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The HS-303 Communications Satellite Project

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The first communications satellite planned to carry regular commercial telephone traffic is expected to be launched in the spring of 1965. This article briefly describes the satellite itself and the associated system design, the modifications necessary at the United Kingdom earth station at Goonhilly, and the way in which the various earth stations will inter-work.

INTRODUCTION

It is expected that the HS-303 communications satellite will be launched early in the spring of 1965. It is the first satellite planned to carry telephone traffic on a regular and commercial rather than on an occasional and experimental basis.

The satellite will be placed in synchronous orbit; that is, it will be at a height of approximately 22,300 miles, travelling in eastwards sense and, therefore, having an orbital period closely equalling the period of rotation of the earth. It will not, however, be geostationary, for the orbital plane will have a modest inclination to the equatorial; probably some 13°. The longitude of equator crossing will be about 27° 30′ W, so the satellite will remain constantly visible to earth stations on each side of the North Atlantic Ocean; its track as seen from an earth station will appear as a narrow figure-of-eight with an inclination to the horizontal depending upon earth-station location.

The satellite is being built by the Hughes Aircraft Company to the order of the Communications Satellite Corporation of the U.S.A. It represents the first phase of "space sector" development to be undertaken under the auspices of the International Agreement* signed in August 1964, and is designed both to gain experience of commercial acceptability of the synchronous-orbit satellite, and to augment traffic facilities on the North Atlantic routes by providing up to 180 circuits. The British Post Office Engineering Department and its counterparts in certain other European countries have had the opportunity to play a part in the overall system design from the inception of the project, and representatives of the Space Communication Systems Branch of the Engineering Department have been present at all of the relevant international discussions held at capitals in both the U.S.A. and Europe.

†Space Communication Systems Branch, E.-in-C.'s Office.

*The Post Office and Satellite Communications. *P.O.E.E.J.*, Vol. 57, p. 191, Oct. 1964.

THE SATELLITE

The satellite will be in the form of a cylinder 23¼ in. long and 28¼ in. diameter, the microwave communication aerials being an axial boom on one end. The total weight will be rather less than 85 lb.

Fine control of position and attitude of the spinning satellite is accomplished by jets of hydrogen-peroxide released under command from the ground. The velocity-control jet is radial and thrusts through the centre of mass of the satellite. From observations made on the ground it is possible to determine the precise position and attitude of the satellite; if it is necessary to alter the velocity of the satellite in a particular direction then the velocity-control jet is caused to operate each time the mouth of the jet is opposite to the direction in which it is desired to give the satellite an increment of velocity. The attitude control jet is parallel to, but offset from, the axis of the satellite; it is pulsed once per satellite revolution under ground control whenever the axis of the satellite needs to be tilted.

The thrusts given by the control jets are, of course, very small, but they can be continued for considerable periods of time if much correction is required. It is indeed remarkable that the small and quite brief "puffs" can position the satellite so accurately, but the method has already been demonstrated in the SYNCOM series of satellites; for example, SYNCOM II was positioned so accurately that its angular velocity in orbit was equal to that of the earth to within 0·014° per day and the spin axis was within 1° of the design value. When perturbing forces cause unacceptable wander, tilting or precession, correction can be effected under ground command.

Power supply for the HS-303 communication equipment, command-signal receiver, telemetry transmitter, and operation of the jet valves, is obtained from n-on-p silicon solar cells protected by 0·012 in. cover plates of fused silicon quartz. A secondary battery of nickel-cadmium type is also provided, but this is large enough only to ensure that the command and telemetry facility is maintained when the satellite is in eclipse; it is not large enough to sustain the communication equipment. Fortunately, the satellite will eclipse for only up to 70 minutes at around local midnight on certain nights on either side of the autumnal and vernal equinoxes and at times when loss of circuits can be tolerated.

The telecommunications equipment carried by the

A

satellite incorporates two sensibly independent frequency translators, each having a bandwidth of 25 Mc/s and feeding a common-output travelling-wave valve; there is a spare travelling-wave valve that may be brought into service under ground command should the first fail. Frequencies in the 6 Gc/s band are used for transmission from earth stations to the satellite and in the 4 Gc/s band for the satellite-to-ground direction of transmission. The satellite aerials are so constructed, and the attitude of the satellite so arranged, that there will be aerial gain in the direction of earth stations in the north-east of North America and in the west of Europe.

SYSTEM DESIGN

As is well known, the higher the orbital altitude of an earth satellite of given mass the greater is the thrust required of the launching vehicle. It follows that the size, weight and power of the telecommunications equipment must be kept down to the minimum consistent with being able to obtain the desired circuit capacity. This means that the radio-frequency power level at the input to the satellite must be as high as possible and the output radio-frequency power as low as possible. The corollary is that, at the earth stations, the output power and transmitting-aerial gain must be high, the receiving aerial have the largest possible signal-collecting area at the maximum attainable efficiency, that the minimum possible noise be added to the received signal, and that use be made of demodulators capable of generating a baseband signal-to-noise ratio far in excess of the received carrier-to-noise ratio. Experience gained as a result of preparations for, and working with, the TELSTAR and RELAY experimental satellites is serving in good stead, and only relatively modest refinements and equipment changes are necessary to make the United Kingdom earth station at Goonhilly suitable for working to the new satellite.

Design philosophy has been based on providing for a maximum of 240 telephony circuits. However, for the reasons mentioned above, margins are unavoidably small: at best, the margin between an acceptable and an unacceptable signal as received at the various earth stations will be only about 4 db, and small changes between the design and achieved performance of both satellite and earth stations could affect considerably the actual number of circuits obtained. It is considered at this time that the most likely capacity will be 180 circuits.

MODIFICATIONS AT GOONHILLY

It will be recalled that the existing aerial at Goonhilly, together with the associated radio equipment, was designed and built in the period 1961 to mid-1962 to meet the characteristics of the experimental TELSTAR and RELAY satellites. These satellites are in relatively low elliptical orbits. In contrast, the HS-303 satellite will be in an extremely high circular orbit, will transmit only the same order of carrier power, will be available on a full-time as distinct from part-time basis, will have a low as distinct from high angular velocity relative to the ground, and will, it is expected, carry commercial traffic. In addition, it will use radio carrier frequencies differing from those appropriate when working to the TELSTAR and RELAY satellites. It follows that changes have to be made to the station to make it suitable for working to the HS-303 satellite. Operations with the TELSTAR and RELAY satellites were suspended at the end of August 1964, and it is the aim to have the station ready to work to HS-303 before the end of February 1965—a task no less formidable and strenuous than the original building of the station.

The modifications to and re-equipping of the station are being engineered by the Engineering Department's Space Communications System Branch and the Microwave, Space Systems and Maser Division of the Research Branch. United Kingdom industry will once again play an important role: modifications to the aerial structure itself have been planned in co-operation with the Consulting Engineers, Husband & Co.

The original steerable aerial at Goonhilly is being modified in order, in the first place, to achieve gain improvements of 1 or 2 db (the gain already approaches 60 db), and gather information that will be of great value when finalizing the design of the second large-aperture aerial. Some changes are also necessary to ensure the required performance when the aerial is moving only very slowly following a satellite in synchronous orbit.

The aerial is being equipped with a new reflecting surface which will be of greater focal length than used previously, and with a new form of feed-support structure designed to give reduced obscuration and scattering of both transmitted and received radio signals. The reflector proper will be of stainless steel and will be adjustable (if necessary, automatically) by means of peripheral jacks. It is hoped that the degree of departure of the reflector surface from the theoretical paraboloid will not exceed $\pm 1/20$ in., for such a surface would not only result in improved efficiency but also in a reduction of aerial-noise temperature.

