# Post Office Telecommunications Journal

*Published by the Post Office of the United Kingdom to promote and extend knowledge of the operation and management of telecommunications*

## Contents



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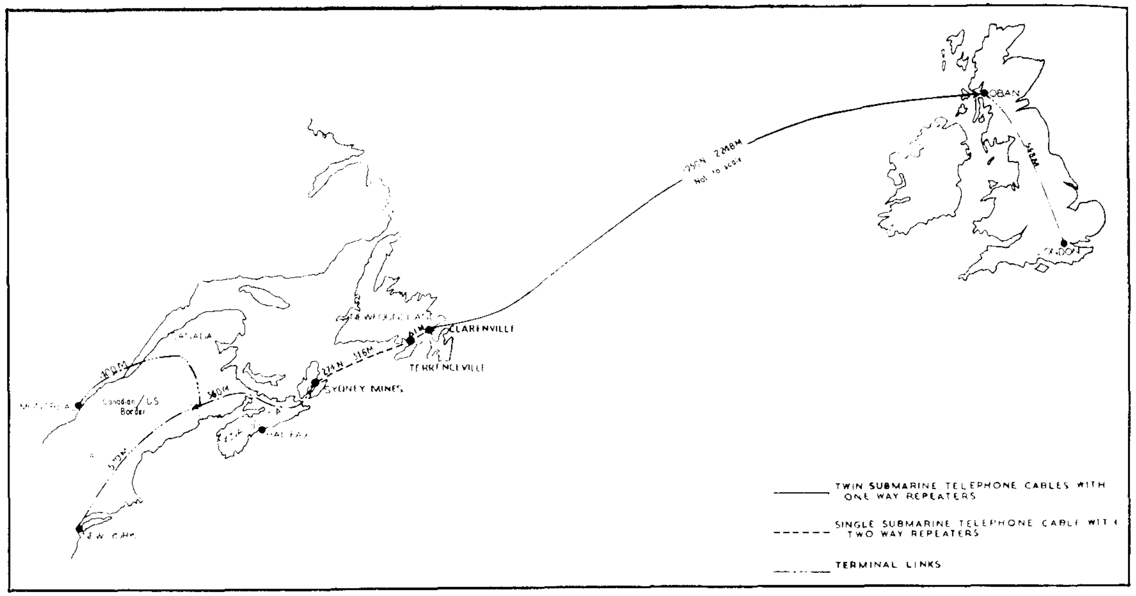
## Increasing the Pace

THE MODEST REDUCTION IN THE ORDER LIST IN 1954-55 masks the fact that the Post Office achieved a very substantial increase in the rate of supplying new telephones and building up the system. The number of new connexions in the year was 410,000 against 379,000 the year before; the net increase in the number of connexions working was some 237,000 or about one-third greater than the previous year's increase, while 175,000 pairs of wires were added to the local cable system, and this again was almost a third more than the previous year.

Demand in the years 1950-52 remained pretty steady and had it resumed the same trend after recovering from the depressed level of 1952-53, the problem of the Order List would now be well on the way to solution, but since the Autumn of 1952 demand has been rising rapidly. In the March quarter, 1953, it was 98,000 and in the March quarter this year it had risen to nearly 138,000.

Welcome as this increasing demand may be as a reflection of the country's continuing prosperity, it faces the Post Office with a very difficult problem. As we have already reported, the plans for this year contemplate a capital investment in telephone development of some £81 million compared with about £70 million last year. In preparation for the expanded programme we increased the engineering workmen force by over 3,500 men during last year and are expecting to take on perhaps another 2,000 in the present year. We have also provided to take in during this year stores to the value of about £33 million compared with £24 million last year.

Our problem is not just one of connecting new subscribers this year; it is more a problem of so deploying all our resources as to build up our system to supply even more telephones in future years.




## The Transatlantic Telephone Cable

*THE first transatlantic telephone cable is being constructed as a joint undertaking of the Postmaster General, the American Telephone and Telegraph Company, the Canadian Overseas Telecommunication Corporation and the Eastern Telephone and Telegraph Company of Canada, as reported in the* Journal *for February,* 1954. *The cable system embodies the results of some* 30 *years research and experience by the Post Office and the A.T. & T. Company in submarine cable design and in the development of repeaters (valve amplifiers) capable of being laid with a submarine cable and of remaining on the ocean bed, at depths up to three miles, for periods up to* 20 *years without attention.*

*The system will extend from the Scottish coast near Oban to the United States-Canada border near St. John, New Brunswick. The main Atlantic crossing—about* 2,000 *nautical miles in length from Oban to Clarenville, Newfoundland—will consist of two cables (one for each direction of transmission); this part of the system is of American design embodying the American one-way flexible repeater at intervals of about* 37 *nautical miles in each cable. The part of the system from Clarenville to the Canadian mainland at Sydney Mines is of British design; the British two-way repeaters which will be inserted every* 20 *nautical miles, permit a single cable to be used for both directions of transmission.*

*From Sydney Mines the system goes "on the air" and is carried through the Maritime Provinces of Canada to the United States border by line-of-sight micro-wave radio link.*

*Each of the partners concerned with the operation of circuits in the cable is providing, in his own territory, the necessary connexion from the ends of the cable system to the operating terminals in London, New York, and Montreal. In all,* 35 *high quality telephone circuits are being provided—*29 *to New York and* 6 *to Montreal; they will be free from the difficulties of operation associated with the existing* 16 *radio circuits and will provide for growth in transatlantic traffic for which radio space is not available. In addition the cable system will provide additional telegraph circuits to Canada; these will strengthen the Commonwealth telegraph system between the United Kingdom and Canada and, via the existing Pacific telegraph cables, other parts of the Commonwealth.*

*The Atlantic has ever been a proving-ground for long-distance overseas communication; the first transatlantic telegraph cable (opened in* 1866*) and Marconi's transatlantic radio experiments established patterns for the development of world-wide telecommunications as we know them today. This latest major conquest of the Atlantic, providing transocean telephony by cable for the first time, will undoubtedly in its turn set the new pattern: and from now on the telecommunication system of the world can be expected to share in an increasing degree the benefits of submarine cable telephony.*

# Transatlantic Progress Report

*C. J. Gill*

*External Telecommunications Executive*

A FEW DAYS AFTER THIS ARTICLE IS PUBLISHED, H.M.T.S. *Monarch* will be making history: she will be laying the first repeatered telephone cable ever to cross an ocean. Steaming steadily from Newfoundland towards Scotland she will leave behind on the ocean bed—at depths reaching two and a half nautical miles—an ever-increasing trail of submarine cable and repeaters: the first of the two cables in the ocean link of the Transatlantic Telephone Cable. This operation—hazardous and exciting as it is—is but one of the series of complex and costly operations which by the end of 1956 will link the Old and New Worlds by cable telephone for the first time. All along the 4,500 miles of route, construction of the cable system and of its terminal links is now proceeding apace: in London, in Scotland, across the Atlantic, through the bogs and lakes of Newfoundland, across the Cabot Strait, through the Maritime provinces and on to Montreal in Canada and through Maine to New York, equipment is being installed, cable is being laid and buildings and radio masts are going up on a tightly drawn schedule which gives little margin for delays.

**Part of a new factory at Erith, Kent, with two production lines built to produce more than 4,000 nautical miles of coaxial submarine cable at up to 80 n.m. a week. The cable will cost about £5,000,000 and will contain 2,700 tons of copper, 1,400 tons of polythene, 11,000 tons of steel wire, 1,800 tons of jute and 2,400,000 yards of cotton cloth**

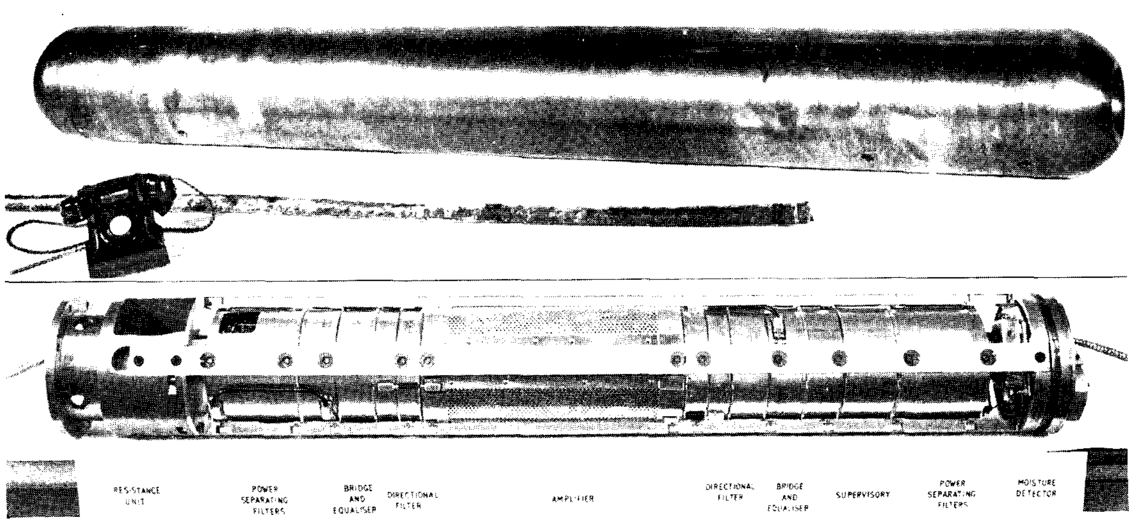
The announcement by the Postmaster General in the House of Lords on December 1, 1953, that an Agreement for the provision of the first Transatlantic Telephone Cable had just been signed marked the end of months of intensive negotiations, during which the conditions of partnership and the arrangements for financing and managing the cable had been hammered out in detail and the broad technical plan for the construction of the system had been established. But the signing of the Agreement, which calls on the partners to "use their best endeavours to complete the cable system and place it in operation on or before the 1st of December, 1956", inaugurated a period of even more intense activity, particularly for the engineers on both sides of the Atlantic concerned with the detailed design of the system. Specifications and detailed plans, covering all components and methods to be used, had to be drawn up at high speed so that the great programme of manufacture could be set in motion; time-tables for the complete series of interlocking operations had to be prepared—and redrawn as manufacturing difficulties and delays showed themselves.

Members of the Post Office Engineering Department, of the Long Lines Department of the A. T. & T. Company, of the Bell Telephone Laboratories and of the Canadian Overseas Telecommunications Corporation have worked as one team in this novel international co-operative, meeting regularly on alternate sides of the Atlantic. At the same time there has been constant discussion between the partners of the many management problems associated with the enterprise; among other things methods of accounting have been established, contracts have been drawn up, agreed and placed, costs continuously scrutinized and methods of use and operation of the cable facilities explored and settled.

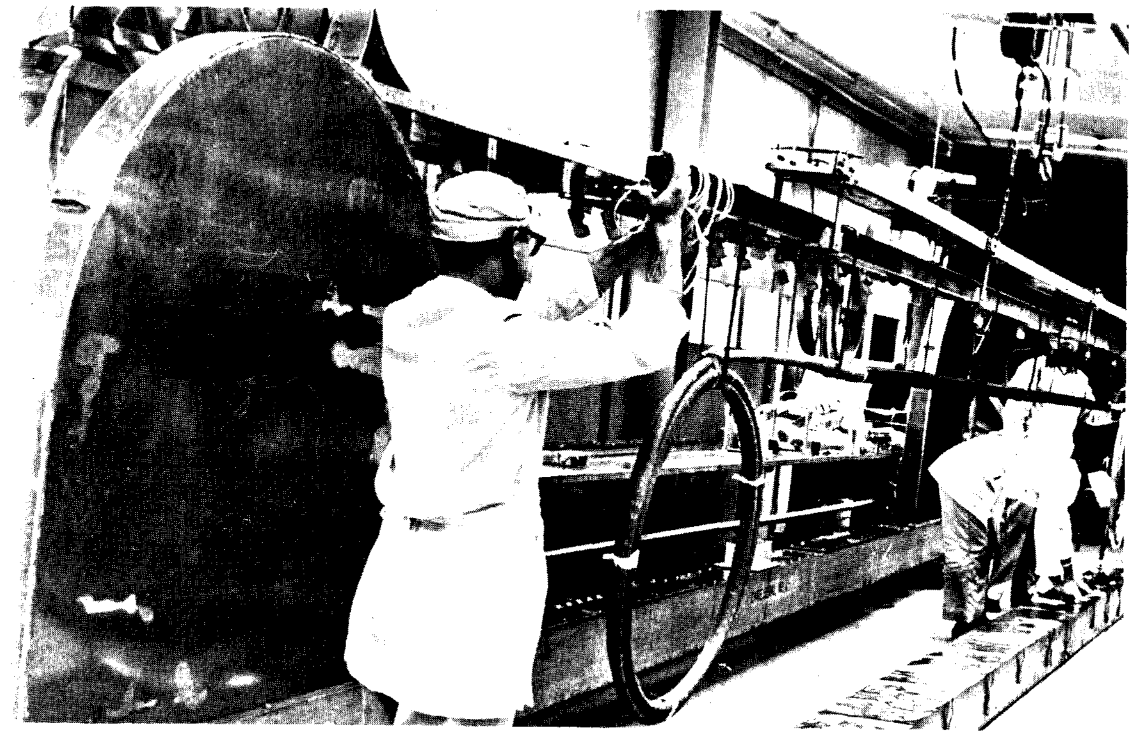
The fixing of a three-year programme for planning, maunfacturing and constructing the cable system took account of the time required for preparation, for manufacture of the large quantity (about 4,500 nautical miles) of high grade cable which would be required, and for the quantity production of precision equipment—particularly repeaters—much of which had previously been made only piecemeal under laboratory conditions. It also took account of the very limited season in the North Atlantic during which weather conditions permit an operation of this size and precision; a season so limited that only one of the two cables can safely be laid in each of the years 1955 and 1956.

In preparation for cable manufacture in the United Kingdom—where most of the 4,500 nautical miles will be made—Submarine Cables Ltd., built at Erith, in record time, a complete new cable factory capable of producing up to

**Seventeen of these Post Office submerged repeaters will be used in the Newfoundland-Nova Scotia section. Amplifying both directions and including directional filters, they will permit bothway transmission through one cable. Each has duplicate amplifiers, so that traffic can continue if one fails, and a means of announcing its location should a fault develop. Components are gold plated and are expected to last up to 20 years without failure**





**The American type repeater is much smaller than the British, and amplifies in one direction only. It is flexible and, after being jointed in to the cable, is laid with it in one continuous operation. Here is one of the repeaters (heavier line, *right*), with its stub cable (*centre*) and case for transport (*left*)**

80 nautical miles of finished cable each week and, so that *Monarch* can berth alongside their factory to receive the cable, dredged and moved out to sea some 300,000 tons of Thames river bed. The manufacturers of repeaters here (Standard Telephones & Cables Ltd.) and in the United States (the Western Electric Company) have each built air-conditioned dust-proof factory-laboratories for assembling and testing repeaters, in which elaborate precautions are taken to avoid impurities entering the repeaters; even the people who assemble the repeaters change into operating theatre type clothing before entering the shops.

The time-table of operations has to allow for moving large quantities of cable, repeaters and equipment from the places where they have been manufactured to the locations in which they will be installed or assembled ready for laying—often on opposite sides of the Atlantic. This is because the allocation of responsibility for design of the sections of the system has been based on the use of tried and established techniques: the country of manufacture of repeaters and terminal equipment is fixed by this arrangement but, to balance as nearly as possible the sterling and dollar contributions of supplies for the system, the greater part of the submarine cable is being made in the United Kingdom. As a consequence the American repeaters for the main crossing (they are 80 feet long, including the cable stubs) are being flown over the Atlantic in specially designed cases, elaborate precautions being taken to avoid damage to their components. They are spliced into the cable on arrival and stored, with the cable, in tanks at Erith ready for loading on *Monarch* at appropriate times. British terminal equipment for installation in Newfoundland and Nova Scotia is being shipped westwards, and the American terminal equipment for Oban eastwards across the Atlantic.

Despite these complications, the great programme of manufacture, delivery and installation is now running smoothly and the whole complex operation is moving according to plan.

Some of the Post Office team splicing the land cable in Newfoundland

Follow the route from London and see how construction is proceeding now and what is planned for next year.

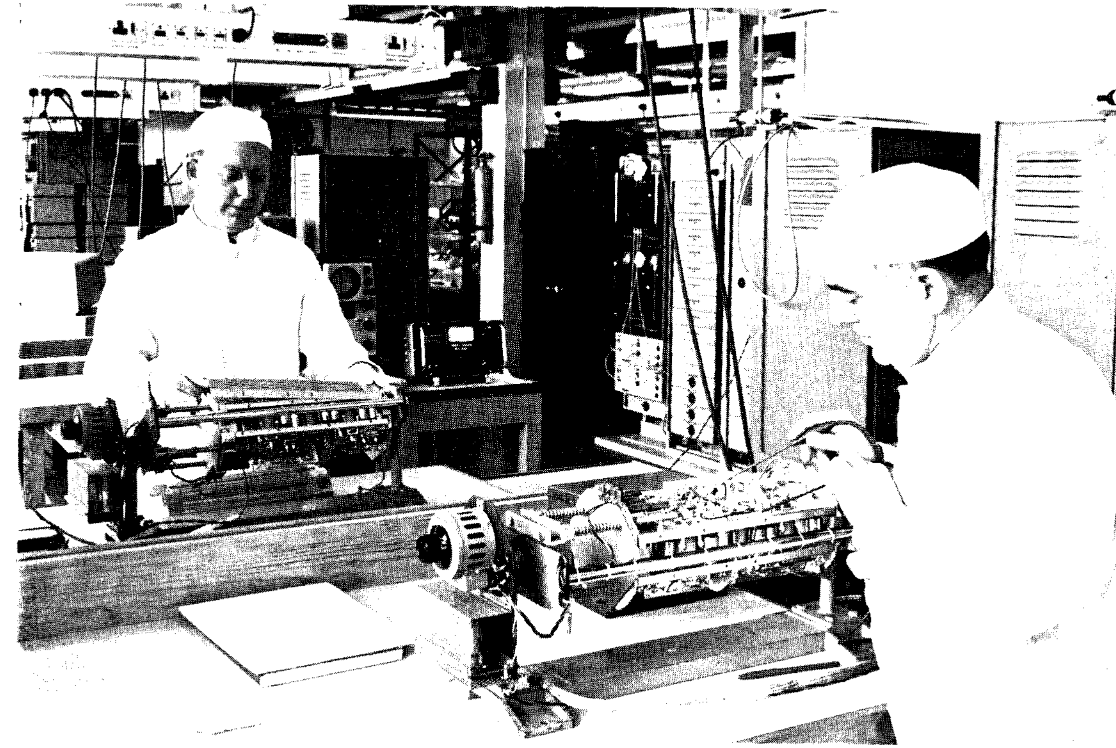
The International Exchange in London, where the circuits will terminate, is being extended and special equipment to facilitate connexion with inland and continental subscribers has been designed, tested and is now being manufactured.

