australia is contained in the following brief outline of the various services.

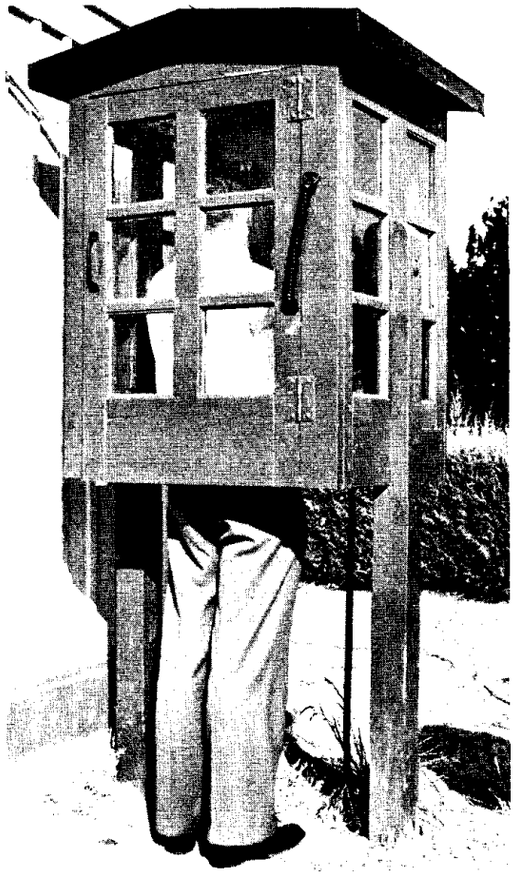
Telephone Service

Local Exchange Service. Of the 728,000 metropolitan exchange lines in service at the present time, 98 per cent. are connected to automatic exchanges, and the remaining manual exchange installations are to be cut over to automatic working within the next two or three years. The number of automatic exchanges within each capital city's metropolitan network ranges from 10 in Hobart to 94 in Sydney. The numbering system consists of a one or two letter exchange code and a four-figure exchange number, that is to say a 5- or 6-digit step-by-step closed numbering scheme.

Mechanization, however, has not been restricted solely to capital city areas. In fact, one of the greatest achievements since the war has been the increase in automatic working in country areas. Since 1946, the number of automatic exchanges in rural districts has risen from 160 to 934, considerable use being made of rural automatic exchange units which have been designed to meet the needs of Australia's small country communities. These



A fully equipped Rural Automatic Exchange Unit on its way to provide service



Half-type kiosk for public calls

units are fully automatic in operation with a maximum capacity of 200 lines and are suitable for use with single-wire subscribers' lines, 2–10 party-line services and multi-office trunk circuits.

Trunk Line System. The Australian trunk line system can, perhaps, be best described as a "fringe" system, the main routes paralleling the coast between Cairns in Queensland and Carnarvon in Western Australia, with major routes radiating from capital cities and important intermediate stations to inland provincial switching centres. At present, the trunk line network comprises over 13,000 individual trunk line circuits, involving some 926,000 channel miles.

Because of the distances involved, the network is predominantly of open wire construction, but the stage has been reached where trunk line requirements on many routes will justify greater use of trunk cable which, so far, has not been used extensively.

Indeed, consideration is now being given to the laying of a six tube coaxial cable between Sydney and Melbourne, a distance of approximately 600 miles.

The development of carrier working has been along the lines of installing 3- and 12-channel carrier systems on aerial construction and 9-, 12- and 17-channel systems on pairs of trunk cables. The 12- and 17-channel systems are now being group modulated to provide 24 and 34 channels respectively to increase the capacity of the existing cables. There are, at present, 45 17-channel systems, 106 (open wire and cable) 12-channel systems and eight 9-channel systems in operation.

Radiotelephone equipment is making a valuable contribution to the expansion of the trunk line service in Australia; in all, an additional 204 trunk lines have been added by this means. Major gains have been secured from five 23-channel pulse time modulated systems, and one 24-channel radiotelephone system which is obtained by operating two 12-channel carrier systems over a radio link. In addition, radio systems are in operation between the mainland and Tasmania and between Melbourne and Perth, a distance of some 1,700 miles.

Developments contemplated in the radiotelephone field are the establishment of a radiotelephone network in areas of New South Wales which have been subject to isolation through flooding in recent years, and the provision of a subscribers' radiotelephone network in Broken Hill, New South Wales. The Broken Hill system will serve a number of subscribers located in an area of between 50 and 200 miles from the base station and will operate more or less on a party-line basis.

Other features of the Australian trunk line system have been the introduction of automatic transit switching equipment for trunk line traffic at four capital cities and 24 major provincial switching centres, the establishment in three capital cities of subscriber dialling levels whereby metropolitan subscribers can dial directly certain nearby country exchanges, and the provision, to a limited extent, of multi-metering facilities from country automatic exchanges to the metropolitan areas.

Telegraph Service

From a pre-war annual lodgment of 17 million messages, telegraph traffic in Australia rose to its highest level in 1946, when just over 36 million

telegrams were originated. However, with the increase in leased private-wire services and the development of improved airmail and telephone trunk line facilities, it was inevitable that a certain amount of telegraph traffic would be diverted to these media. Notwithstanding this, however, telegraph traffic appears to have become stabilized at around 22.5 million messages annually.

Over 60 per cent. of the telegraph business in Australia is handled on machine systems using teletype and teleprinter equipment, and a voice-frequency telegraph network, comprising some 590,000 channel miles, links all capital cities and major centres. Some hand operated morse circuits are still in operation in several of the more sparsely populated districts, but the growth of the telephone network and the progressive conversion to machine working are gradually reducing the volume of telegraph traffic dealt with by morse.

An increasing proportion of telegraph business is being transacted in the phonogram sections and the Post Office is encouraging this service, not only as a means of originating traffic, but also for delivery purposes. The procedure in Australia provides for messages to be telephoned immediately to the addressee and a confirmatory copy made available if desired. The unit delivery cost per telegram handled by telephone is 7d. as against more than 1s. 2d. for messenger delivery. Nowadays, nearly 20 per cent. of telegraph traffic is delivered by telephone. The practicability of introducing the facsimile method of transmission between Chief Telegraph Offices and the premises of large users of the telegraph service is also being investigated. Recently, the first facsimile service in Australia was introduced for the Meteorological Bureau for the transmission of information and reports between weather stations in South Australia and Victoria.

As a means of reducing operating costs, plans are now in hand to introduce a teleprinter reperforator switching system in the Australian telegraph service. The system will enable automatic repetition of telegrams in transmission between offices of origin and destination, thereby reducing the time taken for telegrams to reach their destination and eliminating much of the intermediate labour costs.

Leased private-wire telegraph services have always been popular with Australian business and newspaper organizations and over 700 are now in operation. The facilities provided include both local point-to-point and long distance services.

To encourage the development of these services, a Teleprinter Exchange Service (Telex) was established some two years ago and has since been extended to include all mainland capital city offices.

The picturegram service in Australia is also controlled by the Post Office and 6,500 pictures are handled annually. Recently, however, some newspaper organizations have been authorized to use their own privately-owned transmitting equipment over departmental channels. A feature of the public service is the use of portable transmitting equipment at centres where a picturegram service is not permanently established. The equipment is of robust design and is retained at central depots for ready despatch by air to any desired location.

With one or two exceptions, the north western portion of Australia relies exclusively on the telegraph service for communication with the outside world. Roads and railways are virtually non-existent and practically the whole of the area, which includes no less than about one-sixth of the continent, is in the monsoon belt. During the "wet" season, it is subject to severe cyclonic disturbances which frequently disrupt the telegraph landlines. To provide communication during these periods, tele-radio sets have been provided at the various

Flood repair work in Maitland, N.S.W.

centres and these work with the control base station at Broome.