The gear ratio of the elevation drive is being reduced, and the aerial steering mechanism is being modified to accommodate input data presented at 10-minute rather than 1-minute intervals.

A new feed is to be provided consequent upon changes of radio frequency and change of the focal-length-to-diameter ratio of the aerial, and upon the fact that radio transmission will involve linear rather than circularly-polarized signals.

To reduce power loss between the high-power transmitter and the feed, and to improve the noise temperature of the receiving system, over-moded waveguide is to be used between the feed and the transmitter and receiver cabins.

New masers—worker and stand-by—are necessary because the satellite-to-earth carrier frequency is not the same as that used for the TELSTAR and RELAY experiments. Opportunity is being taken to make use of a superconducting magnet instead of a large permanent magnet.

The power of the transmitting valve as used in the TELSTAR experiments has been increased from 5 to 10 kW; this has necessitated the use of a ceramic output window, and the design of this is due, as was the design on the unmodified valve, to the Signals Experimental Research Laboratory. The modified valve has already been tested at Goonhilly and found satisfactory, though the enhanced power adds to the difficulty of designing the output feeder and maintaining it in such a condition that the risk of generating arcs is minimized.

The carrier-to-noise ratio of the signal received from the HS-303 satellite will be such that a normal type of limiter-discriminator demodulator would be unsatisfactory; worker and stand-by frequency-modulation negative-feedback demodulators are therefore being provided, these being slightly improved versions of equipment that proved very successful in the course of experiments made when range and attitude conditions resulted in TELSTAR and RELAY producing very low carrier-to-noise ratios.

EARTH STATIONS

It is likely that the following earth stations will be used. In North America:

Andover, Maine, U.S.A.
Mill Village, Nova Scotia, Canada.

In Europe:

Goonhilly Downs, Cornwall, United Kingdom.
Pleumeur-Bodou, Brittany, France.
Raisting, Bavaria, Germany.
Fucino, near Rome, Italy.

Of the above, all but Fucino have large-aperture aerials and low noise-temperature receiving equipment. The size of the aerial and the power of the transmitter at Fucino are being increased, but the characteristics of the modified station will be such that it will not be able to deal with appreciably more than 36 circuits. Andover, Pleumeur-Bodou and Goonhilly are, of course, stations of long standing; both Raisting and Mill Village are new: the former was brought into experimental use during the last quarter of 1964, while the latter is expected to be ready in the second half of 1965.

The design of the two transponders and common output stage in the satellite is arranged so that if one of them is receiving carriers from two earth stations in simultaneous operation then the total capacity of the system is seriously reduced. It is planned, therefore, that, at any one time, only one European and one North American earth station will be in use; for example, Goonhilly might be carrying traffic with Pleumeur-Bodou acting as a staffed stand-by station ready to take over the load should a failure occur at the working station, while Raisting would be undergoing any maintenance that might have been found necessary. Operating the stations in this way has the merit that, while each station gathers experience of working with satellites under operational conditions, at none of them is it necessary to provide the complex of spare plant (including aerials) that would be necessary were each station operated independently.

It is likely, at least initially, that this grouping of the larger European earth stations will be operated only for 8–12 hours per day, i.e. during the periods of heavy traffic demand. It is possible that the lower-capacity station at Fucino will be used at other times. Of course, should there be a massive interruption to the trans-atlantic cables then the earth stations could remain in sensibly full-time operation.

ASSOCIATED TERRESTRIAL NETWORK

Each of the European earth stations either is, or is being, connected with its national switching centre: Goonhilly to London, Pleumeur-Bodou to Paris, Raisting to Frankfurt, and Fucino to Rome. It is further planned that there will be a triangular switchable network connecting London, Paris and Frankfurt, and a link between Rome and Frankfurt. By means of the network between switching centres it will be possible to re-route traffic between earth stations at times when stations have a change of function, e.g. pass from the "worker" to the "stand-by" mode, or when a fault at an earth station or on a link between an earth station and its associated national switching centre makes it necessary to interchange the worker and stand-by functions.

The existing temporary microwave link between Goonhilly and Plymouth is not suitable for carrying the equivalent of four supergroups of telephony, and is being replaced by alternative equipment. The Goonhilly to London link and, so far as the United Kingdom is concerned, the inter-switching-centre links are being provided over conventional coaxial-cable or microwave systems.

The relatively long one-way transmission delay (some 270 ms) inherent in transmission via a satellite in synchronous orbit results in a requirement for echo-suppressors of special characteristics, and it is likely that units having a performance similar to that of Bell Telephone Laboratory's BH type will be used.

Signalling over the circuits provided by the satellite link will be as appropriate to manual or semi-automatic inter-continental trunks, depending upon the type of working in use between the pairs of countries concerned. For manually-operated trunks 1,000/20 c/s signals will be sent to North America and 500/20 c/s signals will be received. Trunks operated on a semi-automatic basis will use signalling equipments in accordance with the C.C.I.T.T.* No. 5 system.

Maintenance control of the trunk circuits will be in the hands of International Maintenance Control (I.M.C.) centres and will conform with practices already regarded as standard for transatlantic operation. Maintenance speaker circuits will be required between I.M.C.s and with the various earth stations. Maintenance speaker circuits will also be required between co-operating pairs of earth stations on each side of the Atlantic; these circuits will be connected with a Control Center that the Communications Satellite Corporation is to set up in Washington. The latter linkage is required so that earth stations can be advised of the condition of the satellite and be provided with data on which aerial steering may be based.

EXPERIMENTAL PHASE

As soon as the satellite has been positioned and checked for correctness of operation, there will start a series of experiments that will not only check the performance of the various earth stations when working with the satellite but also permit final determination and optimization of such parameters as index of modulation and degree of pre-emphasis. These tests are expected to take several weeks to complete. They will be followed by traffic tests to determine the performance of circuits and to exercise the whole complex comprising the space sector, terrestrial sector, and maintenance and control network.

OPERATIONAL PHASE

If, as is hoped and expected, the experimental phase proves successful, circuits will be placed in service and there will be witnessed the taking of the next major step towards the goal that will be reached when communication via artificial earth satellite is regarded as a normal method, taking its place beside other long-distance communication techniques that are already well established.

The unknown factor is user reaction to the inherent transmission delay and the effects thereof. It is possible

*C.C.I.T.T.—International Telegraph and Telephone Consultative Committee.

that difficulties may arise if circuits have to be extended over long distances. But it is a primary objective of the HS-303 project to determine practically what role the synchronous-orbit satellite—as distinct from its counterpart in medium-altitude orbit—will play in the development of this means of communication. The results of experience will be very significant, for upon them will depend to a large degree the characteristics that will be specified for later, and probably global, satellite systems.

CONCLUSIONS

The pace of development of communication satellite techniques is truly remarkable. It is as recent as 1961 that the first proposals for experimental satellites TELSTAR and RELAY were outlined, but by mid-1962 TELSTAR was in orbit (followed a little later by RELAY) and large-capacity earth stations at Goonhilly, Andover and Pleumeur-Bodou were constructed and working to them.

It was late in 1963 that the proposal was made to produce the HS-303 system, but it is expected with great confidence that it will be in operation and carrying traffic by mid-1965. And there is equal confidence that it will be followed in 1967 by the initial stages of a fully global system.

That this rate of progress is possible is due to the great enthusiasm of all concerned; not only of our American colleagues involved in the development of the launch vehicles and the satellites, but also of all those in many countries concerned with earth stations, administration, finance, and even politics. Now to all these are added, with confidence, those whose task it is to provide the associated terrestrial networks and thereby weld satellite systems into the general everyday whole of inter-continental telecommunications.