Special high quality channels are being provided to extend the cable circuits from London to Oban and as part of the work a new coaxial cable is now being laid from Oban to Glasgow. The duct work and repeater station are completed; cabling and equipment installation is in progress.

The ocean cables will be landed in a little bay just south of Oban: and, in the hillside overlooking it, the terminal equipment associated with the cables and with the inland connecting links is now being installed in a chamber hewn from solid rock. The construction of this horse-shoe shaped tunnel-like chamber and its long adit tunnels was started in March, 1954, and completed in twelve months by John Mowlem & Company Ltd.; in that time 11,000 cubic yards of rock were excavated and 90 tons of steel rib and many thousands of cubic yards of concrete were placed in position to form the supporting arches, the lining and the deck which divides the main tunnel into two chambers. On the upper floor the American terminal equipment is now being installed; this (and the similar equipment at Clarenville) supplies power at 2,000 volts for the operation of the repeaters in the cable and adapts the signals coming in from the cable for transmission on the inland network. Alongside it the British equipment associated with the inland network is being

The Post Office International Exchange, where the London ends of the New York and Montreal telephone circuits will be operated





Assembling British repeaters in the air-conditioned workshops at Woolwich, where workers wear overalls and caps for cleanliness (hence the shops are nicknamed the "Woolwich Dairy"). All parts undergo rigorous tests before assembly. There are 300 components in each repeater, in a forged steel case about 9 ft. long and 10½ ins. in diameter : the whole weighs three-quarters of a ton

installed by the General Electric Company: and on the floor below a common power and battery plant will run the station from the mains and keep it running if the mains fail.

And so to the Atlantic: this year *Monarch* is laying the first cable towards Oban, next year she will start from Scotland and lay to Newfoundland. Each cable will be laid in three continuous lengths complete with repeaters. At the end of June this year *Monarch* laid 200 miles of shore end from Clarenville, Newfoundland (this cable had been made by the Simplex Wire and Cable Company in New Hampshire, U.S.A.) and buoyed the seaward end; after returning to Erith to load she left early in August to lay the 1,300 miles of cable across the ocean to the Rockall Bank and in September she will lay the remaining 500 miles of cable which will join the first cable to the terminal equipment at Oban.

The course of the cables has been carefully plotted in advance to avoid existing telegraph cables and the more precipitous of the hills and valleys on the ocean bed. *Monarch* carries Decca and Loran radio aids for navigation which, in conjunction with the existing shore installations in Europe and America and a specially erected chain of temporary Decca stations in Newfoundland, will enable the cable to be laid precisely on the predetermined course. At all times during the operation *Monarch* is in direct touch with the shore, both through the cable she is actually laying and by radio-telephone and telegraph.

In Newfoundland the cable terminal station at Clarenville has been built and is now being equipped by Eastern Telephone and Telegraph Company.

From Clarenville to the Canadian mainland the British single cable system, with two-way repeaters, is being installed. For the first 60 miles the cable deserts the sea to cross the Newfoundland plateau; here a trench is being excavated in the rocky terrain interspersed with lakes and bogs,

H.M.T.S. *Monarch*, which is laying all the cable, lying at anchor off Clarenville, Newfoundland, while motor launches pull the first shore ends from her holds. *Monarch*, built for the Post Office in 1945, is the only cable ship afloat capable of carrying the 1,500 nautical miles of cable, which must be laid in one piece across the deepest part of the Atlantic

and the cable laid in it. The Comstock Construction Company, a Canadian undertaking, has the contract for this work but a team of Post Office engineers is living in the camp to supervise the work, joint the cables and insert the repeaters. Their equipment includes X-ray cameras to check the quality of the joints made and precision testing gear for overall testing.

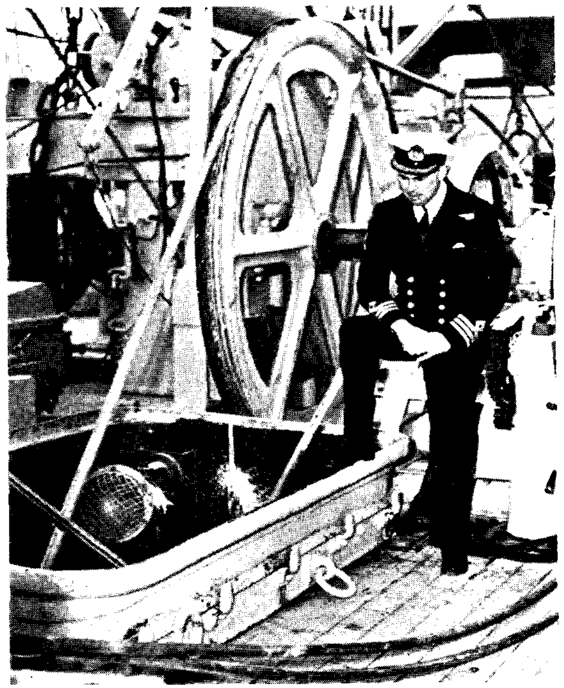
At Terrenceville the single cable again enters the sea to cross the Cabot Strait, but this part of the cable will not be laid until the Spring of 1956 and activity at present is limited to the cable and repeater factories in the United Kingdom.

From Sydney Mines, where another cable terminal station similar to that at Clarenville has already been built to house the British terminal equipment, a micro-wave radio system is under construction to carry the cable circuits on to the United States border. Through the hilly country of the Maritime Provinces 13 repeater radio stations are now being built—seven of them have been completed. Perched on hilltops to give the "visual" line between stations necessary for this type of system, the stations with their tall masts supporting reflectors are similar in appearance to those used to carry the television service from Holme Moss to Kirk-o'-Shotts. This equipment, partly of American and partly of Canadian manufacture, is all being installed by Eastern.

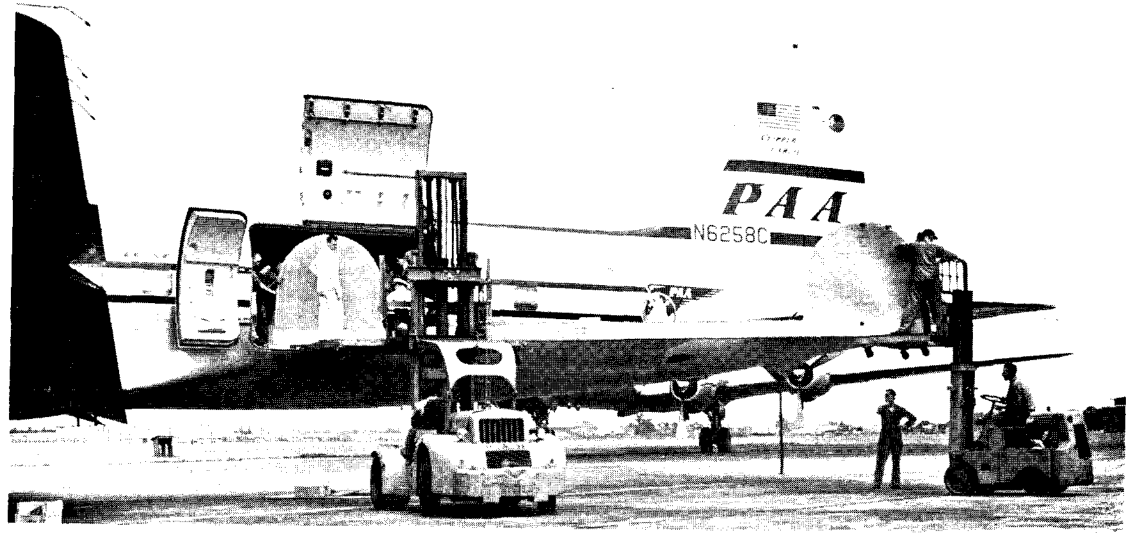
From one of the repeater stations near St. John, New Brunswick, the Canadian circuits will branch off the system and be carried on inland plant, now under construction, to the Montreal Terminal. In Montreal a new building is being erected for the Canadian Overseas Telecommunication Corporation, and in it the terminals of the United Kingdom-Canada transatlantic circuits—both telephone and telegraph—will be installed next year.

From the United States border the American Telephone and Telegraph Company is building a similar micro-wave link of six repeater stations, through Maine; three of these have been built and are already in use for relaying television pro-

*Monarch* at Newington, New Hampshire, U.S.A., in June: Chief Officer Bates watches cable coming aboard







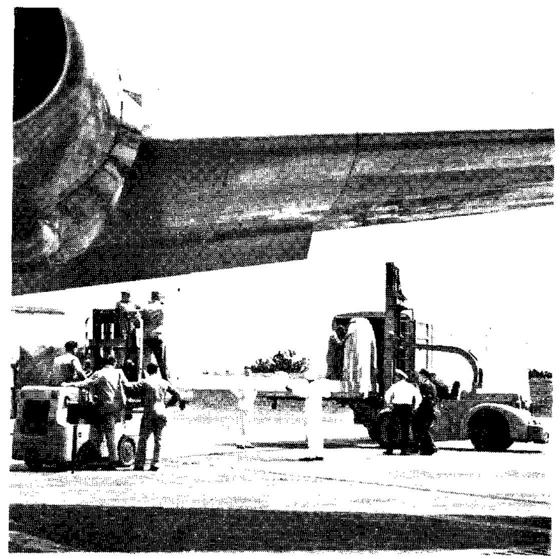

American repeaters being unloaded at London Airport. Elaborate arrangements are made to avoid damage risk in moving them from the Hillside, New York, factory to Ocean Works, Erith, Kent, for splicing into the cable. Each case contains a thermometer and a "bump-meter" to record the force of bumps during transit

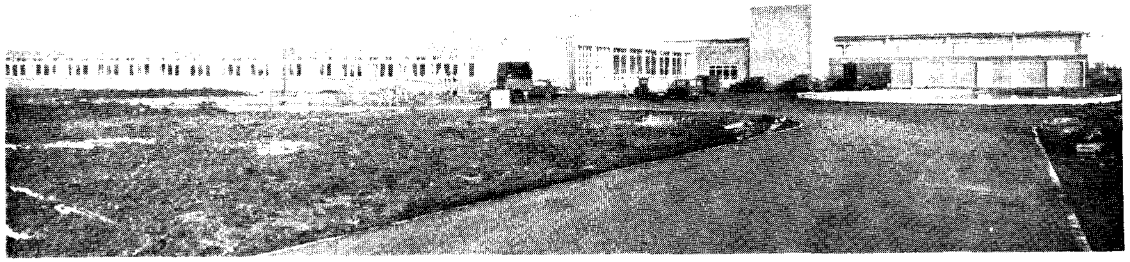
grammes. The final connexion to the Company's overseas operating centre at New York will be made over existing plant in the Company's long line network.

By the middle of next year the main links in the system from the United States border to Clarenville and the west-east cable across the Atlantic will have been completed and subjected to rigorous tests, and will be under continuous observation; all will then await the completion of the east-west transocean cable, due to be laid between June and September, 1956. The engineers will pounce as soon as the final splice is made and put the whole system through a series of tests and final lining-up adjustments in readiness for bringing the complete system into use later in the year.

The first calls made over the system between London and New York and Montreal will make telecommunications history; spoken through land-based coaxial cables and repeater stations for 550 miles in the United Kingdom, through 2,000 miles of submarine coaxial cable and 52 repeaters deep on the bed of the Atlantic, across Newfoundland and under the Cabot Strait through 370 miles of cable and 17 repeaters, and from hill top to hill top by radio waves for 360 miles in Maritime Canada and 500 miles on, the words of the speaker reaching New York and Montreal will open a new phase in the continuous effort to improve communications from the United Kingdom and the rest of Europe to the North American Continent.

Reloading the repeaters into a special van for transport to the cable works at Erith.





*a*: Rugby "B" building

# New Transmitting Station at Rugby


## *I. J. Cohen*

### *External Telecommunications Executive*


RUGBY RADIO STATION HAS BEEN A LANDmark to travellers between London and the north of England since 1925, when its 12 820-foot masts were erected to carry the aerials for the high power long wave radio-telegraphy transmitter. Since that time a long wave radio telephone and some 20 short wave transmitters have been installed in two blocks of buildings known as Rugby "Main" and Rugby "A". Traffic requirements for overseas telegraph and telephone services have increased to such an extent that it has been necessary to construct another large transmitting station and this is known as Rugby "B". It was ceremonially opened on July 28.

The site covers a flat area of about 700 acres of arable and pasture land separated from the existing site by Watling Street. Arrangements have been made to allow local farmers to use the land as much as possible. The building is near the middle of the site and the aerials are near the periphery, being connected back to the station by high frequency transmission lines. Signals can be radiated in all the principal directions and cover the full 360°.

The Ministry of Works' architects have produced a building, combining functional efficiency with a fine modern appearance, which is designed to be a "show-piece" of the Post Office radio services. The most striking feature is the long curved wing, facing Watling Street, containing the administrative offices, welfare rooms and stores. The photographs (see *a* and *b*) of this wing and of the old Main Building enable the contrast to be appreciated.

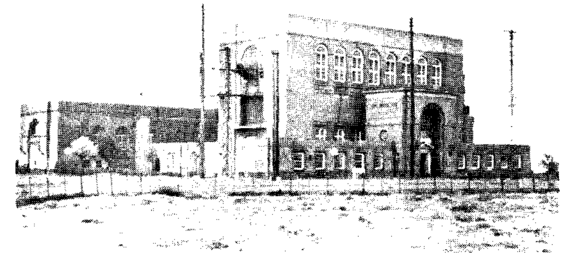
A glass walled hall connects the main entrance with the Central Control Position (C.C.P.) which is the operational centre. The three transmitter rooms are arranged to be visible from the C.C.P., which is raised a few feet above the general floor level. The transmitters are along both sides of the rooms. The individual power cubicles containing oil-filled equipment, such as the main power transformer, smoothing chokes and capacitors, are outside the main structure, in fire-proof rooms accessible only from the outside. Gantries at the back of the building are provided for the termination of the external transmission lines which join the transmitters to the aerials.

For long distance short wave communication wavelengths between 11 and 75 metres (that is, frequencies between 4 and 27 megacycles per second) are used and directional aerials are necessary at the transmitting and receiving ends of the circuits. Rhombic aerials are used exclusively on the new site; they are built in the shape of horizontal diamonds of wire a few wavelengths long and have the advantages of being easy and cheap to construct, while each may be used to cover a band of frequencies. These aerials are not usually more than 100 feet high.

The azimuthal direction of transmission of maximum energy is in line with the major diagonal of the rhombic and by suitable design (length of sides and height above the ground) the direction of maximum radiation can be made to point some degrees above the horizontal plane, for optimum transmission of the signals. Two rhombics can be built on the same set of poles or masts, without appreciable interaction, when they are required to cover different frequency bands in the same directions.

Open wire transmission lines run from the aerials to the gantries, one pair of wires being used for each aerial. These outside transmission lines are joined through to the system of copper-tube transmission lines which is used inside the building in such a manner as to avoid loss of power at the junction of the two dissimilar types of line. (Copper tube connectors can be seen rising above the cubicles which house the transmitters—photograph *c*.)

Special aerial switches (shown in photograph *d*) are provided to allow the transmitters to be connected to different aerials. Some transmitters

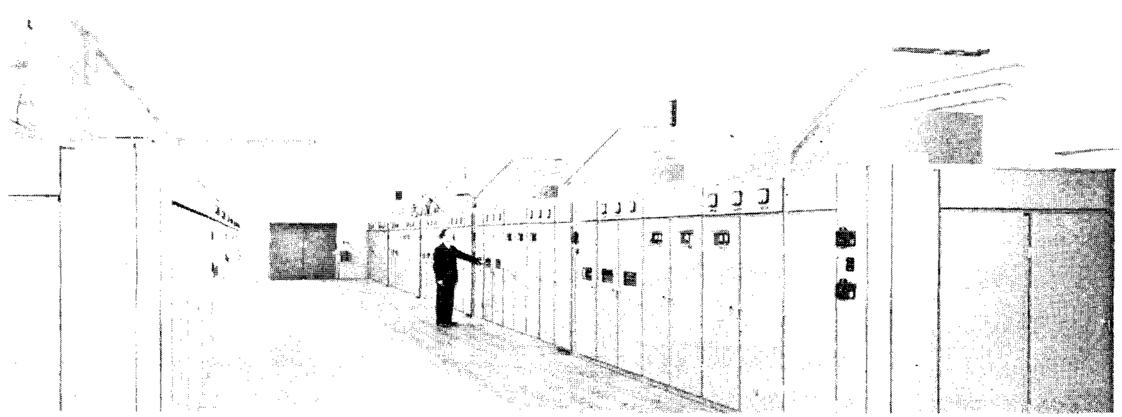


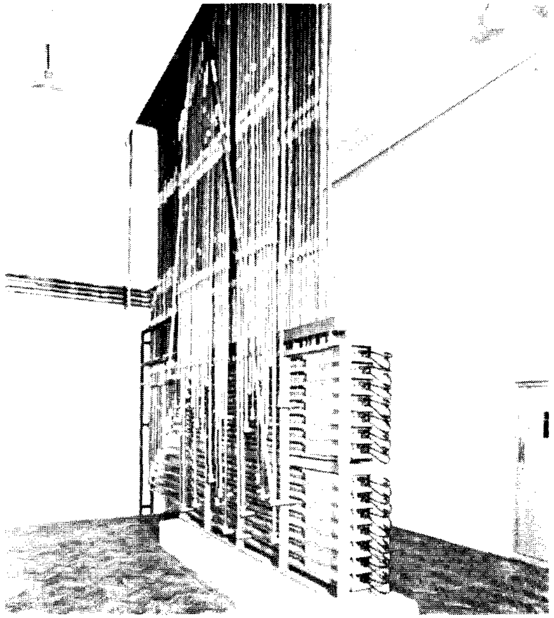
*b*: Rugby old Main building

have short schedules of traffic for several destinations during the day; for instance, one transmitter works to Moscow on telephony for four hours, to Australia on radio-teleprinter for six hours, to Cairo on radio-teleprinter for one hour and to North America for Hellschreiber (a form of printing telegraph) for three hours. Aerials for these varying directions can be connected by the aerial switches. Provision can also be made for replacing one transmitter by another in the event of a fault. Normal daily switching can be done by remote control, from the C.C.P., of the motors which move the switches.