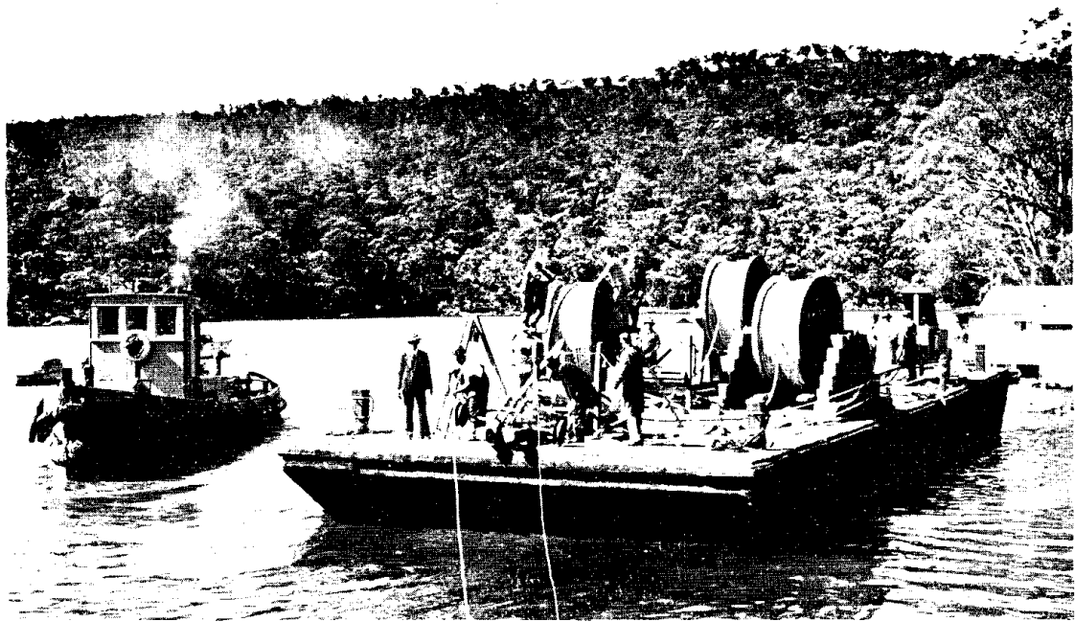
In other outback areas, networks of private radiotelephone stations have been established and are used for passing telegrams to and from points remote from the landline system. Chief among these is the system provided under the sponsorship of the Royal Flying Doctor Service which, in association with medical bases established in Cloncurry and Charleville in Queensland and Port Hedland, Derby and Wyndham in Western Australia and other centres, operates control stations serving some 800 outpost stations and over 400 portable installations.

International Service

Overseas connexions by radio and cable are controlled by a separate government authority, the Overseas Telecommunications Commission (Australia), the Post Office handling the terminal switching into the local networks.

The Commission provides the Australian terminals of the overseas telephone circuits and the Post Office extends these circuits from the Overseas Telecommunications Commission stations to the overseas telephone exchanges in Sydney and Perth. For the telegraph service, however, the Commission is the operating authority and provides both the transmitting and receiving equipment, as well as the terminal equipment, the Post Office being concerned only with the internal circulation of telegraph traffic in Australia, that is, the delivery of inward telegrams and the acceptance and transmission to the Commission's offices of outward messages.

A new radio transmitting station at Doonside, New South Wales, was opened in February this year by the Postmaster General of Australia, the Hon. C. W. Davidson, O.B.E. The Postmaster General in London, the Rt. Hon. Ernest Marples, M.P., sent a letter of good wishes which was transmitted by radio phototelegraph. This station will carry a large proportion of the telegraph and telephone traffic from Australia to Britain and the rest of the world. It covers 774 acres and has 36 directional aerials and 29 transmitters ranging in power from 2 kW to 30 kW.



Armoured cable being laid across a river

Teaming by Loudspeaker

E. G. S. Smith

Chief Telecommunications Superintendent, Chester

ALTHOUGH PROBABLY OF LIMITED APPLICATION, the following account of an attempt to assist in the maintenance of a good service in the last stages of the life of the C.B.S. multiple board at Bangor, North Wales, may be of interest.

To relieve overloading, pending conversion to automatic working, an island suite of operating positions was installed in a separate room. These switchboards, which represented the final possible extension of the exchange, were equipped with a full subscribers' multiple and with an ancillary appearance of calling signals of some U.A.X. and incoming trunk and junction circuits. Subscribers calling equipments were not provided because at the time there was ample equipment on the main suite and to introduce them into this island suite room would have involved complications.

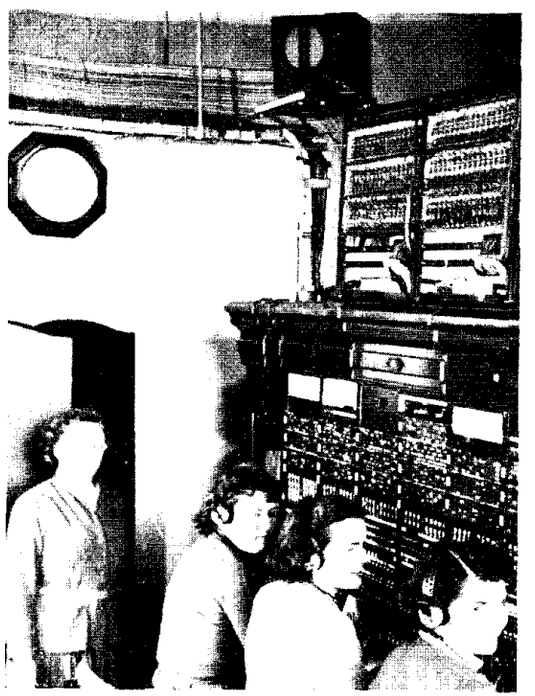
Although the new suite gave much needed relief, it soon became evident that difficult peaks of traffic still occurred on the main suite at times when the island suite was relatively calm. "Teaming" of subscribers' calls from the main suite to be answered in the multiple on the island suite would have helped to balance the load, but this was not possible by normal means.

The local traffic and exchange staffs solved the problem by getting their engineering colleagues to provide a microphone suspended through a counterweight from the ceiling in the main room wired to an amplifier and loudspeaker in the island room. The microphone was fitted with a locally constructed handle and suspended at such a point as to be readily accessible to the section supervisors.

The device has worked well and has given no trouble at all since it was installed.

Left **Microphone in main room**

Below **Loudspeaker over island suite**



Earthing the Positive

IT IS GENERALLY KNOWN THAT THE STANDARD POST Office practice is to earth the positive pole of batteries used for communication purposes, but the reasons for so doing are by no means so well known. The explanation is interesting and instructive.

With the negative pole earthed the remainder of the system is at a positive potential and if a leakage of current occurs a deposit of copper oxide (copper plus oxygen) is formed at the point of leakage. This being non-conducting, the insulation of the wire is not impaired and the fault is masked until the wire has been so heavily eroded away that communication is broken down. The action is like that of an electrolytic cell, the line being positive represents the anode or wasting pole.

On the other hand, if the positive pole is connected to earth, a deposit of metallic salt and hydrogen of a conducting nature is formed at any points of leakage. This deposit in effect cleans the wire but increases the leakage. The result of this action accentuates the original fault thus rendering its discovery practicable while the circuit is intact. It is probably for this reason that negative current is used for testing insulated wires as leakages would be brought to light by it which with positive current would in all likelihood escape notice. Motor car manufacturers have in recent years changed over to the use of positive earthed car batteries, the earth being represented by the chassis of the car. Three-rail electric railway systems in this country use the opposite method to Post Office practice; they make the supply rail positive (i.e. the negative pole is earthed). This is probably because it is more economical to renew the supply rail than the running rails or permanent way.

We are indebted to the L.T.R. Internal Maintenance Bulletin for the information on the above subject which appeared in its publication of April, 1957.

Britain-Iceland Cable.—A combined telegraph and telephone cable, which will carry telex, is to be laid between Scotland and Iceland via the Faeroes, jointly by the Post Office, the Danish and Iceland administrations and the Great Northern Telegraph Company. It will contain several telephone and telegraph circuits for the civil aviation services, especially for controlling the transatlantic routes. The cable should open for service in 1959.

Some Inland Telecommunications Statistics

In this quarter we are able to present a few of the main statistics for the whole year 1956-57, compared with those for the two previous years. Among the outstanding facts is the fall in the order list for telephones by over 97,000 during the year.