A Wall-Mounting Version of the Switching Unit for Use with 700-Type Telephones—Plan-Set N 625, Wall

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U.D.C. 621.395.65:621:395.721.1

A switching unit is required with 700-type telephones on extension plans with inter-communication. For table telephones the unit takes the form of a plinth fitted beneath the telephone. A version of the unit for use with wall-mounting telephones is described in this article.

INTRODUCTION

A PREVIOUS article[1] described the Plan-Set N 625, a switching unit for use with 700-type telephones on extension plans with intercommunication. This plan-set is a plinth which is fitted beneath a Telephone No. 706 or 710. A wall-mounting version has now been produced for use with the Telephone No. 711,[2] an instrument which offers the facilities of both the Telephone No. 706 and the Telephone No. 710. The new item has been designated Plan-Set N 625, Wall, and the original item is now known as Plan-Set N 625, Table. The wall version, together with a Telephone No. 711, is shown in Fig. 1. Plan-sets are available in black, grey and ivory.

DESCRIPTION

The wall-mounting version of the Plan-Set N 625 provides the same facilities as the table version and, as far as possible, uses the same components. In three features, however, it differs from the table version.

The base consists of a framework and backplate connected by a double-acting hinge. This is held shut by a spring-loaded catch operated by a slide bar. To gain access to the plan-set when it is mounted on the wall the slide bar may be pressed with the blade of a screwdriver

FIG. 1.—PLAN-SET N 625, WALL, AND TELEPHONE No. 711

†Subscribers' Apparatus and Miscellaneous Services Branch, E.-in-C.'s Office.

[1]AKESTER, K. M. A Switching Unit for Use with 700-type Telephones—Plan-Set N 625. *P.O.E.E.J.*, Vol. 53, p. 242, Jan. 1961.

[2]HARVEY, F. J. A New Wall Telephone—Telephone No. 711. *P.O.E.E.J.*, Vol. 57, p. 51, Apr. 1964.

and the body slid to the right until two studs disengage from slots in the edge of the backplate. The plan-set will then swing open. To close the plan-set the studs are engaged in the baseplate, the body slid to the left and pressure applied to the hinged end to lock the slide bar.

The cord passes through the backplate and is held by a clamp. It is unusual to provide wall-mounted apparatus with a cord and terminal block, but this has been done to avoid the necessity of running several cables up the wall.

The operation of the hinge and the method of fixing the cord are shown in Fig. 2.

All keys are of translucent opal cellulose acetate butyrate (c.a.b.). When the SPK EXTN EXCH HELD and EXTN TO EXCH keys are depressed they are illuminated by a red lamp and a white lamp, respectively.

CONCLUSIONS

The only apparatus previously available to customers who required a wall-mounting switching unit for extension plans with intercommunication has been the Bell-Set No. 20, which is used with a separate telephone. On most exchange systems the Plan-Set N 625, Wall, allows the provision of a single wall-mounting unit incorporating 700-type apparatus. While the majority of customers are likely to require the table version, the wall-mounting set should prove a useful and popular addition to the range of modern subscribers' apparatus.

ACKNOWLEDGEMENT

The Plan-Set N 625, Wall, was developed for the Post Office by the General Electric Co., Ltd., under the British Telephone Technical Development Committee procedure.

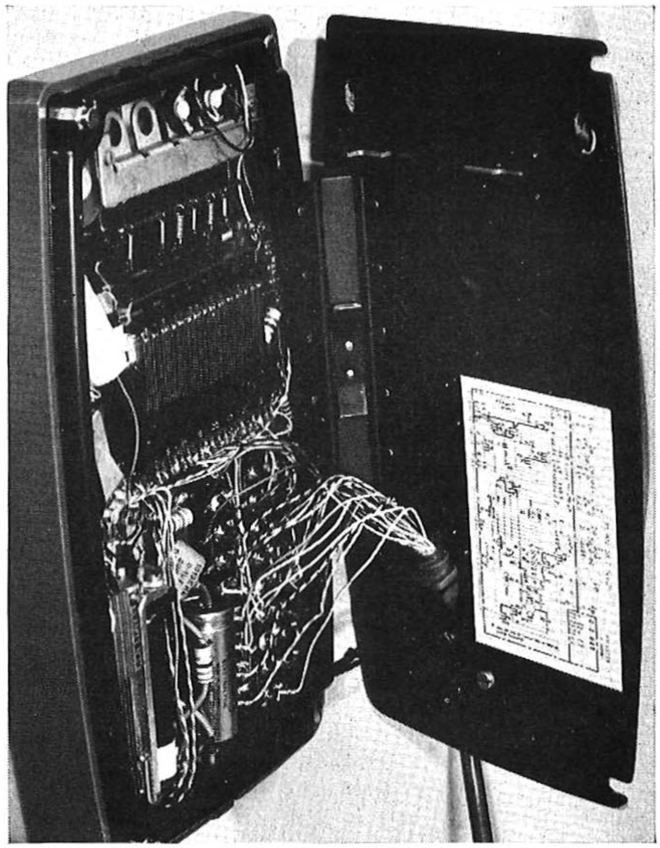

FIG. 2.—INTERIOR VIEW OF PLAN-SET N 625, WALL

Book Reviews

"Radio and Electronic Components. Vol. III—Fixed Capacitors." G. W. A. Dummer, M.B.E., M.I.E.E., Sen. Mem. I.E.E.E., M.Brit.I.R.E. Sir Isaac Pitman and Sons, Ltd. xi + 270 pp. 151 ill. 45s.

The first edition of this book came out in 1956 and its value to the practical engineer was quickly recognized.

A second edition has now been published, and it may well be, as claimed on the wrapper, the most comprehensive book on fixed capacitors yet produced. Its 13 chapters deal respectively with, classification and specification categories; formulae; coding and dielectric properties; measurement of capacitance; paper capacitors; mica capacitors; ceramic and glaze capacitors; plastic-film capacitors, electrolytic capacitors; air, vacuum, and gas-filled capacitors; special and experimental types of capacitors! dielectric-film evaporation and deposition techniques; faults; and future developments.

Since many engineers are familiar with the first edition it is interesting to compare the second with it. The format (and the price) remain the same, but by increasing the number of pages, and omitting the comparison charts of characteristics, room has been found for a new 13-page chapter on dielectric-film evaporation techniques, etc. This covers most of the evaporated capacitor dielectrics at present likely to figure in thin film circuits (or as separate capacitors) viz. silicon monoxide, silicon dioxide, glasses, lanthanum oxide, reactive sputtering of tantalum oxide, silicon nitride, and thin film deposition by glow discharge. Much of the information from the comparison charts that have been eliminated has been incorporated in the appropriate individual chapters, as has also a number of smaller additions and modernizations which describe developments that have taken place since 1956.

A substantial collection of references is given in pp. 221–266 arranged in groups in the same order of subjects as the chapters. It would be an improvement in the next edition if the references within each group were arranged in alphabetical order of authors' names to facilitate searching.

This book can be recommended to all electronic design engineers. A.A.N.

"International Series of Monographs on Electromagnetic Waves, Vol.5, Electromagnetic Scattering." Edited by Milton Kerker. Pergamon Press, Ltd. xii + 592 pp. 140 ill. 140s.

In the introduction to this volume the editor writes " . . . this does not purport to be a treatise on electromagnetic scattering but rather a collection of papers. . . ." He might have added that the papers were largely of a theoretical nature.