The transmitters in the new station, although all basically alike, will carry a wide variety of

*c*: The wing of Main Transmitter Amplifiers





Aerial switching equipment for connecting transmitters to their aerials

types of telephone and telegraph services. Nevertheless, it has been possible to standardize the equipment to a large extent and to divide it into the following main groups :—

(*a*) Land-line amplifiers and terminal apparatus.
(*b*) Drive units for the transmitters which are of two designs, one for telephony and one for telegraphy (see photograph *e*).
(*c*) Carrier generating equipment.
(*d*) Transmitter-amplifier units (all similar) (photograph *c*).
(*e*) The central control position (photograph *f*).
(*f*) Testing, supervisory and monitoring units.

Incoming land-line signals control the drive units after passing through the line amplifiers and terminal apparatus. These produce the required form of output signals, at a mid-band frequency of 3.1 megacycles per second, which are then fed to the frequency changers in the transmitter-amplifier units. The fixed intermediate frequency of 3.1 Mc/s permits standardization of frequency translation and filtering arrangements, irrespective of the type of service.

Because of single side band[1] operation and the congestion of the frequency bands in the ether, it is necessary to maintain an extremely high degree of constancy in the frequency used for the radio transmissions. The International Telecommunication and Radio Conferences in Atlantic City in 1947 determined that the frequency tolerances applicable to new "fixed" station transmitters having powers above 500 watts, in the frequency band 4 to 30 Mc/s were to be 0.003 per cent. or 30 parts in a million.

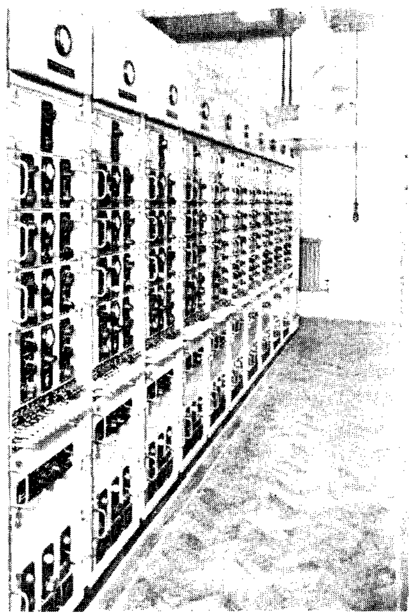
Modern practice is, therefore, to produce the carriers by means of quartz crystals which, being piezo-electric[2], can be made to oscillate at frequencies determined by the physical size of the quartz plates. By cutting the plates at specified angles to the axes of the quartz crystals, frequency changes can be reduced to one part in a million per degree (centigrade) change of temperature, and crystal oscillators well within the requirements can be produced. The generating equipment comprises groups of up to six crystal-controlled oscillators, each group being normally associated with one transmitter.

The basic frequencies are produced in the range 3.5 to 7 Mc/s and are fed to the transmitters, where they can be doubled or quadrupled in the harmonic generators. These carriers and signals from the drive units are then mixed to produce outputs of the required radio frequency and form. Simple amplifications by several stages of the transmitter-amplifiers finally produce output powers of the order of 30 kilowatts, peak.

*[1]For single side band transmission the upper or lower side bands in the channel are removed to reduce the width occupied and so to reduce noise.*



Transmitter drive units



When fully equipped the station will have 28 similar transmitters, each capable of transmitting independent side bands extending to six kilocycles per second on each side of the carrier frequency.

Each transmitter can be controlled either locally (that is, at the transmitter itself) or by remote control from the C.C.P. Six pre-set frequencies are available for each transmitter and frequency changes (with resulting changes in the wavelength of transmission) can be made in a matter of a minute or two.

Output efficiencies of the order of 60-70 per cent. are obtained, but with outputs of 30 kW a large amount of energy is wasted by heat produced in the transmitters, and this has to be removed. This is one of the major problems in designing a transmitting station and at Rugby "B", where air cooling is employed, large air ducts have had to be built underneath the transmitter cubicles.

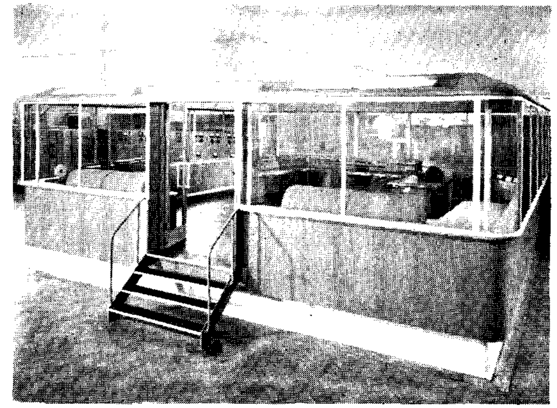
Large transmitting valves have their anodes[3] as part of the external envelope, the remainder being of special glass construction, supporting the other electrodes. Their weight is such that a small crane is necessary to lift the valves into position in the cubicles. For air cooled valves, dissipating 10 kilowatts, the anode is equipped with a large number of metal fins and the cooling air is pumped past the fins. Part of this cooling air is circulated from the transmitters into the transmitting rooms for space warming.

The anode voltage of the final valves is about eight kilovolts, supplied from grid controlled mercury pool rectifiers, six being used for three phase full wave rectification for each transmitter. Direct current heating for the filaments is used for all the power stages to keep the "hum" noise low, and this is obtained from large metal rectifiers.

Each transmitter-amplifier comprises a number of associated units occupying a total floor area of 21 feet by seven. They are arranged in rows as shown in photograph *c*. Because of the dangerous voltages used in the transmitters all the doors of the units are mechanically interlocked with the main circuit-breakers, so that it is necessary to switch off the power before access can be obtained to the internal equipment.

*[2]Piezo-electric crystals are crystals which develop an electric charge when "squeezed or stretched", as described in an article in the May-July* 1952, Journal.

*[3]Anodes are the electrodes through which the current enters a valve.*



The Central Control Position

The maximum power demand of Rugby "B" will be about 1,100 kilovoltamps normally drawn from the electric mains, on duplicate 11 kilovolt underground feeders. The sub-stations are at the rear of the transmitting block. These contain the step-down transformers for local distribution at 415 volts: 3 phase.

For emergency operation during a breakdown of the mains supply, the existing emergency diesel generator at Rugby Main Station is being augmented by two further generating sets; a total emergency power of over 3,000 kilovoltamps will then be available for the whole station.

## Extension Opened

The Postmaster General, Dr. Charles Hill, formally opened the extension on July 28. After Dr. Hill's speech a short world broadcast was given, demonstrating plain and scrambled speech and other forms of telegraph transmission. Among the guests, who were conducted round the extension before lunch, were the Chairman of the Rugby Rural District Council, the Lord Lieutenant of Northamptonshire, the Mayor of Rugby, representatives of Marconi and the English Electric Company, members of the Commonwealth Telecommunications Board and the Ministry of Works.

Two Deputy Directors General of the Post Office, the Engineer-in-Chief, the Director of the External Telecommunications Executive, the Director of the Midland Region and other officials were with the Postmaster General.


(B.O.A.C. Photograph)

# Telecommunications at London Airport


## A. D. Neate, A.M.I.E.E.

## West Telephone Area, London


LORD BRABAZON OF TARA ASKED THE POSTmaster General in the House of Lords on March 30, 1955:—

". . . what is being done to make sure that adequate telephone facilities are made available to meet the growing needs of London Airport?"

". . . I am pleased that the noble Lord has asked this question", replied the Postmaster General (Lord De La Warr) "as it gives me the chance of saying how essential it is to have good telephone facilities at London Airport where so many visitors get their first impressions of this country. I am therefore taking steps to provide a first-class service there of which we can all be proud. . ."

In asking this question Lord Brabazon no doubt had in mind the impending opening on April 17, 1955, of the Central Terminal Area for the internal and European air services. The Postmaster General's reply covered a very considerable effort made by the Post Office over the past nine years.

The buildings which came into operation in April are the new Control Building and part of the South East Face Building. The Control Building contains the headquarters of Airport Management, Aeronautical Telecommunications, Air Traffic Control and canteen and welfare facilities. It controls the movements of aircraft approaching or departing from the airport and all movements of aircraft and vehicles on the runways, taxi tracks and perimeter track.

The South East Face Building, to be completed this September, deals with three kinds of passenger: those travelling on European routes and subject to customs, health and immigration clearances; passengers in transit—that is, passing through the airport but not officially "landing"; and those travelling on internal services.

Further developments of the Central Terminal Area will include the Eastern Apex Building opening in January, 1956, providing air line office and air crew accommodation of some 61,000 square feet, a Post Office, news cinema and so on. Buildings to follow include the North East Face to deal with the world air routes, a major freight building on the South West Face and others, as yet unplanned, for the North West Face.

Some idea of the size of the airport can be gained from the fact that it covers six square miles with main runways of almost two miles. In 1954 peak traffic handled was 27 movements an hour (a movement being an arrival or departure) and the maximum traffic is expected to be at least 40 under conditions of poor visibility. By 1960 it is estimated



hat more than 4,000,000 passengers a year will ass through the airport.

Telecommunications by telegraph, telephone id radio are the nerve system of aviation. The ntrol of aircraft on the ground and in the air, ie supply of information to aircraft in operation, ie maintenance of facilities, the movement and mfort of passengers and the handling and uteing of freight—ensuring that all passengers id cargo are in the right place at the right time— pend on these services. The Post Office is ncerned with all three means of communication it at London Airport the telegraph and telephone rvices, with the provision of private wires and nted cables and equipment, are the main interest.

The master plan for the airport was laid down in 46. It was at once realized that considerable and ntinuous co-operation between the Post Office, ie Ministry of Transport and Civil Aviation and ie Air Ministry Works Directorate was essential. Development Engineer was assigned to the task planning Post Office requirements and he has llowed the project along to the present day. It as foreseen that the master plan with its eight inway lay-out, many taxi tracks and parking rons, with three large maintenance areas, would completed with the construction of the major rminal buildings and Control Tower in the ntre of the Airport. With work starting mmediately, Post Office proposals had to be resented to the construction architects, the linistry of Transport and Civil Aviation and the ir Ministry civil and electrical engineers for greement without delay.

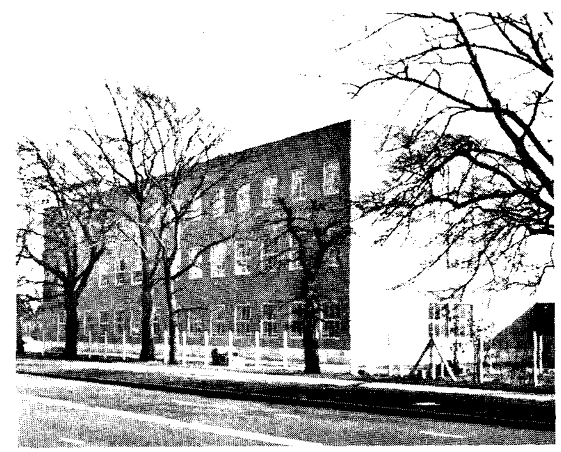
To meet all possible demands a duct plan was prepared which provided for three concentric rings, the inner ring of 12-way ducts, and the middle and outer rings of six-way ducts. These are connected by six radial six-way ducts, with a seventh radial route of 12-ways to the south east.

In discussions with the Air Ministry Works Directorate it was considered that the normal Post Office manhole was unsuitable to take the weight of the heavy aircraft expected and new manholes had to be designed. The covers weigh approximately 4 cwt. each, and mechanical lifters for removing them have been designed. It was also agreed that all ducts would be surrounded by six inches of concrete. The procedure for carrying out all this work is that the Air Ministry and the Ministry of Transport and Civil Aviation engineers inform the Post Office Development Engineer about the work proposed and ask for Post Office requirements; a drawing based on the duct plan is prepared and details of manholes, levels and so on are discussed on site. Duct materials are then requisitioned and supplied by the Post Office to the Air Ministry Contractor, and the duct is laid by the Contractor under the supervision of the Post Office.

The airport opened in 1946 with a three-position P.M.B.X.1A connected to Hounslow exchange for the then newly created Ministry of Civil Aviation and service was provided to the operating companies in various temporary buildings and tented accommodation by aerial cables.

Manhole cover mechanical lifter

Skyport Telephone Exchange



**Aerial view of the South East Face Passenger building. Passengers after passing immigration and customs controls board the awaiting aircraft by the ramps shown in foreground. Background right is the new Control Tower** *(B.E.A. photograph)*

By 1948 the P.B.X. had grown to 12 positions and the rapid development of airline services by 1950 required a further extension to 20. Over this period considerable re-arrangements had to be made as the airport grew. Temporary buildings were replaced by semi-permanent, mainly pre-fabricated concrete buildings, and the Post Office construction staff was under constant pressure to keep pace with the movements. A special modification was made to the P.M.B.X.1A to enable a total of 1,200 extensions to be accommodated.

Up to 1952 almost all telephone service on the airport had been through the Ministry of Transport and Civil Aviation P.B.X., but arrangements were then made for the larger airline companies to have their own installations as required. The first of these major installations was a 16-position P.M.B.X.1A connected to Hounslow exchange for the British Overseas Airways Corporation in temporary offices adjacent to the Bath Road. Later a three-position P.M.B.X.1A was provided for British European Airways which, in 1953, was beginning to transfer its activities from Northolt. A P.A.B.X. No. 1 was installed for Trans-Canada Airlines, but the remainder of the airport requirements continued to be met from the Ministry's P.B.X.

In 1953 work was started on a P.A.B.X. No. 3 to be provided by the Automatic Telephone and Electric Company for B.O.A.C. in new offices and hangars being built in No. 1 Maintenance Area to accommodate staff from Airways House and

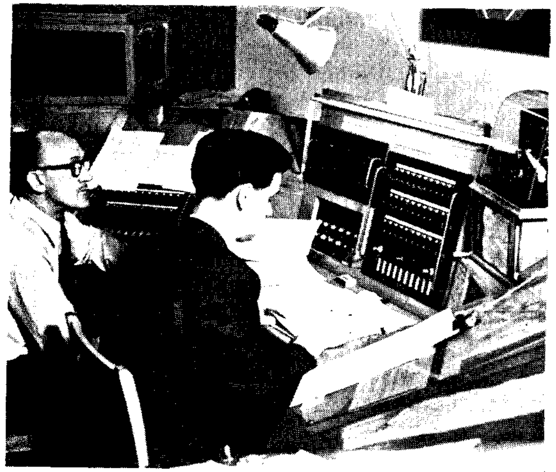


naintenance units from Filton and elsewhere. The nitial provision was 800 extensions, with 500 dditional to be provided in 1955. Further dditions with satellite working are expected. The lock wiring of the huge hangar presented many roblems. The cables had to be laid in difficult onditions, as it was desired to open the P.A.B.X. efore the building was completed. This P.A.B.X. No. 3 was described in the February-April, 1955, sue of the *Telecommunications Journal.*

The development of the Central Terminal Area equired considerable preparatory cabling works, ith special block wiring arrangements in the ontrol Building and the South East Face Building o meet all the various requirements of the Ministry of Transport and Civil Aviation.

In the Control Building, Standard Telephones and Cables Ltd. are building a P.A.B.X. No. 3 for the Ministry of Transport and Civil Aviation to replace the P.M.B.X.1A, which has now grown to 34 positions. The initial installation is for 600 automatic and 100 manual extensions. The telephone traffic carried by this P.A.B.X. will be very heavy as it will be the tandem centre for telephone calls between the various P.A.B.Xs. operated by the airline companies. This facility of extensions on one P.A.B.X. having access to extensions on another without having to be routed via a public exchange is of considerable value to the operation of the airport. The manual board will have 15 positions, including four positions handling traffic for the Southern Air Traffic Control Centre

**erial view of the new Control Tower, London Airport Central Area. On the left is the unfinished terminal building for airline operations and the public** *(B.E.A. photograph)*



The Terminal Manager's Control Room: on the desk are mounted the keyboards controlling the "Teletalk" system and passenger movement through the South East Face Building

mentioned later and two positions to be used as an operational P.B.X.

Additional P.A.B.Xs. are to be installed in the future for B.E.A.C., K.L.M. and Trans-World Airlines and probably other demands will follow. Pan-American Airways are to have a satellite to their main P.A.B.X. which is at their Piccadilly offices.

The major telephone development on the airport is the building of a public exchange designed primarily to meet the telephone demands from within the airport. Skyport exchange, as it will be called, will be part of the director network and is expected to be ready for service early in 1956. It will open with 700 exchange lines and 24 manual positions and will be extended later to 1,500 lines and 44 manual positions. A feature of the exchange is the very high calling rate and holding time expected. There will be a teleprinter workshop in the building where major overhauls will be undertaken of the telegraph equipment in use on the airport. Accommodation has been allocated also for the voice frequency (V.F.) telegraph equipment, amplifiers and terminating equipment at present in a temporary building containing the Ministry of Transport and Civil Aviation's P.M.B.X.1A.

The opening of Skyport exchange will relieve the Ministry of Transport and Civil Aviation switchboard of a large number of miscellaneous telephone users—for example, bookstalls, caterers and so on—as well as major users, such as B.E.A.C., for whom it has not so far been possible to provide exchange lines. The P.M.B.X.1A serves approximately 900 extensions at present and, as previously mentioned, the P.A.B.X. is being equipped with only 600 multiple; considerable transfers will therefore be necessary before it can be opened.

Coin box facilities are an important aspect of telephone service on the airport. A suite of call offices, including two with an attendant, has been built initially in the South East Face Building to help foreign visitors who may find our call offices difficult to operate. Within a week of opening many continental calls had been made.

Adequate call office facilities have also been provided in a temporary building still in operation on the Bath Road frontage, and several kiosks have been erected within the airport boundaries. A suite of call offices is available in the Transit Lounge so that passengers, while not officially landing in this country, are nevertheless able to make use of our telephone network. The main call office suites for the Central Area will be near the Post Office in the entrance hall of the Eastern Apex Building.

## Cable Facilities

Facilities have been given for serving all the main centres and runways by cable as required. Skyport subscribers will be connected by a network of $6\frac{1}{2}$ lb. conductor, flexibility being provided by frames installed in the permanent buildings. Links are provided between the frames for there are very large numbers of external extension's on all the installations. The Sales Development staff have had an exceedingly difficult task in forecasting requirements, because of the rapidly changing situation and the movement of staff into and around the airport. However, cable sizes have been chosen to ensure that adequate provision has been made to meet growth at the key points.