	31*st March*, 1955	31*st March* 1956	31*st March* 1957
The Telephone Service at the end of the Year			
Total telephones in service	6,491,100	6,887,400	7,225,900
Exclusive exchange connexions	3,089,600	3,176,700	3,286,100
Shared service connexions	917,500	1,088,500	1,187,700
Total exchange connexions	4,007,100	4,265,200	4,473,800
Call offices	66,200	68,200	70,400
Automatic exchanges	4,576	4,662	4,784
Manual exchanges	1,351	1,282	1,196
Orders on hand for exchange connexions	371,600	343,600	246,100
Work completed during the Year			
Net increase in telephones	355,000	396,300	338,500
New exchange connexions provided	410,000	427,000	408,000
Net increase in exchange connexions	237,500	258,100	208,600
Traffic	*Millions*	*Millions*	*Millions*
Inland telephone trunk calls	306	333	321
Cheap rate telephone trunk calls	77	87	78
Inland telegrams (excluding Press and Railway)	25	20	16
Greetings telegrams	5	4	3

How Thermionic Valves are Made

R. W. Lawson

THE TOTAL WORLD OUTPUT OF THERMIONIC valves runs into hundreds of millions a year and this country alone produces annually about 50 millions. These are of all types, ranging from large transmitting valves capable of handling kilowatts down to tiny hearing aid valves whose power dissipation is only 10 milliwatts.

Within this range of power dissipation there are many distinct types. For example, the klystrons and travelling wave tubes, used for generating and propagating very high frequencies, bear little resemblance to the better known radio receiving valves. Since receiving valves constitute the greater part of valve production, and because the manufacturing processes and techniques of all valve types have certain principles in common, this article will describe only receiving valves and, in particular, pentode valves of the kind typified by the CV 138. This valve is a high-slope indirectly heated pentode with a power dissipation of 2½ watts. The components of the CV 138 are shown in Fig. 1.

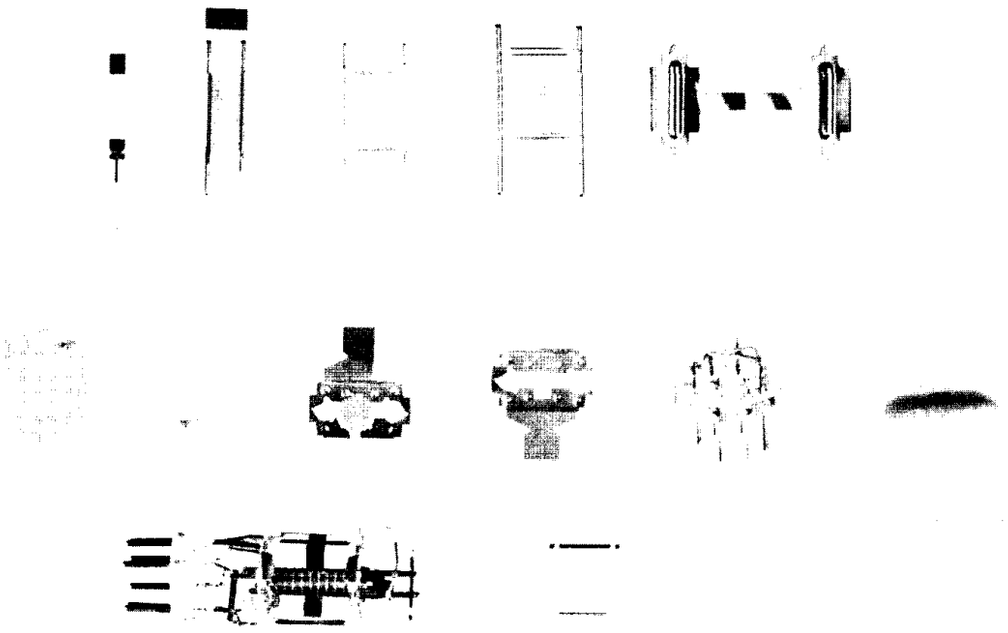


Fig. 1: CV 138 Components
Top row: heater; cathode; control, screen and suppressor grids; anode
2nd row: mica spacers; capacity shields; pressed base *3rd row:* complete mount; getter; bulb

The valve consists essentially of a cathode sleeve coated with an electron emissive material (raised to the operating temperature of 750 C. by the heater) surrounded by three grids and an anode which determine the electrical characteristics. These components are mounted between the two mica spacers to form a "cage". The capacity shields are used to reduce the capacitance between the various electrodes. The "cage" is attached to the pressed glass base which is then sealed to the bulb. These components have to operate in a good vacuum, which means evacuating the valve to a pressure lower than one millionth of an atmosphere.

Construction Materials

In general, the materials used should have a good strength when hot; the cathode, for instance, has to operate at 750 C. The vapour pressure and evaporation rate should be low at the operating temperature and the thermal conductivity should be good. Finally, the materials used should be capable of being formed into complex shapes and readily jointed by spot welding, which I will describe later. The most suitable metals are nickel and its alloys, tungsten, molybdenum, copper and its alloys and iron. Tungsten is used primarily for heaters, nickel for cathode sleeves, anodes, capacity shields and the support rods of the grids and molybdenum for the fine helix wires of the grids. Copper and its alloys are also used for grid support rods.

Economic reasons have led to the development of cheaper substitutes which are used whenever possible. Molybdenum for helix wires is often replaced by a 5 per cent. manganese nickel alloy; anodes and capacity shields may be replaced by a composite material such as iron sandwiched between a thin layer of nickel and a layer of aluminium. Ruby mica, a naturally occurring mineral, is used almost exclusively as spacer for locating and insulating the various electrodes from one another.

Glass is in common use for the pressed base and bulb. It has good mechanical strength and good transparency for heat radiation; furthermore, metal wires can be readily sealed into glass to give a vacuum tight seal, special types of glass having been developed for this purpose.

The heater consists of a helical coil of tungsten wire about 0.003" diameter, coated with a layer of sintered aluminium oxide to insulate the tungsten from the cathode sleeve. Of all the refractory oxides that of aluminium has been found to have the best retention of insulating properties at the temperatures involved—about 1,000 C. The tungsten is wound continuously on to a molybdenum mandrel of appropriate size and is then "set" at 1,200 C. in hydrogen to relieve winding strains. While still on the mandrel the tungsten helix is cut into the required lengths and bent into shape, usually a simple V.

The insulating coating can be applied by various methods, of which perhaps the most widely used is spraying. Here the aluminium oxide is made up as a suspension in suitable organic liquids and sprayed on the tungsten helix, using an ordinary type of paint spray gun. The insulating coating thickness is about 0.004". A firm adhering coating is produced by sintering the heater in hydrogen at about 1,700 C. The final stage is to dissolve out the molybdenum mandrel, the heater then being thoroughly washed and dried.

The complete *cathode* consists of a nickel sleeve coated with electron emissive material. The nickel used is of a special high purity with small controlled amounts of additives; magnesium within the limits of 0.05 to 0.1 per cent. is the most important. The sleeve is made either in the form of a solid drawn tube of appropriate cross section, rectangular or circular being the most common, or, if it is essentially rectangular in section, it can be folded out of sheet material. The wall thickness is about 0.002". A protruding ring or crimp is formed near one end of the sleeve as a means of locating the cathode sleeve within the mica spacers. A fine nickel tape is welded on this end of the sleeve to provide an electrical connexion. There is, however, a trend to produce cathode sleeves with integral tails.

In a working valve the emissive material is an equi-molecular mixture of barium and strontium oxides with about 5 per cent. of calcium oxide. The oxides are, however, unstable in air and the emissive coating is applied in the form of the corresponding carbonates. As with the insulating coating used on heaters, the carbonates are made up in the form of a suspension in suitable liquids and applied by spraying. The sleeves are mounted in jigs which mask the ends; Fig. 2 shows a typical spraying set up. Some cathode spraying is done semi-automatically, but by far the greater proportion is done by hand, and the skill and experience of the operator is relied on to produce a coating having the correct density and texture.