These limitations are enough to warn the would-be reader against expecting either a closely-knit survey of the subject or a practical guide to scattering in the communications or any other field. The volume does, in fact, contain a collection of the papers presented at the Interdisciplinary Conference on Electromagnetic Scattering, New York, 1962. Workers in widespread fields involving the theory of electromagnetic scattering took part, and the exchange of ideas and approaches which are here recorded no doubt proved valuable. This practical impact of wave-scattering on telecommunications is, however, directly reflected in only one or two of the papers included, and this volume, particularly, is of value to the physicist rather than to the communications engineer. J.K.S.J.

Portable Electric Power Equipment and Tools for External Engineering Work

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U.D.C. 621.313.12:621.9.022

Powered tools are being used increasingly to improve the productivity of the Post Office external engineering work force. The factors influencing the choice of a range of electrically-driven tools are discussed, and groups of tools applicable to three distinct types of external work are described.

INTRODUCTION

THE rigorous exploitation of powered tools and aids is an essential feature of any drive towards increased productivity. The supply of power assistance to the external engineering work force of the Post Office has been progressing with increasing momentum over many years, and until recently most of the mechanical aids provided were of the self-driven or compressed-air-driven types. A few electric tools had been introduced to operate from 24-volt lighting sets,[1] and there was a small range of heavier mains-driven tools available. Whilst there is some functional duplication between compressed-air-driven and electrically-driven tool systems, each has its place in Post Office external engineering work. Air tools generally have a superior power-to-weight ratio and are particularly useful where tool weight is a limiting design factor, e.g. in a road-breaker. On the other hand, an electric generating set is approximately a quarter of the weight and a third of the price of an air compressor of comparable power.

With the multiplicity of electric tools becoming available from industry and having application to Post Office work, there was a clear necessity for establishing, at an early stage, a co-ordinated system of electric tools and generating sets exploiting to the full their advantage of portability.

REQUIREMENTS FOR A PORTABLE-TOOL SYSTEM

The external engineering work force of the Post Office is wholly itinerant. All tools, stores and equipment have to be transported to the places of work, and sometimes carried some distance away from the vehicle, e.g. to the top of a multi-storey building. Portability of every item in the system is thus of prime importance and has constituted a limiting design consideration for generating equipment. The weight of any single item of equipment has, therefore, been limited to that which can be conveniently lifted by two men.

With staff working sometimes at a long distance from a repair centre a high degree of reliability is also essential, particularly in the generating set.

CHOICE OF SYSTEMS

A d.c. system was not considered suitable because of its incompatibility with a.c. mains, and because, in certain tools, particularly pumps, it is advantageous to use an induction motor. The choice was therefore between single-phase and polyphase alternating-current systems.

In a single-phase system, mains transformers can be used as a source of supply where mains power is available. Most tools utilize a.c./d.c. universal motors, but where induction motors are desirable some starting arrangement is required, e.g. capacitor start. Tools for operating from a single-phase system are in widespread use in industry and are, therefore, relatively low in cost.

A polyphase system allows the general use of induction motors, and avoids starting problems; maintenance costs therefore tend to be lower. The rotor speed at 50 c/s would, however, be too low for most applications, and it is usual to increase the supply frequency to 200 c/s or even 400 c/s. At these frequencies the higher torque produced brings the power-to-weight ratios of the tools above those of a compressed-air system. The polyphase high-frequency system is, unfortunately, expensive due to the low commercial demand for the tools, which at the moment are mainly produced abroad and in a limited range.

The single-phase 50 c/s a.c. system was chosen on grounds of cost, compatibility with mains power supplies, and the wide range of tools already available.

Choice of Generator Capacity and Voltage

Having specified the maximum weight of the generator (the specification limit is 150 lb) its power output is limited by the best power-to-weight ratio obtainable. This is attained by an American set having a weight of 145 lb and an output of 2 kVA. The set is marketed by a British firm. No other set employing a 4-stroke engine, deemed necessary from the reliability point of view, has a power-to-weight ratio approaching that of this set, i.e. 14 watts/lb.

For a given power the choice of system voltage entails arriving at a compromise between safety and the size of cable and connectors. Safety considerations require the lowest possible voltage, but limitations are imposed at low voltages by the physical size of connectors and cables, and the maximum load current beyond which these items become a definite hindrance is approximately 20 amp. With a chosen power output of 2 kW, 100 volts would therefore be suitable, and the nearest standard voltage, 110 volts, has been adopted for the system. It has been designated "orange" in the Post Office standard colour code for supply voltages.

Any residual risk inherent in a 110-volt system has been diminished by connecting the case of each tool to the centre point of the alternator or transformer output through the third wire of the connecting cable. This circuit is not directly connected to the frame of the alternator or transformer, and thus there is no earth-return path should the insulation of the tool break down. An earth fault in the alternator would put a maximum of 55 volts across the operator.

As a precaution against connecting any item of equipment to a power source other than 110 volts, a unique variation of a standard plug and socket was chosen for all connexions. The plugs and sockets are rubber-clad

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and weatherproof, and were adopted as standard for the "orange" range of tools and power sources before the publication of the revised British Standard 196,[2] which details plug and socket variants for all common supply voltages.

Tool Power

With few exceptions the tools are powered by the universal a.c./d.c. type of motor. This is essentially a conventional d.c. series-wound motor with a laminated field-assembly to reduce eddy-current losses when operating on alternating current. Armature speeds may be of the order of 20,000 rev/min, and the unit is therefore capable of high power outputs at tool speeds obtained through one or more trains of reduction gears. The motor has a typically "series" characteristic. This is not necessarily a disadvantage, particularly with drills, since it provides a measure of automatic compensation in reducing the rotary speed when large-diameter drill bits are in use, and it tends to keep the peripheral cutting-speed constant. The change in speed with increasing load is also a useful indication to the operator of the approach of the stalling point, which he can, with experience, avoid by making a suitable adjustment to the pressure applied to the tool.

POWER SOURCES

The various tools and aids may be operated from either portable generating sets or transformers. A choice of power source is thus available for any particular operation, a transformer being preferred if convenient access to mains supplies is available and when it is important to keep the level of noise to a minimum.

Generating Set

The generating set consists of a generator built directly on to the extended crankshaft of an engine, giving the set a compact appearance. This engine-generator unit is mounted in a tubular carrying cradle on shockproof fittings, as shown in Fig. 1. The cradle may be clamped on a 2-wheeled dolly (as shown in Fig. 4) for ease of movement on site.

The engine is a single-cylinder 250 cm^3 4-stroke air-cooled type that may be operated from either petrol or commercial propane.[3] When operated from petrol the set has a 2-gallon tank and petrol pump, and the cylinder compression ratio is 6·25: 1. When operated from propane this tank and pump are replaced by a gas-regulation unit, and the compression ratio is raised to 7: 1 to obtain greater advantage from the higher octane number of the fuel. The engine speed is governed to 3,000 rev/min, and at this speed a power output of 4·8 b.h.p. is developed. Ignition is provided by a flywheel magneto, and the engine is lubricated by an oil pump with circulation by oilways to all crankshaft bearings. The engine is cooled by the airflow from an engine fan, which is directed over the cylinder by a cowling. The engine is started by hand using a recoil rope-starter.

The generator is a conventional 2-pole revolving-armature type with d.c. self-excitation provided by integral d.c. windings and a commutator. The a.c. output and its centre-point connexion are brought out from the armature through three slip-rings and are connected to two output sockets wired in parallel. A double-pole main switch is provided to isolate the load if required.