A further network of 20 lb. conductor is being provided to link the frames to each other and to Skyport, to meet applications for long distance circuits such as private wires, control circuits for the B.B.C. and others. The demand for these circuits is considerable and a special 542/20 cable is being laid for this purpose from Skyport to Mayfair exchange. For normal junction requirements cables are being laid to Holborn and Hayes exchanges to supplement existing cables to Hounslow and Feltham.

The M.T.C.A., B.O.A.C., B.E.A.C., other airline companies and the Meteorological Service make considerable use of telegraph apparatus. Equipment on the airport has grown until now there are some 188 teleprinters, 7 perforators, 21 re-perforators, 50 auto-transmitters and 35 printing re-perforators in use.

In the temporary building for the Civil Aviation Ministry P.B.X. several bays of V.F. telegraph equipment have been installed. Further provision will be made when the equipment is removed to Skyport exchange. As a standby to their own special telegraph network the Ministry have arranged for several telex circuits and, because of the advantage of the increased facilities provided by this new service, many companies on the airport are making similar arrangements. The article on the Civil Aviation Communication Centre in this *Journal* (November, 1953) described the type of circuit which links the airport to this centre.

The Ministry's teleprinter office at the airport works as a telegraph exchange by which teleprinter messages from offices in the airport—for example, Air Traffic Control, Meteorological Office and various airline companies, are relayed over the Civil Aviation Communication Centre's lines to various destinations.

It is not possible in this article to describe the complex arrangements provided for the Ministry of Civil Aviation and the airline companies, but the use to which facsimile transmission is being put for the Meteorological Service is of special interest.

The Meteorological Office is on the Bath Road and, to avoid duplicating facilities, arrangements have been made to transmit to the Sub-Meteorological Office in the South East Face Building and the Air Traffic Control in the Control Tower the information which is required at these points.

Charts are produced at the Air Traffic Control by the "Pofax" system within a few minutes of the half-hourly readings of wind speed and direction, cloud conditions and barometric pressure.

In the same way using the "Mufax" system, charts of flight forecasts and other material are produced in the Meteorological Briefing Room in the South East Face Building for the information of airline operational staff.

The Ministry provides a teleprinter broadcast service to many offices on the airport giving weather information, changes in service procedures, hazards and the like. Also, some smaller airfields without teleprinter installations can telephone messages to the airport for transmission over the Aeronautical Fixed Telecommunications Network (A.F.T.N.) via the M.T.C.A. teleprinter office.

## Specially Rented Cables

The Post Office supplies and maintains all land-lines used by the Ministry for telecommunications.

The most important cable and what can be described as the airport's "spinal" column is the Perimeter Cable. At the airport, this has been laid in a figure of eight formation with the two loops to the east and west of the Central Area and with the terminations at the point of contact in the Control Building. Important circuits such as those required by Runway Controllers, Ground Control Approach (G.C.A.) vehicles and Landing Aids: (for example, Instrument Landing System, control and monitor circuits) normally work on a "ring main" basis; that is, no matter which runway is in operation the necessary circuits are made available at the required control points; should a fault

Post Office Cable and Wireless counter: telephone cabinets can be seen on the right; other cabinets are in an alcove to the right of the counter and assisted calls are established by the counter clerk

develop the circuit is routed via the other serviceable part of the ring. There are 200 circuits on each loop of the Perimeter Cable but because this cable is vital, two separate 100 20 cables have been installed and special precautions taken with the duct work to ensure that the possibility of interruption is reduced as far as possible.

Another vital cable which has been installed in duplicate is the one that links the airport's main radio transmitter in Faggs Road, Feltham, with the Control Tower. Routed in this cable are the audio circuits which modulate the transmitters and thereby connect the Approach, Aerodrome and Ground Movement Controllers with incoming aircraft. The receiving station is within the airport boundary and duplicated circuits are provided in the same way to the Control Tower via the Perimeter Cable.

Circuits have also been provided for control and monitor purposes to the Outer Markers for the Instrument Landing System (I.L.S.) outside the airport; one, for example, is in the Windsor area. The I.L.S. landing aid enables aircraft to approach the airport on the correct glide-path until within 150 feet of the ground, after which an Approach Lighting System (A.L.S.) enables a safe landing to be made.

### Radar

The Approach Controllers situated in the Control Tower have been provided with radar surveillance of an area within a radius of about 60 miles by the Cossor A.C.R. Mark VI. The aerial head is near the Bath Road and a four tube coaxial cable, about a mile long, has been provided to the Control Tower. Three of these tubes are required for operational purposes and the fourth is spare.

The A.C.R. Mark VI has been developed to be free from echoes from fixed objects so that a very clear display of moving objects is obtained and small aircraft can be detected up to 25 miles away, and Stratocruisers up to 70 miles and more.

For the B.B.C. a 7 20 polythene cable links the Control Tower to Harmondsworth Telephone Repeater Station and television signals are there injected into the London-Wenvoe coaxial cable system when outside broadcasts from the airport are being given.

The rapid movement of aircraft on the ground to their allotted points is as important as the flow of aircraft in and out of the airport. This is obtained by linking Ground Movement Control, Airport Management and Apron Marshallers with a special network which also serves those operatives concerned with re-fuelling, re-victualling, passenger movement from coaches and so on. Although "walkie-talkie" and other radio links are used, the main service is made up of two parts, the Telemove and Teletalk systems.

In the Telemove, single-way working circuits are provided from a central point in the Control Building, to the Terminal Manager's Control Room, enquiry desks, Freight Loading Supervisors, V.I.P. lounges and air line offices—in fact to anyone interested in the coming and going of aircraft. The circuits are routed via block wiring and tie cables between buildings and the system is a ticker-tape arrangement using Exchange Telegraph apparatus. The Telemove Communicators' duties are to "eavesdrop" on the Approach and Aerodrome Controllers and select the required information to transmit to their "customers". In this way a printed record of aircraft movement is received and action taken as required.

### Teletalk System

Complementary to the Telemove system is the Teletalk which is a standard Post Office amplifier AD2779 with the master unit in the Terminal Manager's Control Room, serving up to 30 loudspeaker stations, including the Apron Supervisor and the Freight Loading Supervisor. With the Teletalk system, however, two-way speech communication is provided via a loudspeaker unit. The Terminal Manager issues all executive instructions to personnel dealing with the aircraft and their loads over this system. Thus, the handling of aircraft on the ground, and loading in the Terminal Areas, is Organised.

In the Approach Control and Aerodrome Control on the 6th floor and the top of the Control Building respectively, are nine keyboards and associated circuits provided and installed by the Post Office. These keyboards concentrate circuits to the important points on the airport and outside; for example, G.C.A. vehicles, Runway Controllers, Fire Stations and Southern Air Traffic Control Centre.

In the Terminal Manager's Control Room a 20-line keyboard has been installed from which direct contact can be made immediately with the officers controlling the routeing of passengers and baggage through the South East Face Building. This ensures that passengers from incoming planes and coaches are directed to the free lanes and avoids congestion at Customs inspection.

On the airport, and recently transferred from Uxbridge, is the Southern Air Traffic Control Centre. This is responsible for controlling all aircraft entering and traversing the area covering the whole of the South of England south of a line through Norwich, Birmingham and Fishguard.



The telephone communications system necessary to enable this control to be effective is most complex, requiring circuits to all aerodromes and airports and other Air Traffic Control Centres. Communication is also required with continental airports and control centres. These circuits are concentrated on keyboards specially designed and installed by the Post Office to meet M.T.C.A. requirements.

The information received over these circuits is used in conjunction with the Radar Control using the Marconi S.232 system. This operates between 600-610 megacycles per second with a range of up to 100 nautical miles. The comparatively long wave length used gives immunity from bad weather conditions and by using the Moving Target Indicator system unwanted "ground clutter" is removed and only echoes from moving objects are displayed. Thus complete control is obtained and air traffic regulated in a precise manner.

The Southern Air Traffic Control Centre has access also to the Operational P.B.X. and through this P.B.X. to all circuits connected to the Ministry of Transport and Civil Aviation's P.B.X. When the P.A.B.X. No. 3 is opened four manual positions will be allocated for this Centre's traffic.

Much of the equipment described above is of such importance that, even with duplication, any fault which occurs must be cleared at once. For this purpose staff attend throughout the 24 hours, so that immediate attention can be given when required.

The total Post Office staff stationed at the airport at present is 32, of whom 20 are employed on maintenance. Additional construction staff are provided for all major projects but the normal staff of 12 are able to deal with day-to-day requirements. A maintenance Assistant Engineer and an Inspector dealing with external construction and maintenance and installation work, are at the airport and, with close liaison with the M.T.C.A. staff, can give prompt attention to any difficulties or urgent work which may arise.

The aim of the Post Office is to provide the world's largest airport with a first-class service. As the airport continues to develop, the telecommunication services, to be completed shortly, together with those already provided, will ensure that this objective will be attained.

## Post Office to have Engineer Director General

Two former members of the Editorial Board of this *Journal* are among the new General Directorate of the Post Office, announced in July.

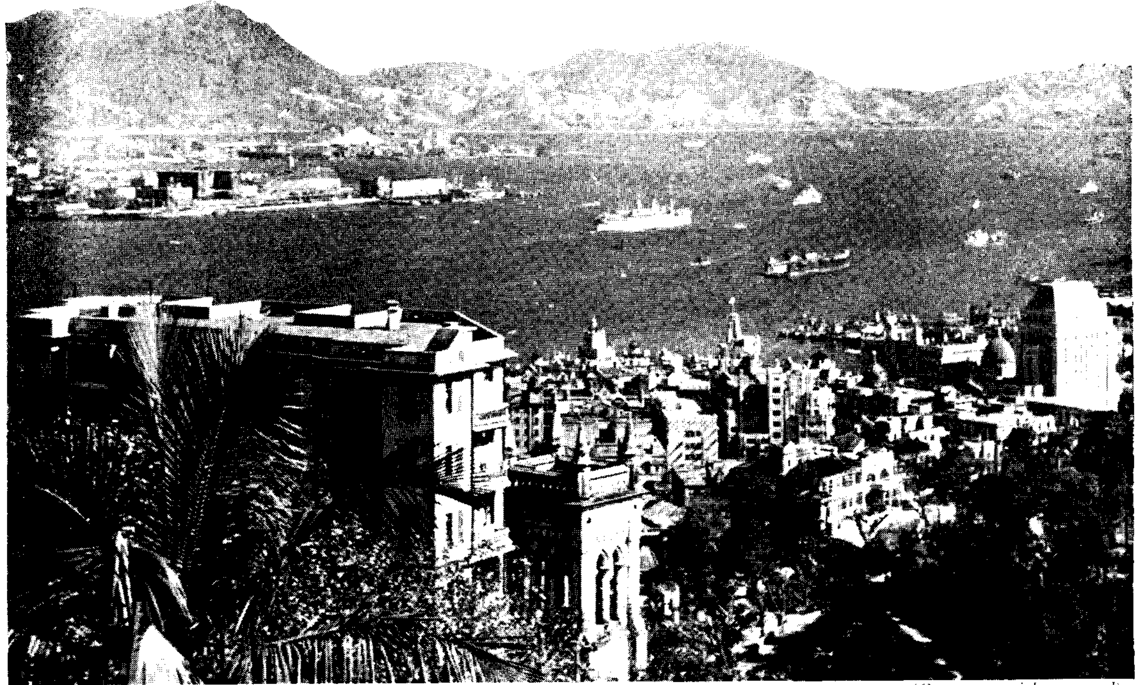
Sir Gordon Radley, who is to become Director General, was a member while Engineer-in-Chief from 1951 until 1953. One of the two new Deputy Directors General, Mr. R. J. P. Harvey, was Chairman of the Board while Director of the Inland Telecommunications Department from 1949 to 1954.

Sir Gordon Radley is the first engineer to become Director General since the post was introduced in 1934; he has been Deputy Director General since October last year. As Engineer-in-Chief, Sir Gordon had final responsibility on this side of the Atlantic for the design of the first transatlantic telephone cable, the progress of which is reported in an article starting on page 136. The repeaters which are going into the distant end of the cable were originated at Dollis Hill while Sir Gordon was Controller of Research. During the same period the hearing aid, now available under the National Health Services, was designed by a small committee of the Medical Research Council under his chairmanship. In earlier years he was prominent in the experimental field work done jointly by what is now the Central Electricity Authority and the Post Office when the first grid lines were built.

Mr. R. J. P. Harvey was seconded from the Post Office to the Treasury in 1936. In the early months of the war he served in the London Civil Defence Region and the Ministry of Food, returning to the Treasury in 1940. He came back to the Post Office in 1947 and was for $2\frac{1}{2}$ years Regional Director, Home Counties. Since leaving the Inland Telecommunications Department in February, 1954, he has been Director of Radio and Accommodation.

Mr. Harvey is succeeded as Director of Radio and Accommodation by Mr. W. A. Wolverson, who has been Director of the External Telecommunications Executive since its inception in 1954. Col. D. McMillan, who has been a member of the Board since November, becomes Director of the External Telecommunications Executive.

Mr. A. Wolstencroft, who was seconded by the Post Office to become first Secretary of the Independent Television Authority—about which he wrote in our May-July issue—returns to become Director of Personnel.



**Panorama from lower slopes showing harbour and fine buildings in Victoria town** *(Crown copyright reserved)*

# *Telephone Services in Hong Kong*

*A. L. Fisher**

THE BRITISH COLONY OF HONG KONG CONSISTS of the Island, with the city of Victoria, and the much larger new territories on the mainland with the town of Kowloon. Separating the Island from the mainland is the splendid harbour, about 10 miles long, and one mile across by the ferry route.

Before the war the Government had a skeleton system of magneto working for their own use but the Hong Kong Telephone Company operated all the telephones in the Colony, the system being entirely Siemen's No. 50A. Since the war the Company, which has taken over the Government cables and incorporated them in its own, has installed new exchanges with the new 2,000 type equipment, and G.E.C. S.E.50.

When war came to the Colony on December 8, 1941, about 17,000 telephones were in operation and there was no waiting list; indeed, canvassers were employed to promote business.

As part of the defence arrangements, all the Company's male European, and many of the Chinese, staff were enlisted into a special section of the Army Signals called the Fortress Signal Company. We spent a very hectic and bewildered 17 days before Hong Kong finally fell to the Japanese on Christmas Day. Before this there was hand-to-hand fighting during which, on December 18, we lost the main Power Station. When the Japanese cut off the power we used our main exchange auxiliary diesel generator to good effect. Besides running our exchange we sent out power to Cable and Wireless Ltd. and enabled them to continue operating. We also gave power to the large food store in our building and enabled them to run their refrigerators. This was an invaluable service for our food supply.

When the Colony surrendered most of our

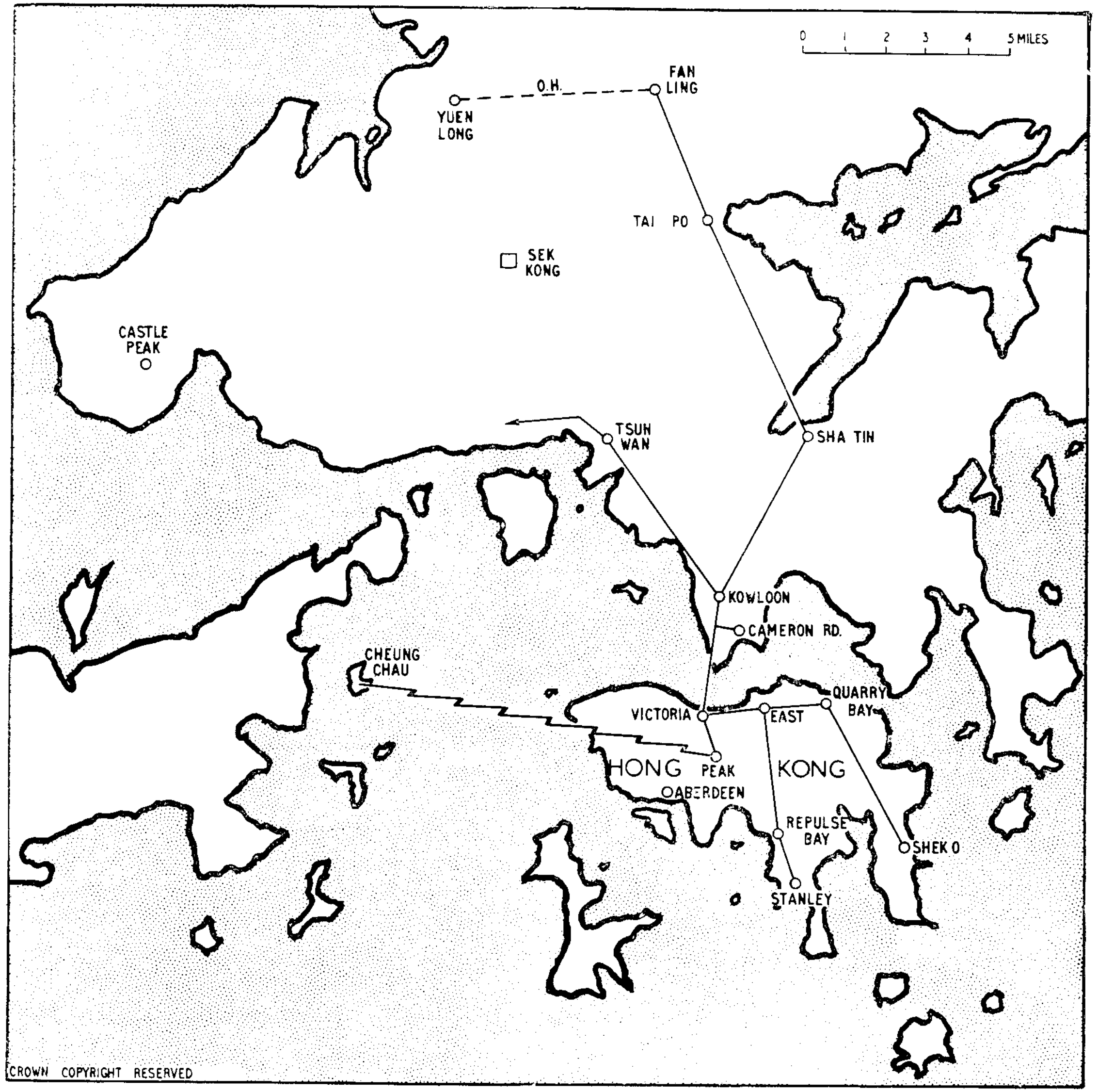
* *Mr. Fisher, who retired about a year ago, held the post of Maintenance Engineer with the Hong Kong Telephone Company.*

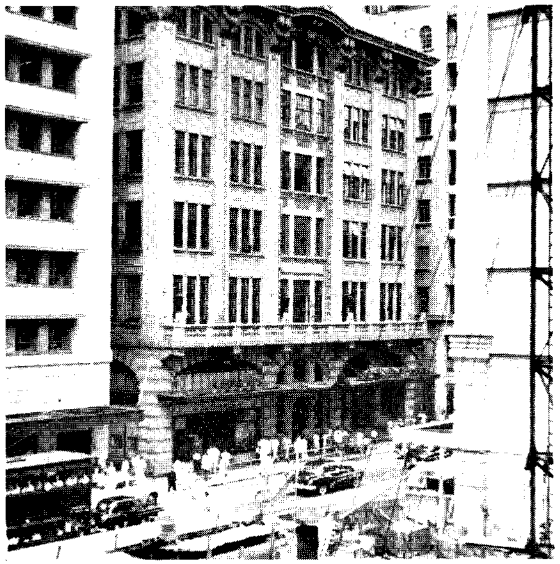


Company staff were in the Central exchange. As I was captured in Stanley Fort, it was not until I met the others in Shamshuipo Prison Camp that I heard their story. When the Japanese came into the exchange all the staff were lined up against a wall and then the exchange was cut off. For a considerable period a Japanese officer with drawn sword patrolled in front of them, practising sword play and slicing slivers off the exchange steps. This was very disconcerting, but fortunately it was all show, and the staff were treated quite well until sent to Shamshuipo some two months later. The exchange was cut off for several weeks, and our engineers had nothing whatever to do with it until after the war.