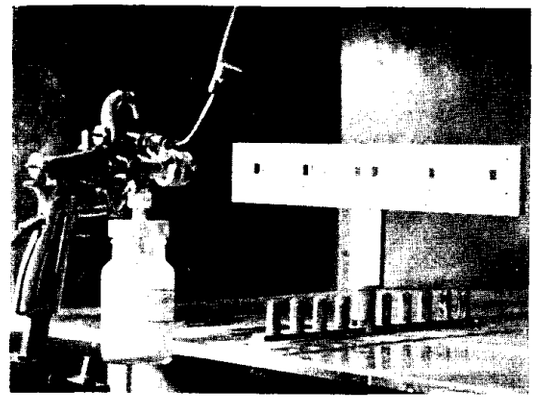


Fig. 2: Typical arrangements for cathode spraying

In the CV 138 valve the *grids*, three in number, consist of a fine helix wire, about 0.001" to 0.003" diameter, depending on the grid, wound on stout support rods about 1 mm. diameter, the helix wire being secured to the support rod by welding or mechanical means. The welding is done by momentarily passing a large current through the helix wire and the support rod; this causes local heating which fuses the metals together, thus producing a sound joint. This technique, known as spot welding, is also used in valve assembly to join other components together.

The mechanical method of securing the helix wire to the support rod is known as nicking and swaging, a special machine bearing some resemblance to an ordinary lathe being used. The two support rod wires, fed from spools, are on a mandrel of the appropriate cross-section (this can be seen between the two wheels in Fig. 3) and are drawn along the mandrel at a speed depending on the helix pitch required, and which may range from 10 turns per inch (T.P.I.) for a suppressor grid to 170 for a control grid.

There are two alternative ways of winding the helix wire. One method is to rotate the mandrel and support wires which, of course, involves rotating the support wire spools. The other method is to rotate the helix wire on its spool round the mandrel. The nick and swage technique can be used in both methods but only welding in the rotating method.

The nick and swage technique as used in the rotating support rod method is illustrated in Fig. 3. The upper wheel (the nicking wheel) makes a small cut in the support rod, the helix wire is laid in the cut and the lower wheel (the swaging wheel) closes the cut, thus firmly fixing the helix wire. The wheels are cam operated and after a grid has been wound are rendered inoperative for a period before the next grid is wound. The machine produces a "stick" of grids about 12 inches long, part of which can be seen in Fig. 3. The grid "sticks" are stretched to straighten out the support wires and are then chopped into individual grids. After heat treatment in hydrogen at 800 C. for a few minutes the grids are then given a lateral stretch to get the profile and dimensions correct.

Anodes are blanked and formed into shape out of sheet material about 0.005" thick. Automatic steel presses do this job and the many other pressings required, such as capacity shields.

The spacing and location of the various electrodes in the valve depend entirely on the accuracy with which the *mica spacers* are blanked out. Ruby mica is used, about 0.010" thick, the locating holes and the outside shape being blanked in one operation. The production of accurate mica spacers is one of the few operations not carried out in the valve factory itself, but the valve manufacturer usually coats the mica spacers with a thin layer of finely divided magnesium oxide on both sides, to prevent leakage between the various electrodes.

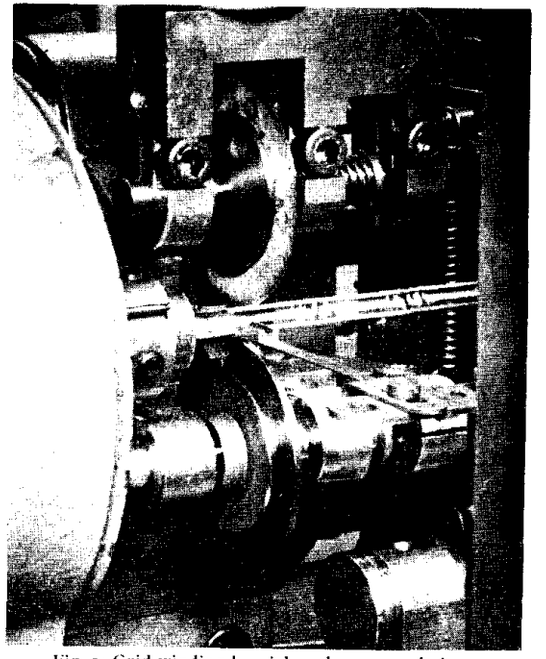


Fig. 3: Grid winding by nick and swage technique

The *glass parts* consist of the bulb and the pressed glass base. The bulbs are made on fully automatic machines capable of making a few hundred thousand a day. The pumping tubulation is fused on the bulb in a separate operation. The pressed glass base consists of a glass disc about ¼" thick; into this are sealed the chrome-iron pins to which the various electrodes of the valve are connected, these again being made on an automatic machine of a type to be described later.

Valve assembly

Before being assembled the components, manufactured separately as described, have to be thoroughly cleaned. All the metal parts are degreased and then fired in hydrogen at 800 C. for a few minutes (the cathode sleeves are cleaned before being sprayed).

This has the effect of removing the last traces of grease, films of oxides, and a proportion of the dissolved gases contained in the metals. The gases are to a certain extent replaced by hydrogen, but this is more easily removed during the subsequent processing of the valve on the pump and is much less deleterious as a component of the residual gas atmosphere in the evacuated valve. The mica spacers are vacuum stoved and the glass parts are water washed and then dried in an oven.

The cleaned components are then taken to the assembly benches where skilled operators assemble them into valves with the help of jigs. Some valve types are assembled completely by one operator, others are broken down into sub-assemblies which are then made into the complete valve later. Some valve assembly operations call for more skill than others and the sub-assembly method allows the use of some less skilled labour.

The first assembly operation is to fix the capacity shields on to the mica spacers. The lower mica spacer is then placed in the jig and the grids, cathode and anode are located in their respective holes. The top mica is then carefully placed in position and the "cage" is welded in the appropriate places to form a strong structure. In the CV 138 valve, tabs on the capacity shields are welded on the suppressor grid support rods at the top and bottom. Small crimps on the support rods of all the grids are used to locate the grids between the mica spacers. The cage is then mounted on the pressed glass base and the pins connected to the various electrodes. Fig. 4 shows the valve in the course of assembly.

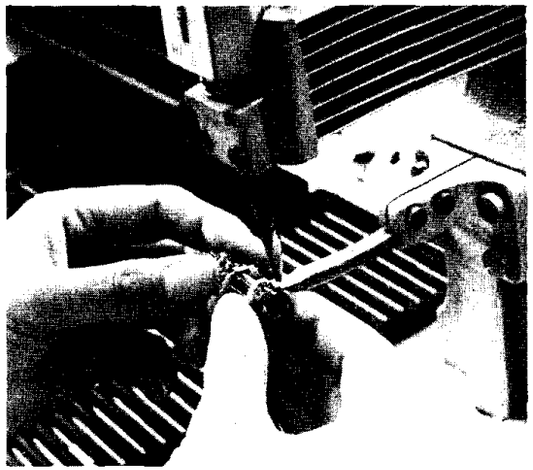


Fig. 4: Assembling valves

An essential component of the valve not so far mentioned is the "getter", which consists of a barium aluminium alloy in a thin-walled iron tube fixed on a nickel wire, and is made by specialist firms. It is mounted on a suitable point of the assembly so that when it is flashed the barium which evaporates preferentially to the aluminium does so on the walls of the bulb and not on the valve assembly where it would cause leakages.

The complete mount has now to be sealed into the bulb. This is done on an automatic indexing machine which is essentially a large turn-table with nine positions for carrying valves spaced equally round the edge of the turn-table. The first and last positions are used for loading and unloading the valves. At all the other positions the valve is brought opposite one of a series of carefully controlled gas-air and gas-oxygen flames.

In operation the turn-table rotates (or "indexes") round the nine positions, staying in each position six seconds. The heat of the flames is gradually increased as the valve progresses round the positions until finally they are hot enough to fuse the base and bulb together. The last positions are used to anneal the seal, the heat of the flames being gradually reduced. Too rapid cooling would set up strains, with subsequent risk of cracking. An inert gas such as nitrogen is injected into the valve during the sealing operation to reduce the risk of oxidation of the metal parts and also to help control the shape of the seal. A similar type of machine is used for the manufacture of the pressed glass base.