The set provides a 110-volt 50 c/s single-phase a.c. output of 2 kVA and will supply a short-term overload of 10 per cent, if required. The dismounted set weighs 145 lb—a low figure made possible by the production of the cylinder and crank case as an integral iron die-casting and by the unit construction of the set.

Transformers

The transformers to operate the tools are of the isolating type and are provided in two ratings. The first is a 240/110-volt 2 kVA type, which may be used to operate any individual aid indefinitely; it is intended for use in circumstances where the exact load requirements cannot be foreseen. Where a smaller aid is to be used a 240/110-volt 1 kVA transformer is provided. Each of these transformers is rated for continuous operation.

The transformers at present in use are of drip-proof design and are fitted in earthed metal cases. Future transformers will be of splash-proof design and will be fitted in robust insulating carrying cases. An earthed metal screen will be incorporated between primary and secondary windings.

The weights of the transformers are 80 lb and 40 lb for the 2 kVA and 1 kVA types, respectively. Two output sockets are fitted to the 2 kVA type and one socket to the 1 kVA type. Carrying handles are fitted to each transformer.

APPLICATIONS OF ELECTRIC TOOLS

Ideally, work should be measured and minimal-cost work-methods decided upon, followed by the design of suitable power-driven aids. Such aids would, however, be expensive to produce in the quantities required by the Post Office and would probably take several years to develop. With the introduction by manufacturers of ranges of standard power tools at low cost, it therefore becomes advantageous, wherever possible, to plan work methods around the tools and aids that are readily and cheaply available.

To illustrate the application of electric tools in Post Office engineering operations, three distinct aspects of external work have been chosen—joint-box building, tree-cutting, and pumping, and the group of tools applicable to each will be described. A description will also be given of some other tools that may be used to assist with a wide range of external work.

In Telephone Areas outside London, joint-box building and tree cutting are performed by Post Office staff, and are types of work well-suited to the application of powered tools. In both instances a large part of the labouring work involved can be power assisted.

Pumps are widely required in external work, and range from small units to deal with seepage into joint-boxes and manholes to high-capacity units for dealing with floodwater. In the 110-volt (orange) range, two pumps are provided, designed to utilize to the full the maximum power outputs of the sources available.

JOINT-BOX BUILDING TOOLS

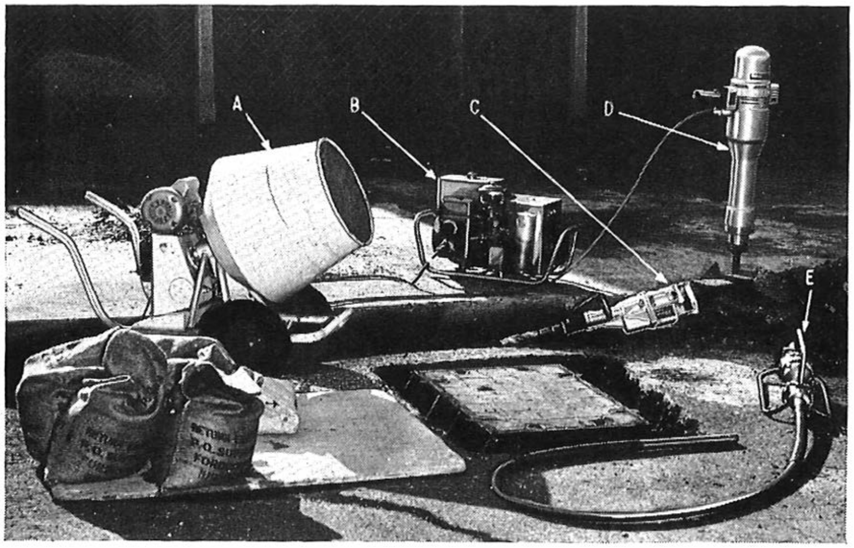
Four aids may be grouped together with a power source to form a composite joint-box building kit. These are:

(*i*) an electric roadbreaker for breaking open road surfaces, and for excavating and trenching in difficult soils, and which, with a punning attachment, may be used for small reinstatements,

(*ii*) an electric hammer for boring in all types of masonry, breaking out brick and concrete walls and for digging, (*iii*) an electric concrete-mixer for mixing concrete on site, and

(*iv*) an electric concrete-vibrator to stimulate the flow of wet concrete into the narrow cavities that occur under replacement frames and covers.

The composite kit is illustrated in Fig. 1. Although the kit is shown as a complete set, individual tools, particularly the roadbreaker and hammer, may be usefully applied to various tasks, other than joint-box building, for which the remainder of the kit is not required.



A—Concrete mixer. B—Generating set. C—Hammer. D—Roadbreaker. E—Vibrator.
FIG. 1—JOINT-BOX BUILDING TOOLS

Electric Roadbreaker

The electric roadbreaker consists of a power unit fitted in a robust light-alloy die-cast casing. An alloy-steel tool-holder is fitted to the casing, and into this may be inserted various boring, breaking, digging or punning accessories. A handle is provided on each side of the upper casing to support the tool.

The roadbreaker is powered by a universal motor that drives a crank disk through a bevel pinion fitted directly on the extended armature-shaft; the crank disk has a crank pin to which a connecting rod and piston are fitted. The rotation of the crank disk causes the piston to reciprocate inside a cylinder. The cylinder is closed at one end, and the movement of the piston sets up cycles of low and high pressure in the air trapped in the cylinder. The cylinder is allowed some limited movement under the influence of these pressure cycles, and at each compression it is driven into contact with a striker, thus imparting a blow to the tool bit inserted in the toolholder. The striking rate is 900 blows/min and the average work of each blow is 50 ft lb.

The air trapped in the cylinder isolates the percussive mechanism from the electrical components; this imparts a long life to the electric motor, which is further protected by "potting" the armature in resin.

The roadbreaker is lubricated by the automatic circulation of oil from a sump in the foot of the tool to all important parts of the mechanism through a system of oilways.

The range of accessories provided with the tool includes points, chisels, a macadam-cutter for opening road surfaces, a digging spade, and a rectangular "walking rammer" for consolidating backfill.

The operation of the roadbreaker, which weighs 77 lb and is rated at 1·5 kW, is controlled by a non-locking switch located in one handle.

Electric Hammer

The electric hammer has an electro-mechanical percussion unit generally similar to that of the roadbreaker, but of smaller size. The percussion may be augmented by a positive rotary drive to the toolholder through a slipping clutch. The design of each accessory shank is varied so that the rotary drive is engaged for spoil clearance whenever boring tools are inserted, and disengaged when breaking or digging tools are fitted.

The range of accessories provided with the hammer includes tungsten-carbide tipped boring drills, points and chisels, a digging spade and an earth-electrode driver.

The striking rate of the hammer is 2,000 blows/min and the average work of each blow is 7·5 ft lb. The rotary drive operates at 250 rev/min. The hammer will bore holes of up to 3 in. in diameter, and the boring rate for 1¼ in. diameter holes in concrete is 12 in/min.

The weight of the hammer is 21 lb and its rating is 750 watts.

Electric Concrete-Mixer

The electric concrete-mixer is of a compact robust design, with a mixing capacity of 3 ft^3 dry mix or 2 ft^3 wet mix. The steel mixing-drum is carried on roller bearings and is rotated by a chain drive from a ¾ h.p totally-enclosed capacitor-start induction motor. The drum and the power unit are mounted on a tubular steel frame with solid-rubber tyres and barrow-type handles. The mixer may be used as a wheelbarrow to deliver the mix to its final placing when the mixing has been completed.

The compact size of the mixer enables it to be transported inside the vehicle used by the joint-box building party. The weight of the mixer is 150 lb.