Most of our Chinese staff stayed on or drifted

**Outline of the Colony showing its telephone exchanges. Yuen Long is post-war and its 70 lines are fed by overhead iron wire. Cheung Chau is served by 2-channel V.H.F. to Peak**





Head Office of the Hong Kong Telephone Company and Central exchange

back to work for their new masters. At first we were a little disappointed at this, but it was no work, no food, and they had to live. None of them enjoyed the new regime, but they carried on and said little. As food was so scarce the exchanges were gradually depleted of all saleable items, and after the war all spare platinum contacts, bus bars, tone bars, and articles replaceable by substitutes, were all gone.

In 1944 lack of fuel caused the power stations to close down, and the auxiliary diesels were brought into use for charging the batteries. These in turn ran out of fuel and the cheap oil used ruined the cylinder liners. Our exchange inspectors were never without light in their homes. When power failed they ran the exchange 50 volt supply out to their homes on a spare cable pair. The Japanese never found out.

The exchange test clerk in Kowloon evolved a very quick but complicated method of testing lines, and when the Japanese asked him to show them how it was done he did it so quickly that they could not catch up with him. When they asked him to do it slowly, he looked round in horror and said, "Slowly, no can" ! He was still at his job when we came out of prison camp.

Admiral Harcourt arrived in the Colony on August 30, 1945, and this day is now a general holiday every year. On September 1 we took over our telephone service from the Japanese. Only about 6,000 lines were working, so we opened up to get more lines on. As many of our engineers had been sent to Japan, one killed and two sent off on a hospital ship, the remaining eight did what they could with the help of Army Signals. So rapid was

Part of the test desk Victoria exchange

Adjustment bench at Central exchange

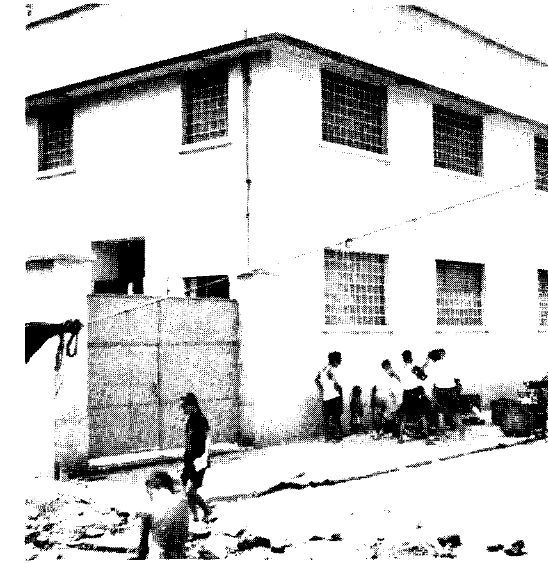


he recovery of the Colony that by the middle of 946 we had to start a waiting list for telephones. This increased with alarming rapidity, and not ntil 1953 did we start to reduce its numbers.

As it stands today there are 24,000 working lines Victoria and the waiting list is 9,800. The osition on the Kowloon side is worse, with 8,200 orking and the same number waiting. This was artly because our new Telephone Building at ameron Road, Kowloon, built to house our new ,000 line exchange, was taken over by the Army soon as it was completed in 1949 and used as a ospital and quarters. It was released only last ear, and the exchange is now nearing completion. The abnormal demand for lines has been brought bout by the retreat of so many businesses from ehind the "bamboo curtain" and their opening p in Hong Kong. From half a million the population has now risen to about 2,500,000.

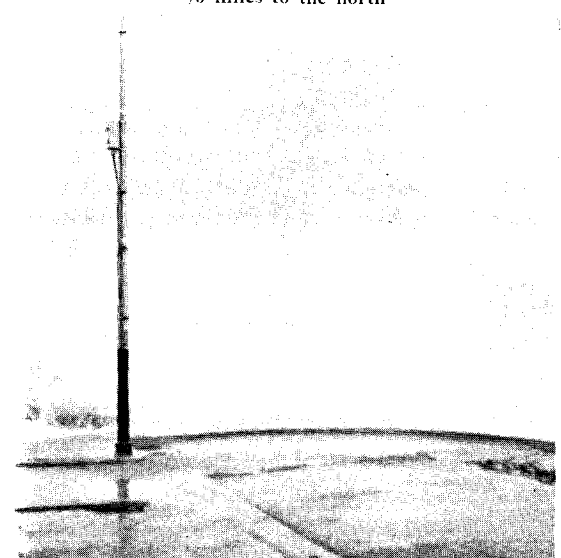
The map shows the rough outline of the Colony nd its exchanges. East is a new post-war exchange f 9,000 lines, as is also Quarry Bay, with 1,000 orking in tandem. Sheko, a small residential istrict, now has a small rural automatic exchange f 19 lines with but two junctions. Repulse Bay nd Stanley are also residential districts, but larger. The Peak exchange of 600 lines is also residential ut, being full, is being replaced by 1,000 lines of he G.E.C. 50 S.E. type. Aberdeen, which is growing rapidly, at present works from the Peak, but a new exchange is planned. There is to be a new exchange also for the Western District.

Before the war a loaded 13 quad trunk cable was worked to Canton, but as this was stolen up to our



The new Quarry Bay exchange

Near-miss typhoon, August, 1954, when the typhoon passed 70 miles to the north



A bathing beach—August, 1954

A view of the island-flecked coast with reservoir and dam in foreground *(Crown copyright reserved)*

border it is now used as a junction cable to various small exchanges. First comes Shatin, with about 30 lines, installed this year. Next is Taipo of 70 lines which was working before the war. Further out is Fanling which has been re-installed and has about 40 lines. Yuen Long is post-war and its 70 lines are fed by overhead iron wire of No. 8 gauge for eight miles. It is still impossible to use copper because of the risk of theft.

On the west of the mainland Tsun Wan is a rapidly growing industrial area, and its 80-odd lines have filled the exchange. A new one is planned. It is fed by a loaded cable which survived the war, and the ravages of the immediate post-war period when it was cut and parts stolen on about 15 occasions. As the Castle Peak Area is rapidly developing the Tsun Wan cable is being extended and a new exchange planned. When this is completed the New Territories will have been encircled. However, the Army have opened a new area at Sek Kong and have cut a new road there over the hills. This is the Company's next problem. Very high frequency cannot be worked because of the hilly district, which rises to 3,000 feet.

Of the many islands comprising the Colony only one has asked for service. This is Cheung Chau, and the Elders of this fishing centre came along with 50 requests for telephones. A magneto board was installed and is worked by 2-channel V.H.F. to Peak.

No picture of the Colony would be complete without mentioning typhoons, those severe tropical storms which rise in the area south of Manila and make for the China coast. Hong Kong gets misses every year and the resultant bad weather, but I recall the one which passed over Stanley on September 2, 1937. I was working in Victoria at the time, and our own building was shaken quite fearfully when the storm passed over. A wind of 167 miles an hour was recorded and, at the time, this was the highest ever recorded. The havoc next morning was terrible. No fewer than 27 ocean-going liners were ashore or sunk. One was 50 feet high on an island, and many smaller craft were found three or four miles inland on the Army Polo ground.

Although the Company's overhead plant is kept to a minimum and iron poles are used, we had 2,000 lines out of order next day. At Stanley a route of poles was flattened, and many of the poles had been snapped off where the base meets the pole. Some of the arms had to be dug out of the ground where they had been driven with the insulators still bolted on. The Chinese fisher-folk had suffered cruelly, and of the 75,000 floating population no fewer than 10,000 had been lost.

I regret losing many fine pictures and films of the aftermath of that typhoon, but like all my other possessions they were lost during the Japanese occupation. On looking back at this period perhaps I should be grateful that I still have my health and memories.



# Electronic Directors at Richmond Exchange

*J. A. Lawrence, A.M.I.E.E.*

*Engineer-in-Chief's Office*

ONE MORNING IN MAY, 1952, A NEW TYPE OF exchange control equipment was cut-over for public service at the Richmond automatic lephone exchange. This new equipment, now own as the Post Office Electronic Director, was e first of its kind to go into public service anywhere the world. It was a bold venture—bold because, the time, many people in the telephone industry garded electronic apparatus as a laboratory vice—something which might be useful in certain ecialized applications where constant and highly illed attention could be given, but unlikely to be real value in a telephone system in which the uipment must always be on duty. Experience is justified the boldness of the venture and day it is no longer doubted that electronic chniques will gradually, in one form or another, come a familiar part of any modern telephone change. Already after only three years the ectronic director at Richmond can be regarded being out-of-date, but it still continues to give liable service at low cost and is still fulfilling its riginal purpose, which was to provide engineering ata for further development work.

To appreciate the problems which had to be vercome before an electronic director could ecome a reality it is worthwhile considering first, uite briefly, the nature and the role of a director n an automatic telephone system. Directors are sed in areas where there are letters as well as igures on the telephone dials. Their principal unction is to interpret the dialling impulses orresponding with the letter code of the called xchange. In essence, the director is a form of nechanical operator, and a typical automatic xchange of the director type would be provided vith perhaps a hundred or so directors in addition o the automatic connecting equipment.

When a subscriber originates a call a director is utomatically assigned to deal with the call. Just s an operator would ask for the number wanted, the director makes a similar request by sending "dialling tone" to the caller. Just as an operator memorises the called exchange and number (or records it on a ticket), refers to routing instructions and sets up the appropriate connexions, so the director accepts and "memorises" electrically the exchange code and number of the wanted subscriber as it is dialled by the caller, consults a routing file contained within itself, and finally sends out the signals needed to make up the desired connexion through the automatic switches.

The selection of a line to the wanted exchange by an operator involves a "translation" of the exchange name into routing information; similarly, the director has to translate the code into routing instructions. Means must, of course, be provided to permit the "routing file" in the director to be kept up-to-date, and these same means also permit routings to be altered from time to time as the junction network is rearranged.

The principal functions of a director are illustrated in Fig. 1. In the Post Office director system, the director accepts only the second and third letters of the exchange name, with the four numerical digits; the first letter of the exchange name is used to operate a piece of mechanism called the A digit selector. This selector is provided to economize in the amount of equipment used in the directors and is needed only with directors using electro-mechanical equipment. If all the directors were made electronic it would be unnecessary to use an A digit selector.

This analysis of the requirements for a director shows that the basic operations to be carried out by electronic means are:—

(1) *Counting of dial pulses.* Each successive operation of a dial by a caller generates a train of electrical pulses. These pulses arrive at a speed of about ten pulses per second and each train of pulses, containing

from one to ten pulses, represents a decimal digit of corresponding value except for a train of ten pulses which represents the digit zero. Letters are represented by the appropriate decimal digit: thus, A, B and C all correspond with the digit 2: D, E and F all correspond with the digit 3, and so on. The significance of the digits representing letters depends on remembering the order in which the digits arrive; for example, CEN is indicated by 236, BER by 237 and so on.

(2) *Storage of digits after counting.* Since a complete number received by the electronic director consists of six digits (that is, two letter digits and four number digits) each must be remembered on a storage unit until it is required for setting up the call. Suppose, for example, that it is required to remember the digit value "six". If the storage equipment for this particular digit has ten positions and it is arranged that only one position of the ten can be active at any one time then, by activating position six, the digit value "six" will be remembered until the storage equipment is reset to its normal position. Similar units are needed for the remaining five digits.

(3) *Translation.* Translation involves, first, the recognition of the code to be translated and second, the selection of the appropriate routing information. The relationship between the code and the corresponding routing information is predetermined. In the director a code consists of two letters and, since each letter of each code can have any one of nine digital values (2 to 0 inclusive) there can be 81 possible combinations—though not all are used. To recognize any particular code the digits stored in the two "letter storage" units must be combined electrically so that just one result is obtained. With this result a selection can then be made from the routing units provided and the particular pre-assigned route selected.

(4) *Sending.* The exchange connecting equipment consists of successive ranks of automatic selecting switches which are caused to make a required selection by sending to them, rank by rank, successive trains of electrical pulses similar to the dial pulses already mentioned. This is illustrated diagrammatically in Fig. 1 where the routing digits for PRO are shown as 46 and the wanted number as 6564; the director would send the digits 466564 in response to the dialling of PRO 6564. The figure also illustrates the routing of a call to another number (5455) on the Richmond exchange itself.

The sending operation involves, first, counting off the pulses in each sequence as they are sent, and second, the separation of successive sequences by a timing period during which the various selector ranks are prepared for the succeeding pulses.

## Register-translator

The translation and route selection operating occupies only a very small part of the total time for which a director is engaged in receiving and establishing a call; consequently, it is possible to arrange that translation and route selection shall be effected in a unit which is common to a number of directors. The basic functions of a director thus become separated into registering the digits dialled by a caller (and later sending the required digits to the exchange connecting equipment) and translation and route selection. Thus, to the engineer, it is more convenient to refer to the director as a *register-translator*—in the United States the director is called a *register-translator-sender*, which is perhaps even more descriptive. However, in this article the name "director" is used to describe the device used in the Post Office director system.

Hitherto, the requirements for a director have been satisfied by using electro-mechanical devices such as switches and relays as the basic components; a typical example is shown in Fig. 2. Directors of this type do, indeed, give excellent service. Their usage, however, is heavy; a director in a London exchange may carry up to half a million calls a year and they need maintenance and overhaul facilities of high standard, which form an appreciable part of the operating costs of the directors. With the development of electronic techniques the possibility arose that the electro-mechanical components of a director could be replaced by radio type resistors and capacitors, thermionic valves, cold cathode gas discharge tubes and metal rectifiers. It was thought that these components, being non-mechanical, should be able to withstand heavy duty better than mechanical components. Reliability and maintenance costs were, of course,



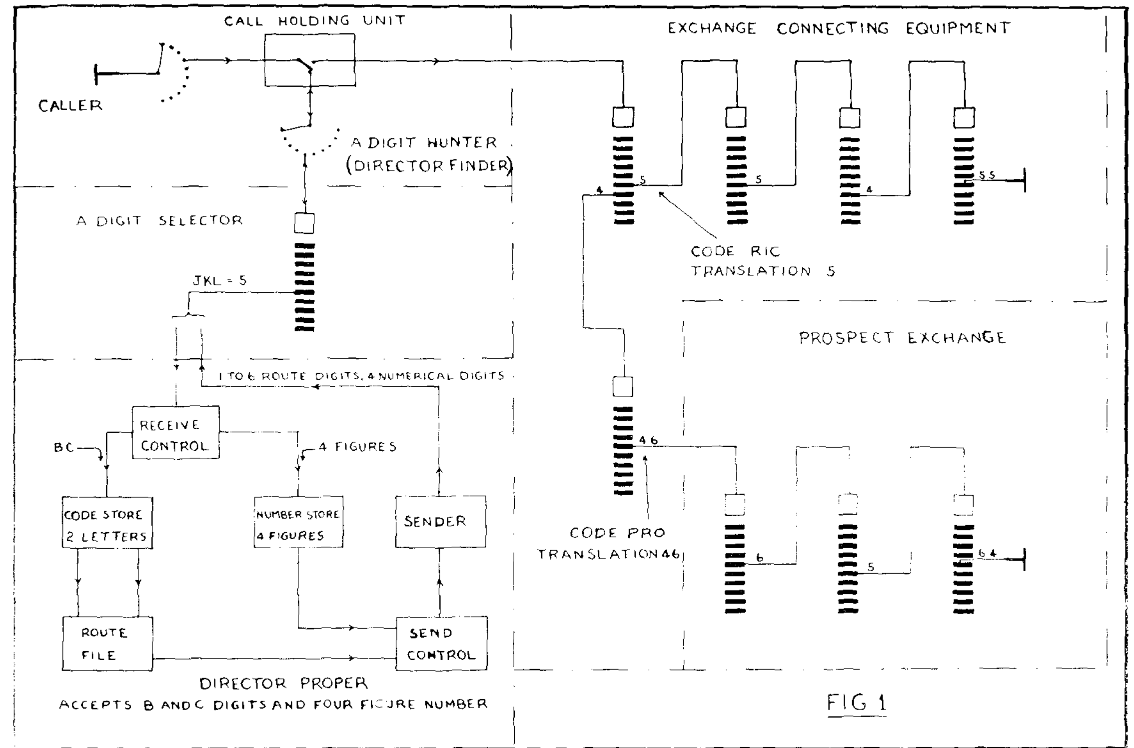



**Fig. 1: Diagrammatic illustration of the principal functions of a director**

material considerations and it was to get such information that the Richmond trial of electronic directors was started, with the satisfactory results already mentioned.