The valves are pumped immediately after the sealing-in operation, indeed, sometimes the valve is transferred automatically from the sealing-in machine to the pumping machine, which is usually a 24-head index type, the speed of indexing again being six seconds. The valve is pumped through the tubulation attached to the top of the bulb, the tubulation being inserted into a thick-walled rubber tube connected to a special vacuum-tight sliding joint and thence to the pumps. Each position on the machine is pumped continuously, the sliding joint preserving the vacuum in the valve while it is transferred from one position to the next. A typical automatic pumping machine is shown in Fig. 5.

The sequence of pumping is essentially as follows: the first six indexing positions are used to evacuate the valve to a pressure of about .01 mm. of mercury. In the next seven positions the valve is subjected to a radio frequency field which induces eddy currents in the anode and other electrodes, raising them to red heat. The radio frequency coils, seen in position in Fig. 5, are raised when the machine indexes.

This induction heating, as it is called, by raising the temperature of the valve components, including the glass, serves to remove occluded gases. This is important since the cathode is adversely affected by some gases and if too much is present in the sealed off valve the emission of the cathode is seriously impaired.

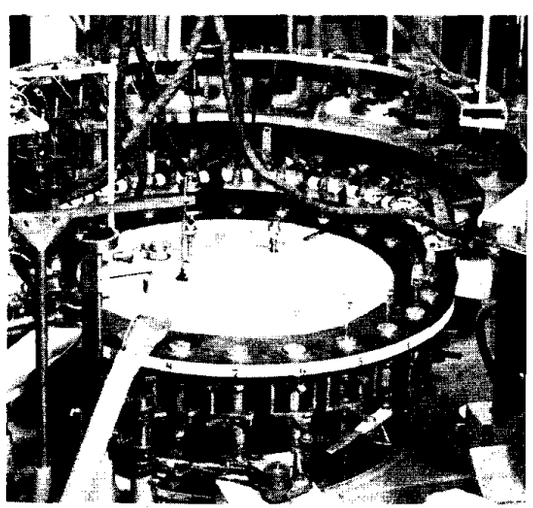


Fig. 5: Valve pumping on automatic indexing machine
Courtesy of Edison Swan Electric Co. Ltd.

Eight positions are then used for flashing th cathode at a voltage about twice the normal operating value to break down the barium strontium carbonates to the corresponding oxides. Carbon dioxide is given off and is pumped away. Induction heating continues during this process. (Free barium metal in the barium strontium oxide is essential for good emission, and the small amount of magnesium in the nickel core plays an important part in helping to produce this free barium by reacting at this stage according to the chemical equation, Barium oxide + Magnesium = Magnesium oxide + Barium.)

The last positions are used for flashing the "getter" described above. The barium evaporated on the wall of the bulb absorbs or "getters" (gets hold of) the gas still present in the valve, thus reducing the pressure in the valve to about one-one hundredth thousand mms. of mercury or better—which is lower than the automatic pumps are capable of producing. Production of thermionic valves on their present commercial scale would be impossible without the use of getters.

The final position is used for sealing off the valve by fusing the pumping tubulation. The pumping is done at the rate of 600 valves per hour, two or three operators at the most being required to attend the machine. Some 50 assembly operators, depending on the complexity of the valve type, are required to keep each pump going at the maximum rate, backed by large numbers of operators in the component preparation departments.

The final stage of the valve's manufacture is an ageing process to stabilise the cathode emission. This consists simply of running the cathode at about 1½ times its normal power, current being drawn to all the electrodes through limiting resistors—usually lamps. The ageing takes half an hour to an hour, and at the end the valve is given mechanical and electrical tests and those passing the specification are packed ready for delivery.

Although all valves on the market today are not made in precisely the same manner, this description will, perhaps, have given some insight into the complex series of very skilled operations required to produce what nowadays is regarded as a commonplace item. Manufacturers are continually introducing new techniques to improve the quality and performance of valves, such techniques being the combined results of the efforts of engineers, chemists, physicists and metallurgists.

When Wishaw Exchange was Evacuated

E. P. Brothers

COMPLETE EVACUATION OF A 1,300-LINE exchange is a most unusual occurrence in peace time and the problems which arose when it became necessary to evacuate the Wishaw exchange in Scotland West Area may be of interest. The exchange is in the Post Office building on the first floor, with the exchange switchroom and apparatus room immediately above the public counter. In the light of the discovery that cavities existed at varying depths below the site for the new automatic exchange some 100 yards down the road from the Post Office, and the knowledge that old shallow coal workings existed in the vicinity, the foundations of the present building were checked.

Cavities were found at varying depths, the worst point being approximately in the centre of the building with only a nine-foot crust on top of a cavity below which there was soft silt. The Ministry of Works reported that there was a risk of complete collapse and, in view of the danger to the staff, the Director ordered complete evacuation in four days' time—November 26, 1956. Evacuation would enable the foundations to be restored by cementation done both inside as well as outside the building.

For the first stage of the restoration it was fortunate that some 80 spare pairs existed between Wishaw and Motherwell (three miles away), and at Motherwell two spare positions were available. Service could thus be maintained for all emergency subscribers and public kiosks while the two dependent U.A.X.s—Carluke and Crossford—were re-parented on Motherwell and Lanark exchanges respectively. Arrangements were made to use the London Telecommunications Region mobile kiosk unit and this arrived in time to connect 10 kiosks to Motherwell by the time the Wishaw exchange was evacuated. A three-position C.B.S. No. 2 switchboard, equipped for 360 lines but with no multiple, was used for the second stage of restoration. This was installed in a caravan trailer similar to those used for mobile automatic exchanges. The nearby automatic exchange site made an ideal site for the caravan and overhead cables were run from the old exchange frame. The caravan arrived on November 24 and by the time the main exchange was evacuated some 240 business subscribers were connected; by the following morning the remaining 120 were working. At this point approximately one third of the exchange connexions serving the essential business services and the community had service. The load on the three positions was excessive, as was to be expected, but by employing the staff in teams for short spells, three operating and three others preparing tickets, a reasonable service was given in the abnormal circumstances.

Welfare facilities for the staff were provided in a holiday caravan trailer adjacent to the exchange caravan. This proved invaluable and provided the hard pressed staff with comfortable accommodation in which to relax during their spells of rest and thereby helping to maintain their high morale.

While arrangements were being made for the mobile exchange it became apparent that the main exchange could not be brought into service again for four to six months. Various means of restoring service to the remaining two thirds connexions were examined and it was finally decided to use a single storey 24-foot by 18-foot garage behind the Post Office for an eight-position exchange. The Ministry of Works arranged to renovate temporarily the inside of the garage by means of plaster over false walls and ceiling, while temporary lighting was provided up to the latest standards. The whole effect was a switchroom probably comparing favourably with many existing manual exchanges.

In the interests of speedy restoration C.B.S. No. 2 positions, fitted with a partial multiple, were used—thus avoiding the need for an Intermediate Distribution Frame (I.D.F.); and for the terminations in the old exchange a "Dexion" iron extension to the main frame was provided. A cable rack between the old exchange and the temporary switchroom was formed by ladders across the intervening space between the two buildings.

A maximum of 960 equipments could be accommodated on the eight positions, and to give service to all the 1,300 connexions shared service had to be arranged for approximately 170 exclusive resident-

al subscribers. Code ringing was adopted to avoid changing all the subscribers' installations or normal shared service working.

Installation of the temporary exchange started on November 28 and with the construction staff working day and night in 12-hour shifts some subscribers were connected to the switchboard during the evening of December 6. During that night all the lines were transferred from the mobile exchange, which was closed on the following morning. Connexion of those subscribers whose service had been disconnected since November 26 then proceeded, and service was restored to all subscribers by the morning of December 10, just two weeks after the main exchange was evacuated.

The whole operation involved preparing many lists of lines to be connected in different categories, letters to subscribers, and changed number lists to fit in with the varying stages of the restoration. Probably the most difficult list to prepare was that covering the subscribers to be connected to the mobile exchange, as only about half the business subscribers could be given service. The Sales Development cards were used to determine the category of each business line and after the connexions falling into the preference category had been extracted, all private branch exchanges serving works were given either one or two lines, depending on the total lines rented, followed by the businesses essential to the well-being of the community—for example, food shops, plumbers, slaters and garages, together with farmers' lines most of which were remote from kiosks. Very few enquiries were received from subscribers not given service.