Electric Concrete-Vibrator

The electric concrete-vibrator comprises a universal electric motor mounted in a carrying cradle and driving a flexible shaft to which a rigid vibrating-head is fitted. The head consists essentially of an eccentrically-mounted rotating mass housed in a steel tube. The unit is lubricated and sealed to render routine maintenance unnecessary. The diameter of the vibrator head is 1¼ in. The weight of the complete tool is 28 lb and its rating is 900 watts.

TREE-CUTTING TOOLS

The introduction of vehicles with hydraulic elevating platforms has led to the concentration of tree cutting on a small number of parties equipped with such vehicles.[4]

The vehicles have accommodation to mount a 110-volt generating set at the back, and are provided with electric cables to the platform. Electric aids can therefore be operated from the platform, and the rate at which trees can be cut may be increased by equipping the vehicle with one or more tools from the following range of tree-cutting aids.

(*i*) A 12 in. electric chain-saw used for lopping main limbs of trees and for sectioning felled branches into more convenient lengths for disposal. The saw may also be used to cut poles, and its convenient size makes it particularly suitable for felling poles by section *in situ*.

(*ii*) A 5 in. electric chain-saw for lopping and sectioning small limbs and branches where the greater capacity of the 12 in. saw is unnecessary and its extra weight would be a disadvantage.

(*iii*) An electric tree-pruner for cutting smaller branches and twigs.

(*iv*) An electric hedge-cutter for the mass clearance of bush growth into telephone wires where individual twigs are too numerous for separate cutting.

The use of these aids assists tree-cutting parties to meet the wishes of tree owners and thus more easily secure permission to cut the trees. The aids are illustrated in a typical location in Fig. 2.

A—Five-inch saw. B—Twelve-inch saw. C—Hedge-cutter. D—Pruner
FIG. 2—TREE-CUTTING TOOLS

Twelve-Inch Electric Chain-Saw

The 12 in. electric chain-saw has an endless chipper chain that runs around a grooved steel guide-bar 12 in. long. The chain is driven through a sprocket by a universal motor controlled by a non-locking double-pole switch in the main handle of the tool. The guide-bar groove and chain are lubricated by a hand-operated oil pump with a plunger conveniently placed for operation by the left hand during use. A safety guard is fitted to the saw above the upper edge of the guide bar.

The full-load rating of the saw is 1 kW and its weight is 19 lb.

Five-Inch Electric Chain-Saw

The 5 in. electric chain-saw is generally similar to the 12 in. type, except that the guide-bar length is 5 in. and no chain-oiling device is fitted. The saw is designed for single-handed operation, and has a double-pole non-locking switch inside the handle.

The full-load rating of the saw is 500 watts and its weight is 9 lb.

Electric Tree-Pruner

The electric pruner is powered by a universal motor fitted at the lower end of a lightweight tubular stem 6 ft in length. The motor drives a shaft contained within this stem and mounted on bearings at regular intervals along its length. The shaft is terminated at the upper end of the stem with a pinion which engages with and rotates a 3 in. diameter saw-toothed cutting ring. The ring is supported on arc-shaped guides in contact with the smooth inner surface of the ring. A section of the toothed external surface of the ring is exposed between two elongated tines, which are placed over the branch to be cut. The pruner is forced against the branch, the exposed edge of the cutting ring engages the wood, and the branch is severed.

The maximum cutting capacity of the pruner is $1\frac{3}{4}$ in. diameter wood. A double-pole non-locking switch is fitted in the handle below the motor. The weight of the pruner is 7 lb and its full-load rating is 500 watts.

Electric Hedge-Cutter

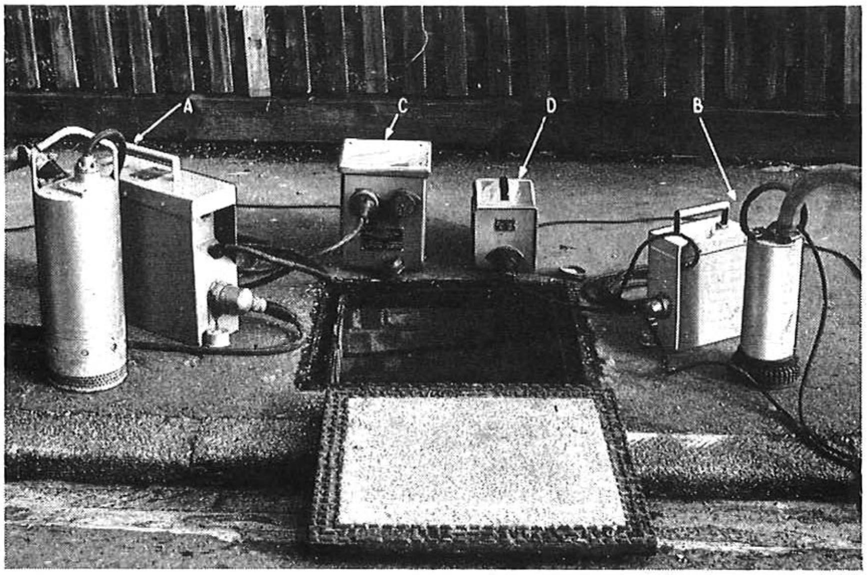
The electric hedge-cutter consists of a universal motor which drives a single-edged reciprocating cutter-bar through an oil-filled worm-and-gear unit. The cutter bar is $16\frac{1}{2}$ in. long and reciprocates at a rate of 350 cycles/minute. Two handles are fitted at convenient points of balance, and a double-pole switch is located in one handle. A webbing harness may be attached to the tool so that the weight of the hedge-cutter can be supported on the operator's shoulders when the tool is used for long periods.

The hedge-cutter has a full-load rating of 350 watts and weighs 12 lb.

ELECTRIC PUMPS

Two sizes of pump are available, primarily for operation from the transformers. One pump is a small unit with a capacity matched to the 1 kVA transformer, and the other is a larger unit similarly matched to the 2 kVA transformer. The pumps and their respective transformers are illustrated in Fig. 3.

The pumps are of the submersible type, thus eliminating the priming problems commonly associated with suction pumps. The absence of suction-lift considerations and the high delivery head provided by these pumps render them particularly useful in locations where very deep manholes are met. The pumps are quiet in operation, and thus with power supplied from a transformer it is possible to drain manholes rapidly in locations where noise must be kept to a minimum.



A—Large pump. B—Small pump. C—2 kVA transformer. D—1 kVA transformer
FIG. 3—PUMPS AND TRANSFORMERS

Large Electric Pump

The large electric pump consists of a pumping unit, which is lowered to the floor of the manhole being drained, and a control unit, which is placed above ground-level near to the manhole entrance. The flexible lead from the pumping unit is connected to the control unit, and the lead from the control unit is in turn connected to a transformer or generating set.

The pump is powered by a capacitor-start-and-run induction motor; the motor is incorporated in the pumping unit and the capacitor in the control unit. The motor stator is hermetically sealed between two concentric brass tubes, and the squirrel-cage rotor is mounted on two grease-packed bearings. An impeller is mounted directly on an extension of the rotor shaft in the base of the pump. Between the lower bearing and the impeller the shaft runs through two mechanical face seals, and between these seals an oil-filled chamber is located. The oil in this chamber may be drained periodically, and an inspection of its quantity and condition gives a reliable indication of the condition of the mechanical seals.

A mesh strainer is located in the base of the aluminium pump-body. Water enters the pump through the strainer, and is driven by the impeller over a diffusion plate and through an annular channel formed between the casing of the pump and the outer surface of the stator case. The flowing water cools the motor, leaving the pumping unit at an outlet spigot fitted on the top of the unit. The delivery is led away by a 2 in. bore collapsible canvas hose. A handle is provided at the top of the pumping unit for carrying or lowering the pump.