## The Application of Electronics

Examples of the basic electronic components are shown in Fig. 3. Resistors, capacitors and thermionic valves are comparatively well-known for all are widely used in broadcast and television receivers. (The thermionic valve was described in the February-April, 1955, issue of this *Journal*.) The cold cathode tube is relatively unknown except to specialists in the electronics and switching fields. It is a near relation of the neon tubes used for advertising, although its shape, purpose and performance are very different. A typical cold cathode tube consists of a glass bulb filled with neon gas and fitted with three connexions which terminate inside the tube on specially spaced and shaped electrodes.

The metal rectifier may also be unfamiliar except to the specialist. There are several types, but in all the important property is that an electric current flows much more easily in one direction than in the other—the directional difference being such that, for most practical purposes, it can be assumed that current will flow through the rectifier in one direction only.

It is not proposed to go into detail to explain how the basic electronic components can be incorporated into circuits satisfying the requirements of a director, but it will be of interest briefly to examine some of the principles involved. One of the requirements is for the storage of a digit; this involves the operation of, say, one out of ten possible similar memory units. The cold cathode tube proves very convenient for this.

Suppose we have a three element tube (a triode) such as is shown diagrammatically in Fig. 4. The elements are respectively the anode, the cathode and the striker and the tube

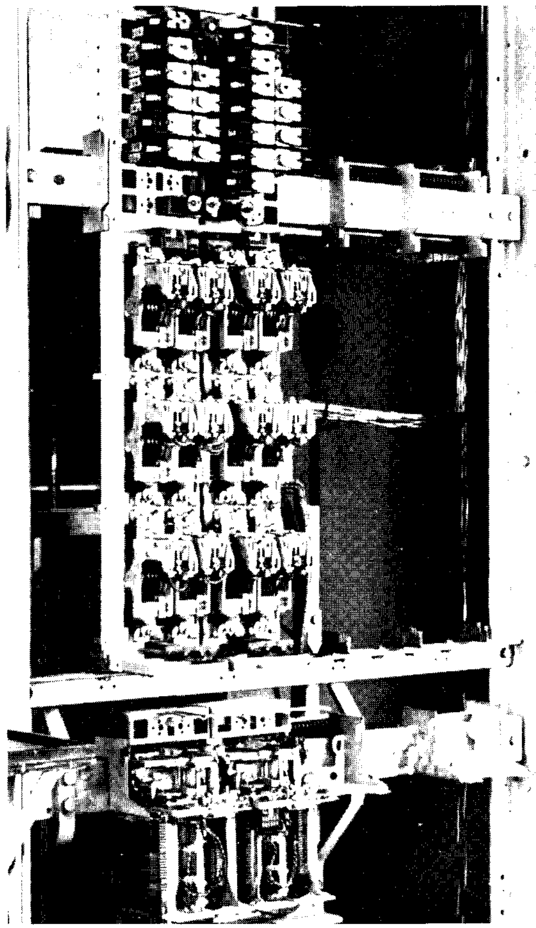


Fig. 2 : Typical electro-mechanical directors with covers removed

contains neon gas at a pressure of about one-twentieth atmospheric. If for the moment we ignore the striker and consider only the path between the anode and cathode we shall find that if we attempt to pass a current through the tube by connecting a battery across the anode to cathode gap we shall be unsuccessful so long as the voltage of the battery is less than about 180. If however this voltage is exceeded, the gas in the tube will suddenly begin to glow with an orange-red light similar to that seen in neon signs, and a current will begin to flow from anode to cathode.

The magnitude of the current depends on the value of the resistor R and the characteristics of the tube. If, now, the battery voltage is reduced below the value at which the glow began (say, 180 volts) we shall find that the glow persists—in fact, it will persist until the battery voltage is reduced to a value just below about 70 volts. This is a most important effect for not only does the glow persist over a wide range of supply voltage but also, while it persists, there is a voltage drop between the anode and cathode which is almost constant and equal to about 70 volts. This voltage drop is called the tube's "maintain voltage" since it is regarded as the voltage which will maintain the gas in a glowing condition. The fact that the maintain voltage is practically independent of the supply voltage over a wide range means that, while a glow persists, the difference between the supply voltage and the maintain voltage must appear across the remainder of the circuit. In Fig. 4 this is the resistor R and, if the supply voltage is 180 volts, the voltage appearing across R will be about 110 volts. If the supply voltage is reduced to say 150 volts the voltage appearing across R will be 80 volts. The voltage across the resistor R is a useful electronic indication of the state of the tube—if the tube is not glowing the voltage across R will be zero whereas with the tube alight the voltage across R will depend on the supply voltage used.

## The Striker

The function of the striker can now be examined. The striker is really a second anode, but the distance between the striker and the cathode is much less than that between the anode and the cathode. If a voltage is connected to the striker the behaviour of the tube is similar to that just described, but because the striker and the cathode are closer together, the voltage between them needed to start a glow is only 75-80 volts instead of the 180 volts needed between the anode and the cathode.

Taking the two circuits operating together a very interesting and useful effect occurs. Suppose the supply voltage connected to the main anode is only 150 volts; this alone is insufficient to cause the anode-cathode glow to start. If, however, the supply voltage connected to the striker is made sufficient to start a striker cathode glow we find that as soon as the striker cathode glow is established the disturbance inside the tube is enough to start the main anode-cathode glow, despite the fact that the main anode supply voltage is below that normally needed to start a glow in the main anode to cathode gap. Once the main anode-cathode

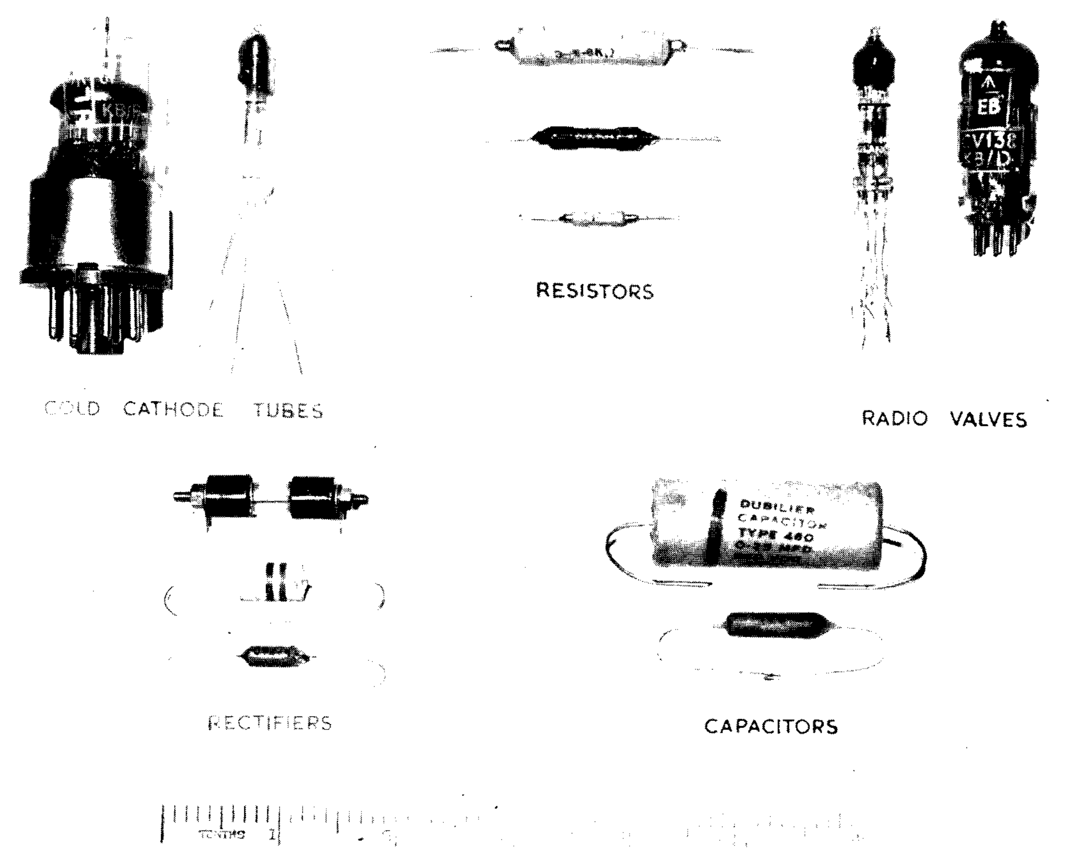


glow begins it cannot be extinguished until the voltage across the anode-cathode gap is reduced below the maintain value for the tube.

This may be thought of as being a triggering effect and is often so described since it is convenient to think of a voltage of 75 volts or so triggering-off a glow which, normally, would need about 180 volts for the same result. There is also a current triggering effect in the sense that the current which must be made to flow in the striker-cathode gap (to cause the main gap to glow) is very many times smaller than the current that can be released into the main anode-cathode circuit by the triggering action. The main anode-cathode current can be made large enough to provide striking current, simultaneously, to several following tubes; in this way the electronic equivalent of a multi-contact action on a relay can be constructed. This effect is much used in the Richmond equipment.

From what has been said about the behaviour of a cold cathode tube it is fairly easy to see that it can be used to "remember" an event by causing the anode cathode gap to glow when the event occurs and to arrange that it remains so glowing for as long as it is desired to store the particular information. Once the anode cathode glow begins the arrangements for striking the tube are no longer of interest and may be removed—in fact, the striking signal may consist of a very short duration pulse signal. When a tube has been activated the voltage drop across the associated resistor (or more generally across the associated circuit) is an indication that the event for which

Fig. 3 : Examples of electronic components



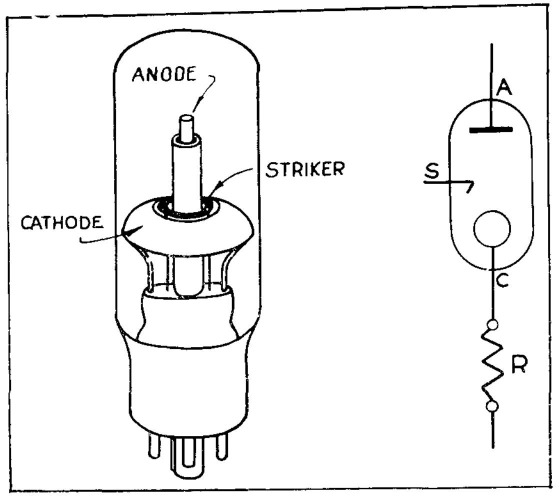



Fig. 4 : Typical cold cathode triode left with conventional presentation right

the tube is provided has been recorded; this voltage drop may then be used to activate further tubes as needed and, by extending the principle, quite complicated networks may be built up to perform desired functions.

The process of counting and recording a sequence of dial pulses is a good example of how a number of tubes may be combined to carry out the dual work of, first, counting the number of pulses, and then recording this number for use later. The operation required may be reduced to the process of recording serially a number of separate but sequential events. Each event may, for example, be the beginning of a dial pulse; such events follow each other quite rapidly (for example, 10 pulses per second) but the speed of response of a cold cathode tube is more than adequate to detect each event separately with plenty of time in hand. Since the maximum number of pulses in a dial pulse sequence is ten, one method of counting and recording is to provide ten tubes so inter-connected that at any time only one of the tubes can be in a glowing condition. Before any pulses have been received all tubes should be extinguished so that when the first pulse arrives it can be made to strike the first of the ten tubes. This condition signifies that one pulse has arrived and that if a second pulse arrives it must be directed to the second tube. Hence the circuit must be arranged so that the first pulse is always directed to the first tube and the second pulse to the second tube, if the first tube is glowing; further, if we are to record the number of pulses that have passed, by having only one of the ten tubes glowing at the end of a sequence, it follows that as soon as the second tube strikes and so records the arrival of the second pulse the first tube must be extinguished. The third pulse should then be directed to the third tube because the second tube is glowing and when the third tube strikes the second should be extinguished, and so on. The glow can thus be made to step along the ten tubes, moving one position for each pulse; for example, in a series of six pulses the counter would be left, at the end of the sequence with only the sixth tube glowing.

This is the type of counter-recorder used in the Richmond director and because the director records six series of digits it contains six similar counters for this purpose. One very useful feature of this type of counter-recorder is that the maintenance engineer can see at a glance what is happening by watching the glows of the various tubes as a call progresses.

## Gate Circuit

When a circuit is constructed to provide a given set of facilities, such as those outlined earlier, the action required of it as a whole can be reduced to a number of so-called logical operations taking place serially in time. Using this concept, various desired effects can be related to specified causes in a manner that helps the circuit designer to meet the requirements with the tools at hand. To reproduce such cause-effect linkages electronically it is necessary to combine electrical signals in the appropriate manner. A device which can provide a "logical" cause-effect linkage is called a "gate" circuit—presumably because of the analogy of a gate barring the way until the gate is opened and the pathway freed for action; this analogy does in fact give a clue to the way in which such a circuit may be constructed and electronic gates are often arranged so that, on the input side, one or more signals are always trying to pass through, whereas, on the output side, nothing emerges unless a particular combination of input signals occurs.

There are many possible arrangements but a simple example will suffice to establish the principle. Fig. 5 shows a two-element cold cathode tube, called a diode, arranged to give an output signal only when two input signals are present together. This tube requires about 65 volts to cause a glow to start. If the signal voltage E1



connected to R1 is less than 65 volts a glow cannot be started by this signal alone. Similarly if a pulse signal P1 applied via C1 is less than 65 volts, again it cannot, alone, cause a glow to start. If, however, the signal P1 is applied in the presence of the signal E1 the total voltage applied to the tube will exceed 65 volts and a glow will start and will, as a result, produce an output signal across the resistor R2.

Metal rectifiers and resistors can be arranged to produce similar results by making use of the unidirectional conduction property of a rectifier already mentioned. Gates constructed from metal rectifiers are very versatile and form a powerful tool for the circuit designer. The ordinary radio type thermionic valve is available to the designer for use as an amplifier, but it too is adaptable to gating techniques and to the generation of pulse signals in a form specially designed to suit gating operations.

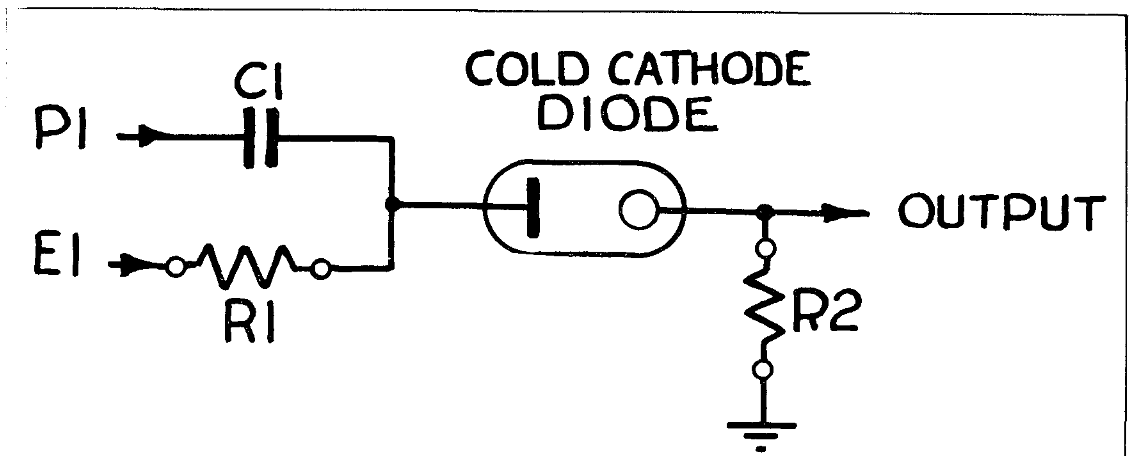
It can be deduced from what has been said so far that electronic circuits can be constructed from a few fairly simple components, all of which are essentially non-mechanical. With these simple components a wide variety of circuit elements can be constructed and these elements can be linked in such a way that logical operations can be performed automatically at high speed and with constant accuracy. The skill required of the circuit designer is considerable but the final circuit is very often quite straightforward to understand and to maintain. Such circuits can be made very reliable; essentially, the reliability of an electronic director can be made equal to that of the components themselves and to that of the goodness or otherwise of the soldering used in constructing the equipment. There are no mechanical adjustments to be made and electrical adjustments can be avoided.

## The Richmond Director

As indicated earlier the Richmond director consists of two parts, a register and a common translator. At Richmond six registers suffice to handle all the traffic to exchanges whose names begin with J, K, or L, and these six registers are served by a single common translator. This translator could, however, serve many more registers without difficulty. A general view of the Richmond installation is given in Fig. 6. Each register contains 200 cold cathode tubes and 24 valves while the translator contains 380 cold cathode tubes and 138 valves.

The operation of the translator is worth a brief description. When a register receives a call it accepts and stores the second and third letter digits and the four numerical digits of the wanted number. The translator is interested only in the letter digits or, more accurately, in their numerical equivalents. Suppose a caller wants a KINgston number. The register records 46 for the letters IN and, having made this record, calls on the translator for routing information which we will suppose is the single digit 6. As soon as the translator receives a request from the register for information it runs through all the information it possesses

Fig. 5 : Use of cold cathode diode as electronic gate



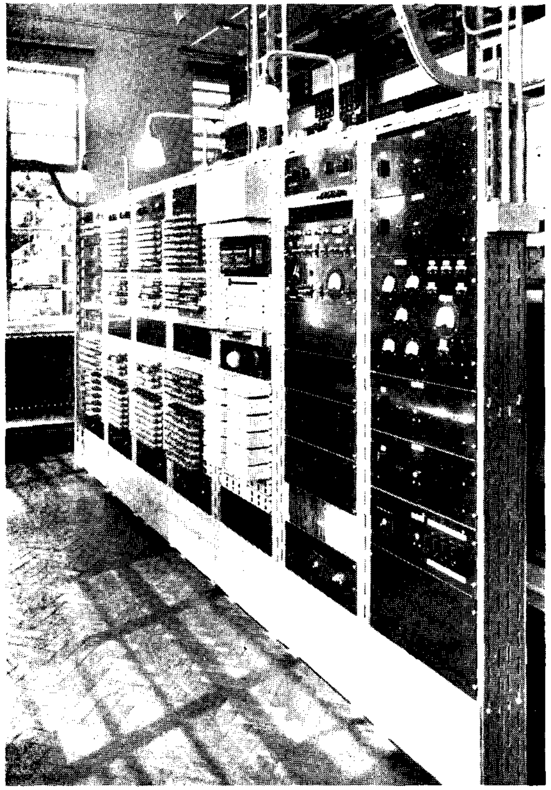


**Fig. 6: General view of the Richmond electronic directors**

searching for the information relating to the letters IN (that is, the digits 46).