In the beginning letters were sent to emergency subscribers advising them of the arrangements for service to be given from Motherwell exchange with letters to all other subscribers advising them of the need to suspend their service. Owing to the speed with which the engineers provided a mobile exchange the letters, with changed number lists, to

Three-position switchboard in the caravan
Courtesy of Owens & Sons, Wishaw

the 360 subscribers who were being given service were, in fact, despatched only a day after the advice of suspension of service.

To avoid overloading the mobile exchange by incoming calls to subscribers whose service was still withdrawn, all calls to Wishaw were intercepted at the directly connected manual exchanges, while in Glasgow it was necessary to intercept the operators' and subscribers' dialling out routes. This also had the advantage that up-to-date information of working lines had to be supplied to only seven exchanges.

A numbering scheme outside the range of the new automatic exchange was chosen for the temporary eight-position exchange to avoid difficulty if it were found practicable to introduce the covering automatic numbers when the old manual was brought into service again. The numbering range covering 960 equipments was 4,000 4,599 for exclusive lines and 5,000 to 5,359 for shared service lines. The sharing partners for the existing shared service lines were given numbers in the 6,000 series corresponding to the 5,000 series partner, while the lines being compulsorily shared were given 7,000 numbers corresponding to the 5,000 series partners. All compulsorily shared lines were marked in red on the 5,000 series calling equipments and partial multiple to draw the operators' attention to the use of code ringing.

The layout of the face equipment followed the usual pattern for a C.B.S. No 2 board with partial multiple but was arranged to minimize position loading problems due to there being no I.D.F. The incoming junctions were terminated on the more lightly loaded positions and in practice the whole layout and numbering scheme worked very satisfactorily.

The initial connexion of lines to the temporary exchange was made in the following order: first the emergency lines and kiosks working from Motherwell; then the lines from the mobile exchange: 17 busy P.B.X. subscribers from the mobile exchange were then transferred to Motherwell exchange and then lines restored to the full quota giving a total of 54 lines.

In carrying out the transfer all lines had to be connected individually as normal methods of transferring were not possible but the whole operation, which was started on the evening of December 6, was completed by the following morning.

The remainder of the lines which had been disconnected since the evacuation were then connected in the order—exclusive business, shared service business, exclusive residential, compulsorily shared service and, finally, the shared service residential lines.

Apart from the working lists which were supplied to the engineers in order of connexion, subscribers had to be advised of the changes and supplied with interim changed number lists. To save time a compromise had to be adopted and suitable letters covering the circumstances were despatched to reach all categories of subscribers down to the shared service businesses on the morning of December 7, with a changed number list covering what was slightly over half the exchange connexions. The remainder of the categories received suitable letters with a complete changed number list on the morning of December 10, while copies of the complete changed number list were despatched to those subscribers who had previously received the interim list.

The full changed number list was printed by the Post Office Supplies Department in Edinburgh, but all letters and engineering working lists and interim changed number lists were duplicated locally.

With speed the essential need in this unusual operation some minor difficulties were naturally encountered and overcome and if there had been more time some stages might have been different. The degree of success can best be judged by the fact that very few critical letters were received and in general the public reaction was sympathetic rather than critical. The temporary exchange continues to function very satisfactorily and by using the two positions in Motherwell for the busy P.B.X.s a good proportion of the junction traffic has been offloaded from the temporary Wishaw exchange.

Apart from the general feeling of satisfaction at successfully dealing with an unusual situation, there is the added pleasure of proving once again that the Post Office Telephone Service always rises to the occasion. This cannot be better expressed than by the following extract from a letter from the Telephone Manager to the Director: "At the higher levels of the staff we almost ceased to consider ourselves as traffic, engineers, what have you, but each tried his best to see what was going to produce the best result in the long run for the man who had to do the job on the spot".

What is Modulation?

H. Williams, A.C.G.I., M.I.E.E.

BEFORE DEFINING FREQUENCY MODULATION and showing its advantages it will be as well to remind ourselves of certain more fundamental matters. Technical readers will note that throughout this article some over simplification has been indulged in in the interests of making the principles clear to non-technical readers.

When we strike a middle C tuning fork we hear a tone caused by the fork vibrating the air 256 times a second and this vibration affects our ears so that we hear the middle C note. When we speak the voice vibrates the air similarly though with varying frequencies so that a listener hears what we say, the energy from talker to listener being conveyed through the air.

To send speech over a pair of telephone wires, the telephone transmitter converts the vibrations in the air into variations of an electric current which starts to flow in one direction in the wires when we lift the receiver. The vibrations caused by the varying tones of our speech are said to modulate the current. In a diagram the modulations would be shown by "wiggles" in an otherwise straight line.

Now, if a record of speech sound pressures is taken by means of suitable apparatus, it will be seen that a very irregular series of vibrations go to make up speech and it will also be seen that two pieces of information are carried in that speech. One is pitch (tone)—that is, whether a low or high sound—and the other is the loudness or amplitude of the speech. For faithful reproduction both of these must arrive correctly at the listener's ear.

We have already mentioned conveying speech over wires by modulating a unidirectional electric current. Actually many other ways of sending this information are possible.

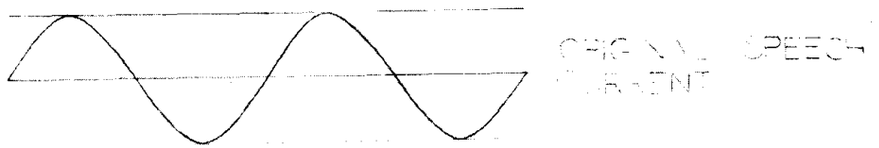
In the Post Office trunk system for instance, alternating current, that is current which changes its direction at a suitable frequency, is used and the speech information is conveyed along the wires by varying the amplitude, or size, of this current to correspond to the speech variations (see *a*) and (*b*) overleaf). It will be observed that as the speech gets louder the size of the alternating current increases and when the speech gets fainter so the size of the alternating current decreases. This process of varying the size of the alternating current (known as the "carrier") in sympathy with the size of the speech variations is known as "Amplitude Modulation". The process of converting these variations in the size of the carrier back to the original speech current variations is known as "Demodulation".

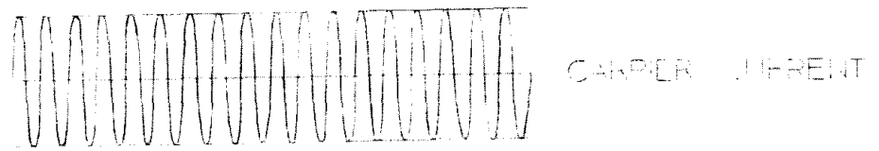
In the diagram (*a*) only one speech note is shown but the principle is the same no matter how complicated the make up of the speech or music. As a matter of interest and to illustrate the importance of the principles involved—a modern cable of tubular construction, 2-inch in diameter, can carry 960 simultaneous conversations, the "carriers" being at different frequencies spaced 4,000 cycles seconds apart.

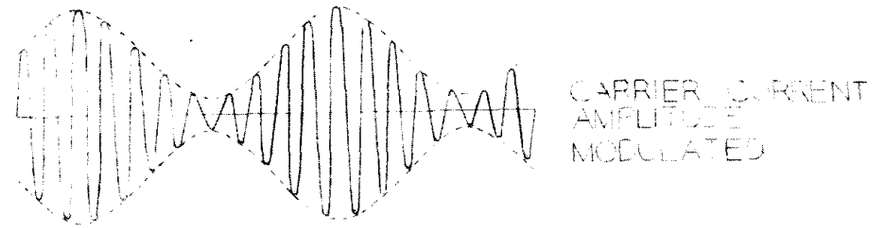
A very similar process is used in broadcasting, the "demodulating" process being performed in your radio set, which then gives a reproduction of the originating sound in your loudspeaker, but it is now necessary that we should introduce a complication. "Noise" (that is, unwanted sound) can be added to the signal between the transmitting aerial and your set. This noise may be from, say, a foreign station on the same wavelength and will add to or subtract from the required programme (that is, the wanted sound) and will of course be heard from the loudspeaker.