The control unit contains, in addition to the capacitor, a number of protective devices to safeguard the pump in the event of misuse. A cut-out in the control unit disconnects the power from the pump if a self-restoring thermal switch in the motor stator becomes excessively hot. This may occur if the pump is run completely dry for a long period. A circuit-breaker in the control unit disconnects the power in the event of an excessive current surge, as may occur if the impeller becomes jammed. The control unit has a weatherproof sheet-steel case with a carrying handle and special multi-way output socket for connexion to the pump.

The pump will deliver 6,000 gallons/hour at a head of 30 ft and 7,500 gallons/hour at 10 ft; the maximum delivery head is 57 ft. The pump unit weighs 90 lb and the control unit 45 lb. The maximum rating of the pump is 2 kW.

Small Electric Pump

The small electric pump is similar in many respects to the large pump except that it is of reduced size and capacity and of more simple construction.

The pumping unit has a capacitor-start-and-run motor with the motor stator sealed and cooled as described for the large pump. The rotor has water-lubricated bearings and the rotor chamber is filled with distilled water. Access to the chamber is obtained through a level plug in the top of the pump, and occasional inspection of the quantity and condition of this water gives a reliable check of the condition of the mechanical seal behind the impeller. The outlet bore of the pump is $1\frac{1}{2}$ in.

The control unit consists of the capacitor, a combined main switch and circuit-breaker, and a special multi-way outlet socket in a metal carrying case.

The pump will deliver 1,700 gallons/hour at 30 ft and 3,300 gallons/hour at 10 ft; the maximum delivery is 38 ft. The weight of the pumping unit is 33 lb and of the control unit 20 lb. The maximum rating of the pump is 1 kW.

MISCELLANEOUS AIDS

In addition to the groups of tools already described, a number of other electrical aids to external work are available. Three such aids are:

(*i*) an electric floodlight to facilitate operations during darkness and to illuminate road works in the interests of road safety,

(*ii*) an electric drill-hammer for general wall-plugging and drilling, especially where hard masonry such as granite or concrete is met, and

(*iii*) an electric impact-wrench to remove ironwork from recovered pole and arms.

Electric Floodlight

The floodlight (Fig. 4) has three sealed-beam lamps each fitted in a shock-proof lamp head and mounted on a collapsible tripod. The tripod has a central telescopic mast 5 ft high when retracted and 10 ft high when extended. A tubular cross-arm carrying a lamp head at each end is fitted to the lower section of the mast. The third lamp head is mounted at the top of the extended mast. All the lamp heads may be adjusted to point in any direction. The mast-head lamp provides overall site illumination and the cross-arm lamps may be used to illuminate particular parts of the operations in progress.

The lamps are of a pressed-glass heat-resistant type, internally silvered to avoid the use of a separate reflector. Their strengthened-glass envelopes will withstand rough use, and "flood" and "spot" versions of the lamp are available to suit the spread of illumination required. Each lamp is rated at 150 watts and, hence, the complete floodlight consumes 450 watts. Up to four of these

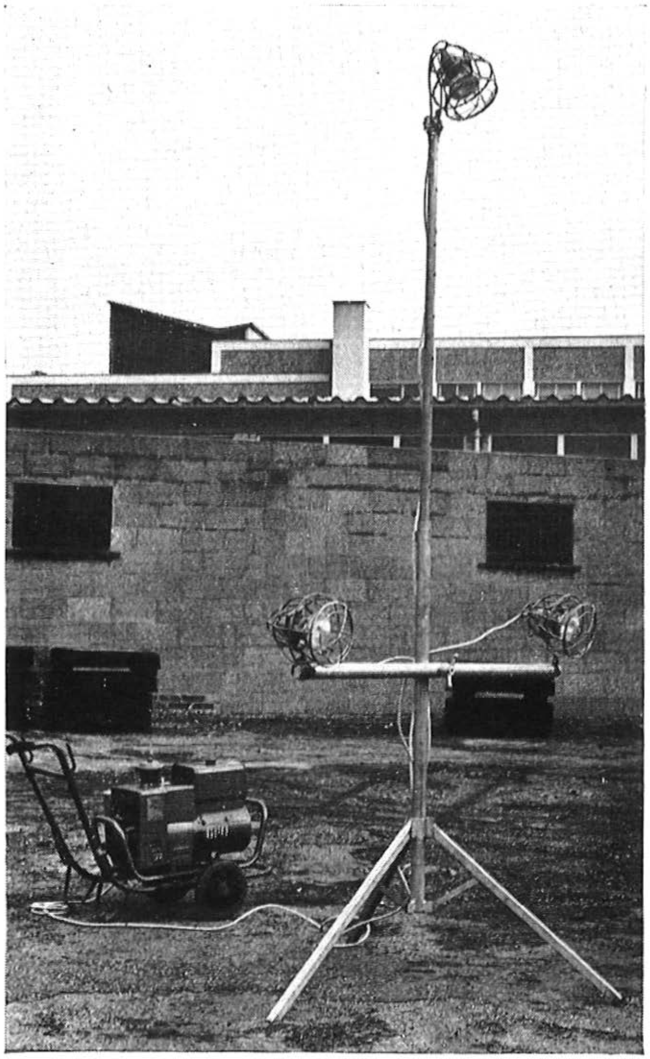


FIG. 4—FLOODLIGHT AND MOUNTED GENERATOR

floodlights can be operated simultaneously from a generating set if necessary.

Electric Drill-Hammer

The electric drill-hammer (Fig. 5) is a slow-speed electric drill on to the drive of which a rapid percussive force is superimposed. The drill-hammer has a universal motor that drives a chuck through reduction gears and percussion cams. The cams may be adjusted by an external sleeve to lock the percussion mechanism out of action when not required.

Tungsten-carbide tipped drilling bits are used with the tool when masonry is being bored; the drilling-bit tips are ground to have a negative rake to withstand the percussive force. The bits are driven at 750 rev/min and are hammered at a rate of 9,000 blows/min. The drill will bore holes of up to $\frac{1}{2}$ in. in diameter in concrete or up to $\frac{3}{8}$ in. in diameter in steel. The percussive mechanism is engaged to bore masonry and disengaged when boring metal or wood.

The tool has a full-load rating of 300 watts and a weight of 7 lb.