The translator has sets of information relating to some thirty or so different exchanges and it searches for the item required by starting at the beginning of its repertoire and offering, in sequence, each set of information to the calling register. Each set of information consists of the two-figure equivalents of a particular exchange name, followed by the routing information; as each successive offer of information is made to the register, the register compares the figure equivalents of the exchange name with those it is holding (in the example the digits 46 representing IN). For so long as the figure equivalents of the exchange name do not coincide with those the register is holding, the register ignores the routing information.

The translator proceeds more or less without regard to what the register is doing and when, finally, the translator offers the figures the register wants (that is, 46) the register immediately opens certain electronic gate circuits to allow the routing information associated with figures 46 into the register where it is stored pending being sent to line. The request to the translator is then cancelled and it returns to normal to await another request.

The search for routing information takes place at high speed (90 exchanges per second). This permits of a simplification in the register design for, if the routing information contains more than one digit (as is the general rule), the register can make repeated applications for routing information digit by digit without delaying the call in any way. Thus, at any one time, the register need have capacity for holding only one routing digit instead of perhaps six such digits on a complicated routing. The similarity in the way in which the translator examines its store of routing information and the way in which an operator might look up a routing file is striking and illustrates very well the way in which electronics can imitate the simpler functions of the operator.

## Results of Trial

The results of the first two years' trial (see *Post Office Electrical Engineers' Journal*, January, 1955) of the Richmond director show that an electronic director is potentially able to improve on the standard obtainable from the best electro-mechanical director.

From the service point of view, the number of calls which fail to be completed at the first attempt is 20-25 per cent. less than with the equivalent electro-mechanical equipment in the same exchange. This is indeed encouraging, because the Richmond equipment represents a first attempt made at a time when much was necessarily conjectural. From the maintenance point of view the fault rate also shows a somewhat similar steady improvement over electro-mechanical equipment. Moreover the number of occasions on which a fault report results in a "Right when tested" clearance is gratifyingly small—to a maintenance engineer this is good because it indicates that the maintenance staff are able to locate the majority of troubles as they occur. An elusive fault is therefore less likely to give repeated trouble over an indeterminate period.

It might be thought that electronic equipment would be more difficult than electro-mechanical equipment for the maintenance staff to understand. This does not seem to be so once the necessary



training has been given. The principal problem appears to be that of orientation. A new entrant has little difficulty in accepting the principles and passing from this acceptance to understanding the circuit action; engineers experienced in electro-mechanical techniques tend at first to be less willing to accept the principles involved, but with a suitable training approach, and a large element of practical bench work, this difficulty soon fades and after a time there appears to be no difference between new entrants and "old hands". There is no doubt whatever that the ability to see what is happening by watching the cold cathode tubes has a special appeal to the maintenance engineer; not only does it help to locate faults, but it also encourages observation of performance which sometimes leads to earlier detection of trouble than would otherwise occur.

To give some idea of the scope of the Richmond electronic equipment: the unit on trial consists of six registers and one common translator. The table shows the numbers of components in the complete installation.

| | |
|---|---|
| Radio type valves ... ... | 280 |
| Cold cathode triodes ... ... | 750 |
| Cold cathode diodes ... ... | 940 |
| Resistors ... ... ... ... | 5,300 |
| Capacitors ... ... ... ... | 2,700 |
| Rectifiers ... ... ... ... | 350 |
| Soldered joints ... ... ... | 35,000 (approx.) |

Most of the component failures have been on valves and on cold cathode tubes, with the radio type valve being roughly 20 times as liable to fail as a cold cathode tube. The radio type valve failures have, however, been infrequent enough to be commercially acceptable—for example, many of the valves have been in operation for over 30,000 hours and are still giving satisfactory results. Nevertheless, the very much better performance of the cold cathode tubes has tended to direct development along lines which endeavour to reduce the number of radio type valves to a minimum. If the Richmond equipment was redesigned today, the number of radio type valves used could probably be reduced to a tenth of the present number. Resistors, capacitors and rectifiers have given little trouble, but enough to suggest that the ordinary commercial type of component is not yet good enough for something which, like the telephone system, must be continuously "on duty".

So far as is known, the Richmond electronic equipment is, to date, the only electronic equipment of such size and complexity to have remained continuously in operation for over three years. There is therefore a need for continued research and development of long-lived highly stable components suitable for continuous operation.

Soldered joints remain a problem. Soldering to a consistent high standard is expensive, while poor soldering leads to a high fault rate. With so large a number of joints, soldering accounts for a large proportion of the total labour costs in production, but progress is being made in two directions. First, development is well advanced towards halving the number of joints by eliminating soldering tags whenever possible and making connexions directly between the components' wires. Second, electronic equipment can now be constructed in which wiring is preformed by a process allied to printing. The designer prepares a diagram in ink of the wiring he needs; the printing process reproduces this diagram in metal (for example, copper) on a suitable insulating material; and, finally, the various components are soldered to the metal at the appropriate places. The use of printed circuits tends to reduce the cost of production. In all instances the soundness and uniformity of the soldered joints is improved by semi-automatic methods of mass soldering.

## Conclusions

The Richmond electronic director has pointed the way to further advances in the automatic telephone system. It has shown that, even with early designs, appreciable improvements are possible; with later developments in both components and circuit technique the evidence points to still greater improvements in performance.

The Richmond trial has not only confirmed the original idea about the potential usefulness of electronics in the telephone system, but has added materially to the store of knowledge and experience possessed by the Post Office Engineering Department and by the British telephone industry, which has given the fullest co-operation throughout the trial. The electronic director is, however, only a beginning and in due course we may have an all-electronic exchange. The Post Office is well to the fore in this field and, within the next decade or two, electronic equipment in the telephone switching field may well become as familiar as the present electro-mechanical equipment.

# TWO HOME COUNTIES

## *OXFORD*

High Street, Oxford, with its fine congregation of Colleges
(By courtesy of *The Oxford Mail and Times*)

The Oxford Area covers about 1,500 square miles and includes Oxfordshire and Buckinghamshire, with parts of Berkshire, Warwickshire, Worcestershire, Northants and Gloucestershire.

The industrial and market town of Banbury, with its "Cross" remembered in the nursery rhyme, is in the north. Westward is the Cotswolds, extending across the Area, with many lovely villages of local stone with its typical grey and tawny hues.

Southwards from the Cotswolds the rivers Windrush and Evenlode flow through rich pasture land and the native-bred Oxford Downs sheep are famous for fine fleeces, which account for the fame of Witney blankets.

The Thames flows south between the Chiltern Hills and the Berkshire Downs with much beautiful wooded scenery. To the south west the Downs are crossed by the pre-historic Ridgeway over the Vale of the White Horse. On the northern slopes is the Atomic Energy Research Establishment at Harwell. In the east are the Chiltern Hills amid which is "Chequers", the country home of the Prime Ministers.

West of the Chilterns lies the fertile valley of Aylesbury, nearly 15 miles wide and mainly pasture. Chair-making, an old rural industry in the Chilterns, has now developed into the manufacture of furniture concentrated in High Wycombe. East of High Wycombe the Area is mainly residential.

Coming to Oxford itself, it is 1,200 years since Frideswide founded a priory among the green meadows where the river ran shallow enough for oxen to ford it. The Anglo-Saxon Chronicle, A.D.912, first mentions a group of inhabitants in Oxford; soon after it became renowned for its university. The titular college, University, was the first to house scholars under its own roof, but it did not acquire status until 1280, although Balliol was endowed in 1263 and Merton has an even stronger claim to the greatest antiquity. Perhaps the College which most captures the imagination is Christchurch, founded by Cardinal Wolsey. Telephone House is quite near to the fine Tom Gateway, surmounted by the tower in which "Great Tom" still sounds 101 bell strokes each night at curfew. Neighbouring Cowley has become a centre of the motor car industry.

The Area has 120 exchanges (102 are automatic) and there are 42,593 exchange connections and 74,370 stations. The total staff (excluding telephonists) is 964.

*Left to Right:* D. H. S. SIMPSON, E.R.D., Chief Telecommunications Superintendent; R. C. SUCH, Area Engineer; Miss B. KNIGHT, Secretary; A. D. V. KNOWERS, Telephone Manager; R. B. FAZACKERLEY, Chief Clerk; C. E. WERRY, Senior Sales Superintendent; P. R. C. GERRY, A.M.I.E.E., Area Engineer.

# TELEPHONE AREAS

## *TUNBRIDGE WELLS*

Tunbridge Wells Area comprising parts of Kent, Sussex and Surrey, covers 1,000 square miles between South London and the English Channel.

Residential and rural, it has a diversity of scenery from grazing sheep on chalk downs to hop gardens and orchards on Wealden Clay. Luxurious spring-time blossom brings inevitably to mind that hackneyed phrase "the Garden of England".

Nearly 900 years ago William, Duke of Normandy, landed at Hastings (now the largest town in the Area) for his conquest of England. In 1940 much of the Battle of Britain was fought overhead and the Area became part of the "bomb alley" through which the Germans flew to attack London. But in 1944 the Area was much used in preparations for the return journey—the invasion of Normandy on the way to Berlin.

The Pantiles, 18th Century fashionable promenade, attracts 20th century shoppers

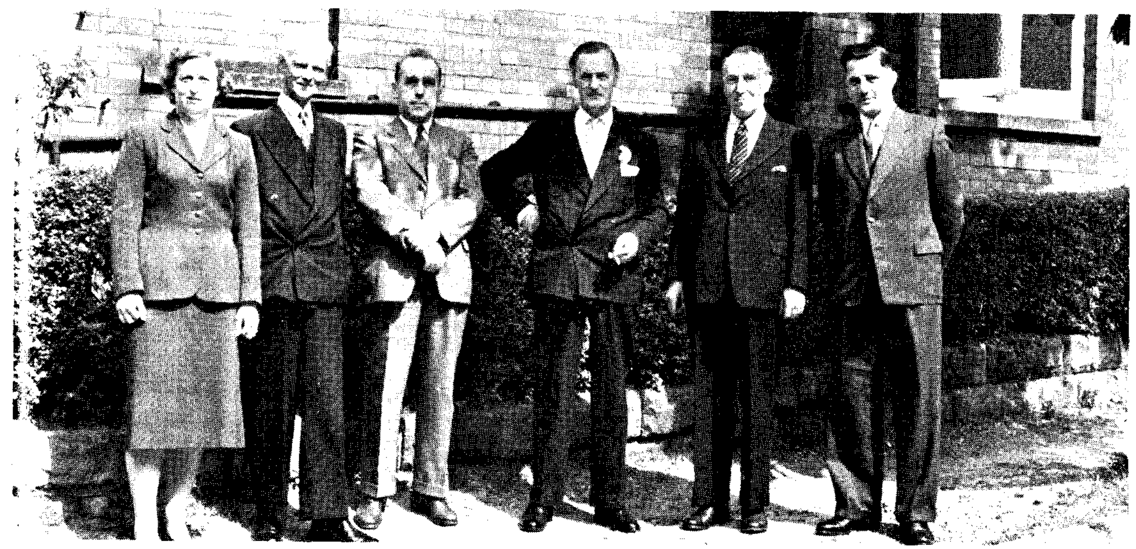
Hastings, which is one of the five ancient Cinque Ports, is a thriving seaside resort. Rapid post-war recovery has more than doubled the number of telephone subscribers since 1945. The medieval atmosphere of neighbouring Rye attracts tourists and artists, and Bexhill near by has many private boarding schools and is popular for family holidays. Post-war residential development has been heavy.

The Area office town, Tunbridge Wells, recalls the days of Beau Nash, and the Dandies taking the waters and promenading on the famous Pantiles; but the town, with its Georgian buildings and extensive commons, is still popular as a place of residence for people working in London. Industry, including extensive printing works and important railway interests, is at Tonbridge, which is also a market town. A municipal telephone system was operated in Tunbridge Wells until absorption by the National Telephone Company.

Development in the Sevenoaks district to the north of the Area, is rapid; British Railways electric services terminate here and new building estates are presenting problems.

East Grinstead, the other centre of population in the Area, is famous for its plastic surgery centre. Bomb damaged buildings have been restored and there are many new building estates. Neighbouring Ashdown Forest is especially popular when autumn tints prevail.

The 54,110 exchange connections and 78,588 stations in the Area are served by 107 exchanges, of which 2 are manual. The total staff (excluding telephonists) is 899 and annual revenue £1,150,000.



*Left to Right:* MISS B. E. NEAL, Secretary; J. McL. HAMILTON, Chief Telecommunications Superintendent; L. W. BARRETT, Area Engineer; E. W. GILLETT, Telephone Manager; V. C. L. HOLLAND, Senior Sales Superintendent; J. L. CHESHIRE, Chief Clerk.

# Relays for the All Scotland Crusade, 1955

*H. J. Revell, B.Sc.(Eng.), A.C.G.I., A.M.I.E.E.*
*Glasgow Telephone Area*

In October, 1954, the All Scotland Crusade Committee—an interdenominational body responsible for organizing the Billy Graham campaign in the Kelvin Hall, Glasgow, from March 21 to April 30 this year—told the Telephone Manager, Glasgow, that during the latter half of the campaign relays would be required to various centres in Scotland. At about the same time the Evangelical Alliance, with headquarters in London, which had been responsible for organizing the relays from Harringay (London) in conjunction with the Post Office in 1954, had told the Inland Telecommunications Department that relay facilities would be required to various centres in the United Kingdom. From experience gained in 1954, the Subscribers' Services Branch of the I.T.D. drafted a procedure for consideration.

It was agreed that the arrangements for the relays from Kelvin Hall would be co-ordinated by the Telephone Manager, Glasgow, to whom the All Scotland Crusade Committee and the Evangelical Alliance would be responsible for all payments to the Post Office on behalf of the organizers of the meetings throughout the country.

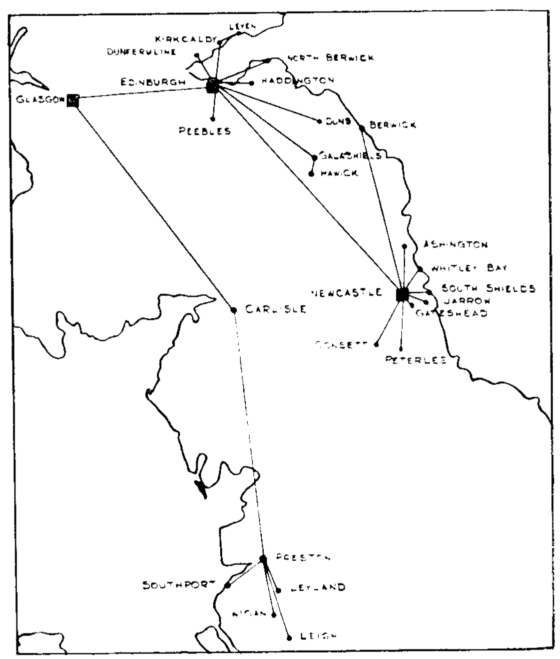
It soon became clear that the relay arrangements would be extensive and complicated and that practically all divisions of the Glasgow Telephone Manager's Office would be involved at one point or another; the whole programme was therefore co-ordinated by the Deputy Telephone Manager.

As it might be difficult to release public trunk circuits to some of the more isolated communities interested in the relays, arrangements were made for the initial enquiries from such places to be referred to the appropriate Telephone Manager's Office for transmission to the Telecommunications Branch at Headquarters, Scotland, and to the Planning Branch of the Inland Telecommunications Department to see if trunk circuits could be released. Headquarters authorized releases for relays to several of the Scottish islands because it was realized that in a small island community it was probable that a large part of the population would be attending the relay centre, that telephone traffic would be light during the relay and that all the relays were taking place outside the holiday season.

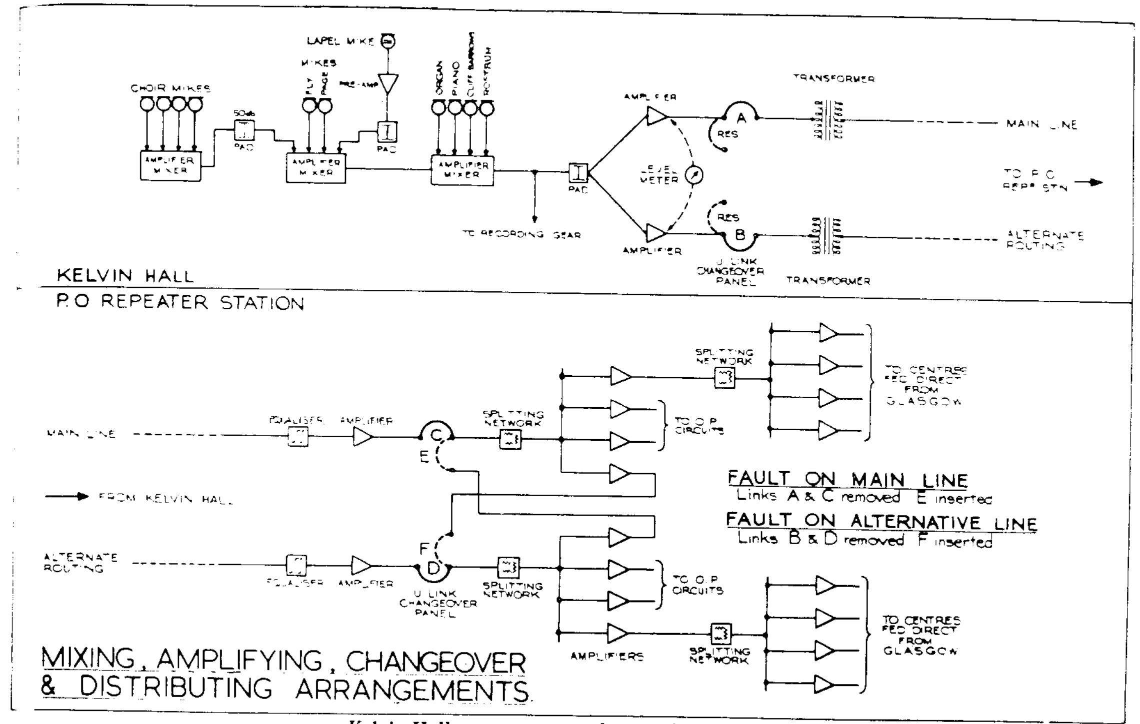
After certain points of detail had been settled, the Subscribers' Services Branch of the I.T.D. issued an instruction on February 10 to all Telephone Managers giving general procedure for the provision of relay services. For example, if a relay was required at a town in England or Wales, the chairman of the local interdenominational committee would apply to the Evangelical Alliance, which would send full details to the Sales Division of the Glasgow Telephone Manager's Office. After this, advice was sent to the Sales Division of the Area concerned, the Engineering Department, the local Circuit Provision Control and the officer in charge of Glasgow F Repeater Station, which was to be the focal point for receiving transmissions direct from Kelvin Hall and distributing them over the relay network.