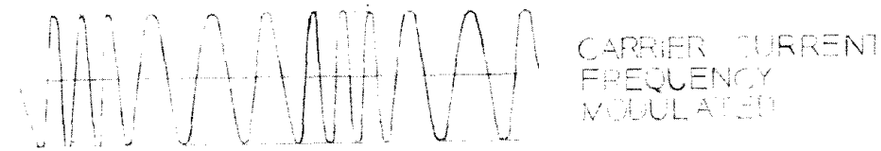
It is, however, possible to transmit speech (or music) information from one place to another using a different scheme from amplitude modulation.

It was pointed out earlier that two pieces of information are needed at the receiver; amplitude (loudness) and pitch (tone). Suppose that it is possible to represent amplitude by varying the frequency of the carrier current, which would then appear as shown in (*c*), if the speech looked like (*a*), the carrier current being squeezed up on a loud signal and opened out on a soft one. Thus the amplitude or loudness information is conveyed by changing the carrier frequency by squeezing and unsqueezing, and the pitch or tone information is conveyed by the number of times in a second that this is done. This method of sending information is known as "Frequency Modulation". We note that the carrier current is now of constant size or,









in other words, we do not vary the amplitude of the carrier. If noise is now added to this signal, for instance from a foreign station, this would be equivalent to making the amplitude vary—but as we do not use the size of the signal the radio set responds only to the local station and turns the "wave" of (*c*) back to (*a*). The result is a noise-free background.

The main advantage of Frequency Modulation, therefore, is that for a given transmitter power a much more noise-free reproduction is obtained. Alternatively we could reduce the power of the transmitter and tolerate the same amount of noise. It is usually the former which is aimed at.

A subsidiary advantage of Frequency Modulation for broadcasting is that the stations are operating at much higher frequencies than medium or long wave broadcasting (about 100 times as high). We are thus able to afford a much greater frequency range to transmit the speech and music, with a marked improvement in quality.

Our Contributors

E. P. BROTHERS ("When Wishaw Exchange was Evacuated") entered the Post Office as Assistant Traffic Superintendent at Brighton in 1935 and was later employed in the Tunbridge Wells and Norwich Areas. After war service as an R.A.F. Signals Officer he moved to the Lincoln Area for a short spell. He was promoted in 1948 to Senior Telecommunications Superintendent, Glasgow, and in 1952 moved to Scotland West Area where he is employed on Equipment and Lines work.

P. F. CONNELL ("Telecommunications in Australia") is Administrative Assistant to the Assistant Director-General (Telecommunications) at Australian Post Office Headquarters. He has been a Traffic Officer in the Telephone Service Branch, has served in the Victorian State Administration of the Engineering Division and the Commercial Branch of the Telecommunications Division.

H. V. J. HARRIS, M.B.E., A.M.I.E.E. ("Britain's only Municipal Telephone Service") has been Telephone Manager for Hull Corporation since March, 1945. He began his career in the Post Office Engineering Department at Bournemouth Exchange in 1925 and in 1927 he went to the District Manager's Office at Southampton as an Assistant Traffic Superintendent. In 1937 he was promoted to Traffic Superintendent Class II at Newcastle-upon-Tyne where he remained until the outbreak of war when he was seconded to the Home Office for duty as a Communications Adviser. He returned to the Post Office in 1944 as Traffic Superintendent Class I at Liverpool, and seven months later took up his present appointment at Hull.

S. T. E. KENT, A.M.I.E.E. (joint author "Identifying Wires in Cables and at Distribution Points") is an Executive Engineer in the Organization and Efficiency Group of the L.T.R. He entered the Post Office in 1928 as a Youth-in-Training in the North West Section of the L.E.D. and was subsequently employed on external construction work and the maintenance of manual and automatic telephone exchanges. In 1935 he was promoted Probationary Inspector in the South West Section of the L.E.D. and was employed on external construction and maintenance works. He was commissioned in the Royal Signals in 1943 and served in Italy until 1946. Returning to the Post Office as an Assistant Engineer, he was employed on external planning duties in South West Area, L.T.R., until promoted Executive Engineer in 1948. From 1948 to the present he has been engaged on engineering organization problems and methods study at Regional Headquarters.

R. W. LAWSON ("How Thermionic Valves are Made") is a Senior Scientific Officer in the Thermionics Group at the Research Station, Dollis Hill, working on problems connected with long life valves for submerged repeater systems. He is an Honour Graduate in Physics of Manchester University and entered the Post Office as a Temporary Physicist in 1946 after two years with the Telecommunications Research Establishment, Malvern. He was appointed Executive Engineer in 1947 and transferred to the Scientific grade in 1948.

H. C. NOTT (joint author "Identifying Wires in Cables and at Distribution Points") is an Assistant Engineer in the Organization and Efficiency Group of the L.T.R. He joined the Post Office as a Youth-in-Training at St. Albans in 1939 and was employed on automatic exchange construction and maintenance until entering the Army in 1941. He served in the Royal Signals in Europe and the Middle East until 1947. Returning to the Post Office he was engaged on exchange and subscribers' apparatus maintenance duties in North Area, L.T.R. until promoted Assistant Engineer in 1955, since when he has been employed on the study of engineering working methods and design of equipment to increase productivity.

SIR GORDON RADLEY, K.C.B., C.B.E., Ph.D. (Eng.) ("Communications and the Future") has been Director General of the Post Office since November, 1955. During his 37 years' career he has risen through the Engineering Department and was Controller of Research, 1944–49, and Engineer-in-Chief, 1951–54. He has taken a leading part in developing repeatered submarine cables and had prime responsibility on the British side for the Anglo-American transatlantic telephone cable opened in September last year.

H. WILLIAMS ("What is Modulation?") contributed an article on "Echo Suppressors" to the Summer, 1956, issue of the *Journal* and his career was outlined in that issue.

J. E. YOUNG, O.B.E., E.R.D. ("Post Office Operates Hull Toll and Trunk") entered the Post Office as a Youth-in-Training at Bradford in 1925. He became an Assistant Traffic Superintendent at York in 1930 and went to Lincoln in 1935 on formation of the Area. He was mobilized with the Royal Signals in 1939 and served in France, North Africa, Sicily and Italy. Returning to the Post Office he became Exchange Superintendent at Hull and in June of this year transferred to the Home Office as a Senior Communications Officer.

A.A. Private Telegraph Network.—Until recently the Automobile Association have relied almost entirely on the public telephone service for means of communication between their centres and offices. The installation of a private telegraph network, with centres at London (serving eight outstations) and Nottingham (six outstations), was completed during May in time to form a highlight at the opening ceremony of new A.A. premises at Nottingham. The system is worked on the torntape principle: page teleprinters at the outstations, printing reperforators and auto-transmitters at the centres. Broadcast and other facilities are being provided.

It soon became clear to the Automobile Association that the network would play an important part in their organization, and proposals are being formulated for a considerable extension to link other offices in the country.

In addition to messages concerned with the everyday interests and services of A.A., the new network will handle many messages on behalf of tourists in the summer, and the distribution of information about road and weather conditions during the winter months.

Mr. A. Kemp

Notes and News

Brigadier Sir Lionel H. Harris

To Head New Branch.—Mr. A. Kemp, Assistant Secretary, who for the past eight years has been a member of the *Journal* Editorial Board, is relinquishing the Planning Branch in the Post Office Inland Telecommunications Department to become head of the new Telephone Mechanization Branch referred to in our leader.

The Branch will deal particularly with group charging, trunk mechanization and subscriber trunk dialling. It will also handle local automatic exchange design, previously under the Planning Branch; routing and circuit provision standards, exchange charging information and subscribers' and callers' instructions, which the Operations Branch has hitherto dealt with; and subscribers' accounts, until now handled by the Subscribers' Services Branch.

Mr. A. Kemp's place in the Planning Branch will be taken by Mr. K. H. Cadbury, M.C., who, as Principal, has been the Postmaster General's Principal Private Secretary for just under a year.

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Mr. Thompson Honoured.—The British Ambassador in Washington, Sir Harold Caccia, presented Mr. W. G. Thompson of the American Telephone and Telegraph Company with the insignia of the Honorary C.B.E. at the Embassy on June 19. Mr. Thompson was awarded the honour in recognition of his services to international communications, especially in connexion with the transatlantic telephone cable.