The programme was in two parts: from April 11-16 the relays were to 30 centres in Scotland, and from April 18-30, when relays went to all

Diagrammatic map showing typical "clustering" of lines for relay purposes






Kelvin Hall arrangements shown schematically

parts of the United Kingdom and the Irish Republic. In all, 662 relays to centres (covering 325 meetings) were ordered.

To transmit the programme from Kelvin Hall to a relay centre it was necessary to have:

(*a*) *At Kelvin Hall*—microphones in the auditorium feeding into special amplifiers where the outputs from the various microphones could be "mixed" to produce a programme properly balanced between instruments and choir, while maintaining natural quality of speech and music.

(*b*) *Between Kelvin Hall and the relay centre*—a high grade circuit capable of transmitting the programme material fed into the line at Kelvin Hall and amplifying it as it passed along the line.

(*c*) *At the relay centre*—public address equipment capable of receiving the transmitted programme, amplifying it and making it audible through loudspeakers.

Responsibility for the installation in Kelvin Hall was shared between a Glasgow firm and the American Broadcasting Corporation. The circuit between Kelvin Hall and the relay centre was the sole responsibility of the Post Office, while various public address equipment engineering firms were responsible for the equipment at the relay centre.

The arrangements made at Kelvin Hall are shown in schematic form. All the microphones, with one exception, were of the ribbon type, noted for its good frequency response, lack of background noise, robustness and reliability. Dr. Graham uses a special lapel microphone of the condenser type (clipped to his tie) during his addresses to give him freedom of movement about the rostrum. This microphone required an amplifier in close proximity to pick up and boost its relatively weak signals.

Physical connexion to the Post Office lines was made by way of special isolating transformers which prevented any varying line conditions from affecting the equipment. It will be seen that two separate lines (each comprising a pair of wires) in different cables and by alternative routes were used to connect Kelvin Hall with the Post Office Repeater Station, and the programme was transmitted simultaneously over both lines. Arrangements were made by U-link panels at Kelvin Hall and the Repeater Station whereby a fault on one of the lines could be dealt with by change-over of U-links, the programme then being fed over the remaining good line with only momentary interruption of service to half of the relay centres. At the Repeater Station the programme was distributed by way of individual amplifiers to the various circuits.

It was impracticable to have separate lines from Glasgow to every individual relay centre and this difficulty was overcome by passing the programme over circuits connecting Glasgow with certain main communication centres throughout Great Britain. A permanent network of high grade occasional programme (O.P.) circuits has been in existence for several years, and is used, when required, for transmitting outside broadcast programmes for the B.B.C.

The diagrammatic map shows the method for "grouping" or "clustering" local relay centres on to the line at the main centre: for example, the Glasgow-Newcastle circuit was used at Newcastle to supply a number of other towns within a reasonable radius over Post Office trunk telephone circuits. Certain towns in the west of Scotland were fed individually and directly from Glasgow.

Each relay centre had to be connected to the nearest Post Office telephone exchange by a pair of wires; in some places where a telephone existed in the church or hall this line was used for the period of the relay. Thus each auditorium was connected by line through its nearest exchange to the appropriate distributing centre. To prevent a fault on one line of a "cluster" interfering with the other lines, special isolating arrangements were made at the main centres, and at each auditorium connexion to the public address equipment was made by transformers.

An even more complicated arrangement was made on April 25 when, by a circuit between Bangor in north Wales and Kelvin Hall, the singing of a choir in Bangor was transmitted over the public address system in Kelvin Hall and passed from there back over the complete relay network, providing a two-way exchange programme between Scotland and Wales.

That the whole relay programme was so successful is a tribute to the painstaking skill of the Post Office staff concerned and the many public address equipment agencies who co-operated so wholeheartedly in this complicated project.

## Some Statistics of the Inland Telecommunications Service

| | 31st March, 1953 | 31st March, 1954 | 31st March, 1955 |
|---|---|---|---|
| *The Telephone Service at the end of the Year* | | | |
| Total telephones in service | 5,927,000 | 6,146,800 | 6,491,100 |
| Exclusive exchange connections | 2,998,700 | 3,027,200 | 3,089,600 |
| Shared service connections | 592,200 | 724,400 | 917,500 |
| Total exchange connections | 3,590,900 | 3,769,600 | 4,007,100 |
| Call Offices | 61,800 | 64,100 | 66,227 |
| Automatic exchanges | 4,383 | 4,494 | 4,576 |
| Manual exchanges | 1,507 | 1,419 | 1,351 |
| Orders on hand for exchange connections | 427,200 | 376,100 | 371,600 |
| *Work completed during the Year* | | | |
| Net increase in telephones | 210,000 | *269,000 | *355,000 |
| New exchange connections provided | 417,000 | 464,000 | 410,000 |
| Net increase in exchange connections | 127,900 | 178,700 | 237,500 |
| | *Millions* | *Millions* | *Millions* |
| *Traffic* | | | |
| Inland telephone trunk calls | 264 | 278 | 306 |
| Cheap rate telephone trunk calls | 66 | 70 | 77 |
| Inland telegrams (excluding Press and Railway) | 35 | 33 | 25 |
| Greetings telegrams | 6 | 6 | 5 |

* This is the difference between the gross new and the gross ceased. The difference between the telephones in service at 31st March, 1953, and 31st March, 1954, and between 31st March, 1954, and 31st March, 1955, does not equal the net increase because the number in service at 31st March, 1954, and 31st March, 1955, has been adjusted as a result of a special check of working telephones. This is being made in conjunction with a change in statistical procedure.



# "Service and Staff" in the Traffic Training School

*P. H. Paul. A.M.I.I.A.*

*Inland Telecommunications Department*

W. H. DAVIES RIGHTLY WROTE:—

*"A poor life this if, full of care,*
*We have no time to stand and stare".*

No doubt he was thinking of our off duty hours, but top level executives in industry are increasingly complaining that they have no time to stop and think. The pressure of day-to-day business is so heavy that they have little opportunity to stand back and view their responsibilities in relation to the overall plan, and the quality of their work suffers in consequence.

This is no less true of the public services, and part of the justification for arranging training courses for experienced men is to provide them with the opportunity to stop the daily round, and to think about it away from the distraction of the "IN" tray and the telephone. This applies not only to the people right at the top, but in varying degrees to staff at lower levels.

One object of the Service and Staff course at the Traffic Training School is to provide just that opportunity for traffic people on service and staff work. Besides its varied responsibilities for initial training, the Traffic Training School has, from time to time, arranged specialist courses designed to impart new techniques and to freshen old ones. These have been mainly on the equipment and lines side, although the need for something similar for those intimately concerned with the day-to-day running of exchanges has long been recognized. Much preliminary work had been done, but it was not until a year ago that a start could be made. Since then, ten courses have been held and the reception given to them has been most encouraging.

Although Regional officers are not excluded, the course has been designed primarily for traffic men and women having responsibility for service and staff work in Telephone Areas.

In common with similar courses it consists of a nice mixture of lecture, case study and syndicate work and extends over two weeks. Syndicate work is merely a high sounding name for a type of group discussion in which the members of the course are divided into groups, and as groups discuss a set problem. Each group subsequently presents its report at a conference of the whole course presided over by the School Principal when further discussion takes place.

To ensure that the exchange of experience in discussion is as wide as possible the course is divided into four groups of four, each group being selected to contain a suitable admixture of experience, and to have within it representatives from different parts of the country. Two groups combine to form a syndicate, the combination being varied for successive problems. Everyone has two assignments, as Chairman and as Secretary, and this provides further valuable training for the less experienced members.

A typical arrangement would be:—

| GROUP A | GROUP B | GROUP C | GROUP D |
|---|---|---|---|
| Brown (London) | Jones (London) | Clark (London) | Bull (London) |
| Green (Glasgow) | Robinson (Lincoln) | Fowler (Norwich) | O'Shea (Belfast) |
| Black (Bristol) | Smith (Manchester) | Ramsbottom (Bradford) | Macsporran (Aberdeen) |
| White (Stoke) | Johnson (Southend) | Widdicombe (Exeter) | Griffiths (Cardiff) |

| SYNDICATE PROBLEM NO. | SYNDICATE NO. 1 | SYNDICATE NO. 2 |
|---|---|---|
| 1 | AB<br>Chairman: Green<br>Secretary: Johnson | CD<br>Chairman: Macsporran<br>Secretary: Widdicombe |
| 2 | AC<br>Chairman: Clark<br>Secretary: White | BD<br>Chairman: Smith<br>Secretary: O'Shea |
| 3 | AD<br>Chairman: Griffiths<br>Secretary: Green | BC<br>Chairman: Ramsbottom<br>Secretary: Jones |

This looks simple to arrange but complications set in by the time one arrives at the later combinations: one must ensure, for instance, that some do not get away with one job while others have three, and that two London people are not Chairman and Secretary of the same syndicate. Knowledge of our customers as well as knowledge of the subjects is necessary for the best arrangement.

An unusual feature is the mixing of the grades, each course consisting of two Chief Telecommunications Superintendents, four Senior Telecommunications Superintendents and ten Telecommunications Traffic Superintendents. Eyebrows were lifted a little when this was suggested, but in practice it has worked very well and bringing the different grades together on a common footing in syndicate discussions has done much to ensure the success of the courses.

The purpose of the training is essentially practical. G. L. Williams, writing in *Venture* on courses of study in public administration, said "Academic studies and practical experience must be brought closer together if these courses are to provide a satisfying and stimulating experience".

Theory there must be, for sound theory is essential to the best practice but it must be theory with its feet firmly planted on the ground. Lectures on theoretical subjects are, therefore, part of the course, but the lecturer's aim throughout is to show how the theory can be applied to the job. Each student has the opportunity in the subsequent discussion to relate it to his own particular problems, and syndicate work provides a further opportunity for theory and practice to be inter-related.

The main theme of the course is "Quality Control", chosen to express in two words the main purpose of traffic service and staff work, for traffic staff are primarily concerned with the quality of service given to the public and the means by which the quality may be controlled and brought to the highest pitch commensurate with reasonable economy. The theme is broken down into five divisions, quality control by organization, planned staffing, training, staff management and sampling and investigation. In each division there are talks by specialists, who subsequently offer themselves for grilling by the members of the course, and syndicate studies.

In "Quality Control by Organization", for example, a Telephone Manager talks on the traffic man's place in the Area organization and there are two talks on the principles of organization and management. Later in this course members study in syndicate the problem "Managing the Service and Staff Job" and are able to argue over the theory they have learned and its application to their own job.

Similarly there are lectures on statistics and on developments in service observations in the division "Sampling and Investigation", followed by a syndicate discussion on the uses and interpretation of service observations.

Traffic staff have responsibility for the efficient staffing of telephone exchange switchboards and following a talk on the theory and practice of exchange staffing discuss in syndicate the problems involved in the determination of staffing requirements for both operating and non-operating duties.

The training division of the course consists of two lectures and a syndicate study on the improvement of refresher training in telephone exchanges.

By far the largest division of the course is on staff management. Many people think that "management" is a much overworked word today, but it is one we cannot escape. E. F. L. Brech said recently that "management is a social process entailing responsibility for the work of others".

Although the word appears in the title of few grades in the Post Office many others come within the scope of Brech's definition. Executive grades in the clerical, engineering, sales and traffic divisions all have some management functions and



need to know how best they may be exercised.

For this part of the course an industrial psychologist is first brought in to set the stage with two talks on human behaviour and the attainment of effective co-operation in industry. This refreshing contact with the outside world promotes plenty of thought which can be later turned to good account in sessions on interviewing, welfare, staff relations and discipline as well as in a syndicate study on supervision.

It has been said that the appraisement of his subordinates is the most important job any executive or supervising officer has to do. When it is remembered that one may start one's Post Office service right at the bottom of the ladder, and finish very near the top there is obviously a good deal of truth in the statement. Consequently three periods are devoted to the study of appraisement technique and the promotion machinery, including a practical exercise in appraising an imaginary officer from a word picture. While this is not claimed to be a perfect method of instruction it is thought-provoking and even the clash between those who give the subject a clean bill of health for any traffic job and those who think he will be useful only at Headquarters may have its purpose.

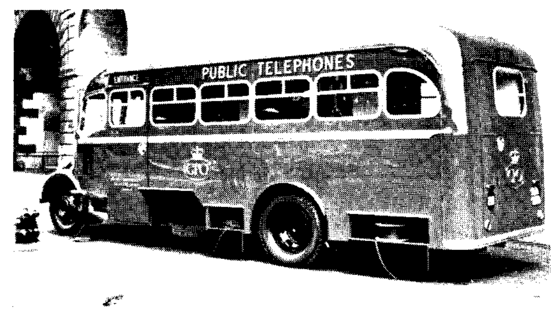
These glimpses of the Service and Staff course can, however, give very little indication of its atmosphere. The course is run as informally as possible, but there is no mistaking the intent of the students to get as much out of the two weeks as they can. The keenness of discussion following lectures is a clear indication that the lecturer's thesis has been closely followed. In syndicate, discussion often waxes hot, though all in good part and syndicates have frequently to be reminded that their time is up. In fact, one might say, following the fashion of Mrs. Beeton, take sixteen traffic men of assorted ranks from all regions, mix well together for two weeks and you have the ideal recipe for good companionship, good fun and hard work. While it is sometimes a matter of regret that the course is not residential, every effort is being made to minimize this deficiency by using to good effect every minute of the time the students are together.

Looking back over these early courses, perhaps the most satisfying feature has been the sincerity and enthusiasm with which the venture has been received; so much so that there is no doubt whatever that real and lasting benefits will accrue, not only to the students themselves, but to the telephone service generally.

# First Mobile Call Offices Launched

The first group of public telephone call offices on wheels in this country was driven in June from London to Norfolk to open for service at Norfolk Agricultural Show. Its official name is the "Mobile Telephone Unit" or "Mobile Call Office Unit"; colloquially and popularly it might well become known as the "Telebus".

Although the new unit started service at an agricultural show, it was planned and has been built primarily for providing telephone service in emergencies. Within a few seconds of the Harrow railway disaster in October, 1952, the telephone services in the neighbourhood were congested with calls for doctors, medical supplies, ambulances and hospitals, and by control calls from the railway people and the police. The Post Office then realized that a mobile unit, containing several call boxes which could be rushed to such scenes and plugged in, would be immensely valuable.




The Engineering Department Motor Transport workshops at Kidbrooke acquired a Bedford chassis from a disused coach. They rebuilt the coach, modernising the overall lines and making booths for telephone positions, which can be used either on a direct exchange line or a coin box basis, with cupboard space for components, and they installed interior lighting, two ventilating fans and treated the walls and ceilings with sound-absorbing material. Stabilising rods were fitted to reduce movement and bounce.

The London Power Section workshop panelled the rest of the interior with "Wearite" and provided cushioned seats in the booths, and the London North Area Telephone Manager's installation staff fitted telephone wall boards and a switching panel.

Finally, the coach was painted and embellished—

Post Office red, gold and black—in the Engineering Department's workshop at Yeading.

By key switching in the attendant's booth, the telephones can operate to C.B. manual or automatic exchanges, including unattended automatic exchanges (except type Nos. 5 and 6); C.B.S. and magneto working are not catered for. The attendant's booth contains a telephone for service to the exchange staff.

When the coach arrives on the spot, a 15-pair polythene cable will be laid overground to the nearest permanent line plant. More than 60 yards of cable are carried.

Power for interior lighting, and for driving the ventilator vans is drawn from the car battery, which is considerably larger than would be needed merely for starting and exterior lighting. A small charging set is included for the larger charging rate. An A.C. mains source, instead of the 12-volt battery, can be used for lighting and ventilation.

The vehicle is exceptionally neat and compact. The overall length is 24 ft. 6 in., and the width 7 ft. 6 in. The wheel base is 14 ft. 8 in. long and 7 ft. wide.

The unit will work in the London Telecommunications and Home Counties regions. It will attend such events as agricultural shows only when not called on for emergencies but, should the need arise, it can be pulled out and rushed at once to the scene.

# NOTES and NEWS

Colonel Read

Colonel Alfred Howard Read, C.B., O.B.E., T.D., who was Director of Overseas Telecommunications of the Post Office, and for some time a member of the *Journal* Editorial Board, has been awarded the Marconi Memorial Medal of Service. The Medal is presented by the Veteran Wireless Operators' Association (U.S.A.) for long and distinguished service to telecommunications.

Colonel Read, who retired from the Post Office in 1954, is now Telecommunications Attaché to the British Embassy in Washington. Educated at Birkenhead Institute and Liverpool University, taking a degree of Master of Engineering, electrical and mechanical, he joined the Post Office in 1922 as Assistant Inspector of Wireless Telegraphy. Among other duties he was instrumental in establishing Rugby Radio Station and the "beam" services to the Dominions and India. After service in the 1939 world war he returned to the Post Office, becoming Inspector of Wireless Telegraphy. In 1947 he was appointed Deputy Regional Director, London Telecommunications Region, and three years later became Director of Overseas Telecommunications.

★ ★ ★

**International Television.**—At least one and probably more regular weekly exchanges of programmes between Britain and the Continent will start in the autumn. The first section of a permanent link—a two-way coaxial cable circuit between London and St. Margaret's Bay, Kent, will be completed in September. The next section, a two-way radio link across the Channel, is due to be completed in 1958. Meanwhile the cables will be extended from St. Margaret's Bay to Swingate, near Dover, where the B.B.C. and Radio-Diffusion-Télévision Française will provide and operate a temporary two-way radio link with Cassel, Northern France.

★ ★ ★

**Northern Ireland Television.**—The new medium power transmitter on Divis Mountain, near Belfast, which serves a wider area than the temporary transmitter at Glencairn, was opened in July, several months ahead of schedule. It is 1,750 feet above sea level and serves a million people—two-thirds of Northern Ireland. A supplementary transmitter for the north-west will be added at Londonderry next year.

★ ★ ★

**Hoist with own Petard.**—Sir Robert Watson-Watt, inventor of radar, was fined £4 10s. in Canada for speeding. He was picked up by a radar speed trap, which is extensively used in Canada.