An Assistant Vice-President of the A.T. & T. Long Lines Department, William Glasgow Thompson has also directed the Bell Telephone oversea services for about 30 years. He has pioneered communication networks for broadcast programmes and the TWX services, and has represented the United States at several international telecommunication conferences.

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Post Office Honours.—In the Birthday Honours, Brigadier L. H. Harris, C.B.E., Engineer-in-Chief, was made a Knight Commander of the Most Excellent Order of the British Empire (K.B.E.) and he is now known as Brigadier Sir Lionel H. Harris; and Mr. W. H. Scarborough, Telephone Manager, Canterbury, an Officer of the Most Excellent Order of the British Empire (O.B.E.).

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Radio Station Links Television Transmitters.—The Post Office micro-wave station at Mynydd Pencarreg, near Lampeter, Wales, is relaying television signals between the B.B.C.'s television transmitters at Wenvoe, Cardiff, and Blaen Plwy, Aberystwyth. A cliff face on the 2,900-foot Brecon Beacons, about 6½ miles laterally from the direct path from Wenvoe, caused a "ghost" during tests, but this was eliminated by installing an aerial so arranged that it would not pick up reflections from the cliff.

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Cable Ships have X-ray Equipment.—Post Office cable ships have been provided with X-ray equipment for routine testing of moulded joints in polythene-insulated coaxial submarine cables. Radiographic examination of a joint detects voids and inclusions of dirt or metal in the polythene, and enables checking of the concentricity of the central conductor. The equipment was designed in the Research Branch at Dollis Hill.

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Telephone and Telegraph Society.—Appropriately, Mr. Kemp (see facing page) will talk on "Subscriber Trunk Dialling in the United Kingdom" to the Post Office Telephone and Telegraph Society on November 4.

This will be the second address in the Society's Autumn and Winter programme, which opens on October 9, with a talk by Mr. L. L. Ellis, Supplies Department, on "The Post Office as a Multiple Tailor: Uniform and Protective Clothing". On December 4, Mr. J. M. Newton, who recently became Director of Postal Services after a spell as Director of Personnel, will speak on "Some Aspects of Selection and Promotion". Mr. F. J. M. Laver, Engineering Department, will discuss electronic computers on January 13 and Mr. H. M. Turner, Telecommunications Controller, London Telecommunications Region, will talk about the Telephone Manager's organization on February 5. The programme concludes on March 10, with a paper called "Your Money Back: The Story of Recovered Stores", by Mr. H. A. Jenkinson of the Supplies Department. All except Mr. Ellis's and Mr. Wolstencroft's meetings—which will be at Waterloo Bridge House, L.T.R. Headquarters—will be at the Institution of Electrical Engineers.

The Society hopes to hold its Annual General Meeting on March 10, also at the I.E.E.

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New Safety Devices for Height Measuring of Power Wires.—When a new telephone line, which crosses the route of an existing power line, is being erected, the height of the existing wire has to be checked to ensure proper clearance. The misuse of a measuring tape, which touched a power line and caused a death, led the Post Office Engineering Department to test new instruments for measuring the above-ground height of power wires. These instruments are optical height-measuring devices by which an engineer, standing beneath a power wire, can ascertain its precise height above the ground.

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Telex Call Offices for the use of the public have been opened experimentally in the Cable and Wireless offices at Electra House, Victoria Embankment, and 18, Old Broad Street, London, and in the Head Post Office, Manchester. Calls may be made to telex subscribers in Britain and abroad. The caller operates the teleprinter; instructions on how to make a call are provided at each Call Office. The charge is 1s., in addition to the normal telex call charge, which is paid as soon as the call has been made. Incoming calls are not allowed.

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Teleprinter Automatic Switching System for I.C.I.—Teleprinters have been used by Imperial Chemical Industries for the past 28 years. The first installation was provided in 1929, when a private circuit was installed between Birmingham and London for the transmission of metal prices.

I.C.I.'s needs for communication by teleprinter outpaced the facilities which could be provided by a system based on point-to-point circuits and, in 1947, the network was converted to a manually switched system with teleprinter switchboards at five main centres in the country.

On June 17 this year, teleprinter automatic switching equipment (TAS) replaced the manual switchboards. The network is now based on four centres: London, Manchester, Birmingham and Glasgow, which serve 58 I.C.I. offices. Many offices require more than one teleprinter installation of course, and altogether 144 teleprinter stations have been provided. More are likely to be required in the near future. Thirty-four trunk lines between the switching centres have been provided.

The equipment and facilities are very similar to those provided on the Shell Mex-B.P. TAS installation described in our Spring issue.

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Essay Competition Results.—J. R. Haggart, Technical Officer, Edinburgh, has won the 5-guinea prize and an Institution Certificate in the Essay Competition, 1956-57, held by the Institution of Post Office Electrical Engineers.

The following (with the titles of their essays) have won prizes of 3 guineas each, and Institution Certificates:—

E. G. Clayton, Technical Officer, Norwich (Home Counties Region), *Hearing Speech Sounds.*

A. L. Watson, Technical Officer, Lincoln (Midland Region), *The Planning of Buildings for Unit Automatic Exchanges.*

R. J. Lukehurst, Technical Officer, Canterbury (Home Counties Region), *Some Aspects of Line Plant Planning and its Allied Works.*

J. S. Kendall, Technical Officer, Birmingham (Midland Region), *The Development of the Direct-Coupled Amplifier for High Quality Sound Reproduction.*

Institution Certificates of Merit have been awarded to:—

E. R. Lamb, Technical Officer, Engineer-in-Chief's Office, *Subscriber's Duplicate Metering System.*

W. Hoy, Technician IIA, Long Distance Area (London Telecommunications Region), *Frequency Instability in Feedback Oscillators—Causes and Remedies.*

D. R. Johnson, Technical Officer, Southampton (South Western Region), *On Camels and Tents.*

J. L. Care, Technical Officer, Eltham (London Telecommunications Region), *The ENG Officer.*

C. F. Carr, Technical Officer, Newcastle-upon-Tyne (North Eastern Region), *Cathodic Protection as Applied to Post Office Cables.*

The essays were judged by W. S. Procter, S. Welch and E. W. Anderson.

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Reporting the Draw.—For the first Premium Savings Bonds Draw at Lytham St. Anne's on June 1 (and the previous day), Preston Telephone Area had to provide for about 50 Press reporters, 35 photographers, and 25 cinema and broadcasting operators.

Thirty-six spare pairs were extended from St. Anne's Exchange to the Bonds Office, and 10 of the P.B.X. lines were intercepted. Twenty-two telephones, each with an acoustic screen, were connected as trunk subscriber circuits to Blackpool auto-manual exchange, and four picture transmission positions, each with a power supply and a 4-wire local end, were provided. Two exclusive telephone lines were provided for Press agencies.

Two telex demonstration installations, each with an auto-transmitter, were connected to Manchester telex switchboard. One perforator was also provided. In addition a teleprinter, No. 7 B.R.P., and an auto-transmitter were installed in a separate room. This equipment was used to prepare a punched tape of the £1,000 and £500 prize winning Bond numbers; the tape was then given to reporters for automatic transmission on the telex equipment.

Circuits were opened for a live B.B.C. television transmission on the day before the draw, and for TV and sound on the day of the draw. Circuits were also made available for A.B.C. transmissions during the draw.

Over the two days 341 telephone calls, nine picture transmissions, and nine telex messages (altogether some 2,200 words) were handled, and 13 Press agencies and offices used the prepared punched tapes for transmitting lists of winners.

Editorial Board. F. I. Ray, C.B.E. (Chairman), Director of Inland Telecommunications; C. O. Horn, O.B.E., Deputy Regional Director, London Telecommunications Region; H. R. Jones, Telecommunications Controller, Wales and Border Counties; A. Kemp, Assistant Secretary, Inland Telecommunications Department; Col. D. McMillan, O.B.E., Director, External Telecommunications Executive; H. Williams, Staff Engineer, Engineering Department; Public Relations Department—John L. Young (Editor); Miss K. M. Davis.

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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."

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