Electric Impact-Wrench

The electric impact-wrench (Fig. 6) has a universal

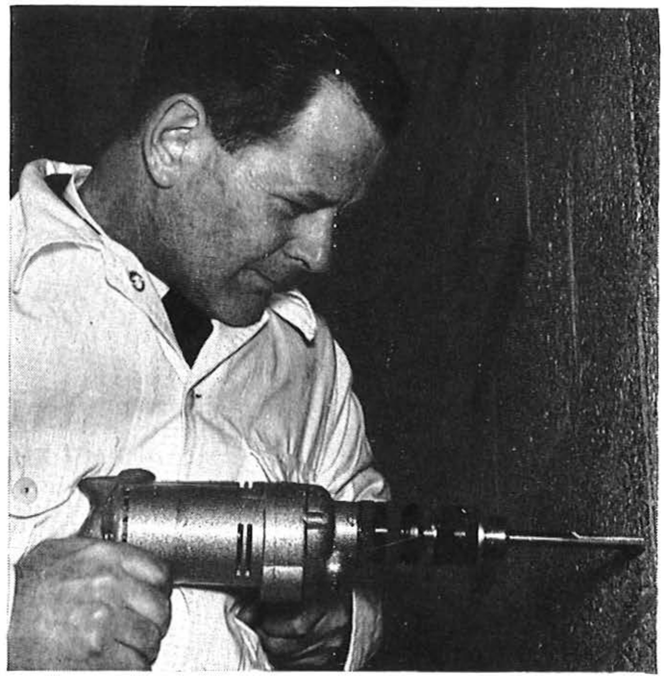


FIG. 5—DRILL-HAMMER

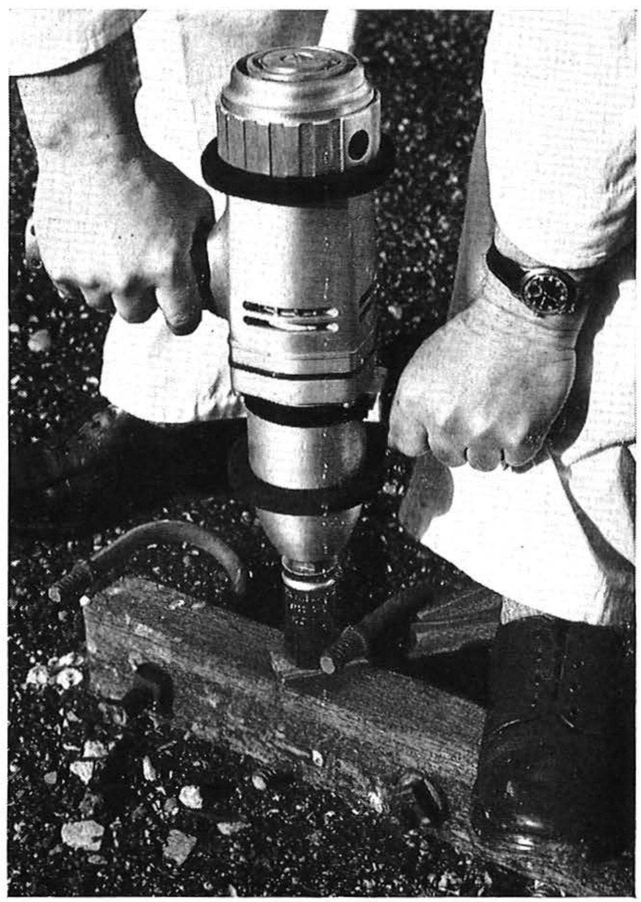


FIG. 6—IMPACT-WRENCH

motor which drives a $\frac{3}{4}$ in. square shaft through reduction gears and a clutch-operated impact mechanism. The direction of the drive may be reversed by a switching sleeve on the tool.

A variety of impact sockets may be used with the tool for different nut sizes and forms. When used to tighten nuts, the wrench spins the nut along a bolt, and, when rotation ceases, it imparts a succession of blows to the socket until the nut is tight. Alternatively, if the nut is already tight, as with corroded ironwork on recovered arms, the direction of rotation is reversed, the wrench loosens the nut with a succession of blows, and then spins the nut from the bolt or spindle.

The full-load rating of the wrench is 435 watts and the weight is 7 lb.

CONCLUSIONS

The principal advantages of the 110-volt system of tools and aids are as follows.

(*a*) Electricity is the most economical and versatile form of power supplied by portable equipment, particularly for items in the small-tool range suitable for application to Post Office external engineering work. Supplied at 110 volts, it is adequately safe and will operate tools up to a capacity of 2 kW.

(*b*) The portability of each item, including the generating equipment, together with their comparatively low cost make it advantageous in many instances to issue the equipment to gangs and working parties on a permanent basis. In most Telephone Areas this policy will tend to be more economical than maintaining an on-demand mechanical-aids service from one or more central points. Specially-trained operators are not required.

(*c*) The wide range of tools available is supplemented by lighting and heating equipment, and the generating sets are also available for supplying power to specialized jointing and cabling aids and for electrically-operated test gear.

(*d*) The standard power supply recommended for building sites is 110-volt 50 c/s a.c. All tools in the 110-volt range, and, in particular, drills and drill-hammers, which can be of considerable advantage in the block-wiring of large multi-storey buildings, can utilize this supply.

(*e*) Stand-by power can be provided at mains voltage by using the transformers to step up the generating-set output.

Electric tools, therefore, have an important part to play in the mechanization of external work alongside the larger-capacity mechanical aids.

ACKNOWLEDGEMENTS

Assistance has been provided from many sources in the development of the electric-tool range. The enthusiastic co-operation provided by the Brighton and Nottingham Telephone Areas in the evaluation of the tools is acknowledged.

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Book Reviews

"International Series of Monographs on Electromagnetic Waves, Electromagnetic Theory and Antennas, Parts 1 and 2." E. C. Jordan. Pergamon Press, Ltd. xxix + 1,330 pp. 70 full-length papers and 55 summaries. £10 10s. (per set).

This book in its two parts contains 70 full-length papers and 55 summaries of papers presented at a Symposium held in Copenhagen in 1962. Although these papers are divided into six sections a very wide variety of subjects is treated within each section and most readers will have only a selective interest in any one section.

While most of the papers are of a scientific or mathematical nature there are some of particular interest to radio engineers specializing in propagation, waveguides and antenna theory. The increased interest in diffraction around a rough earth as a mode of propagation of radio waves is reflected in a number of papers, notably one by Furutsu. In the section on scattering some attempts are made to show in what way scattering may be effective over a wide range of wavelengths from the radio to the optical parts of the spectrum. A number of interesting papers appear in the last two sections covering subjects such as log-periodic antennas, submerged antennas, low-noise feed systems for large parabolic antennas, and multiplicative receiving arrays.

The title given to this collection of papers may suggest that a comprehensive and integrated treatment of electromagnetic theory and antennas is given. As the reader will by now be aware, this is far from the case and the usual disappointments of a symposium record are evident. Nevertheless, the symposium did attract a considerable number of first-class papers some of which, as has been indicated, should be of interest in the engineering of radio-communication systems. J.K.S.J.

"Matrix Algebra for Electrical Engineers." R. Bruce, M.Sc.(Eng.), Hons.B.Sc., M.S.A.I.E.E., M.I.E.E. Sir Issac Pitman and Sons, Ltd. xi + 162 pp. 21 ill. 30s.

There are many books, or sections of books, with titles much the same as this, but this book has something new compared with most earlier works. It emphasizes the geometrical and spatial approach to matrix manipulation, and the reader will be introduced to vector spaces, linear vector manifolds, the nullspace of a matrix, linear mapping, and so on, as well as the conventional algebraic properties of matrices.

Moreover, matrix analysis is presented in such a way as to lead up to tensor analysis, and hence the concepts transformation, invariance, and group are stressed. The last chapter of the book is to be regarded as "an appendix . . . which points to . . . tensor analysis, group theory, and topology."

There are four most interesting chapters on applications of matrices dealing with geometry and mechanics, with linear programming, with linear network analysis, and with diakoptics, which is Gabriel Kron's tearing method for inversion of large matrices.

There are problems attached to most chapters, a bibliography on matrix algebra, tensor analysis, group theory, topology, and applications of matrices and tensors, and an index.

This book is to be recommended, not only to those with no knowledge of matrices, but also to those familiar only with the more conventional approach. W.E.T.

A Remote-Control System for County Fire Brigades

R. J. BLUETT, A.M.I.E.R.E., S. W. CALKIN, and F. W. WOOD†

U.D.C. 621.395.9:614.842:621.395.635.4

County fire brigades can, by centralizing control of staff and the receipt of fire calls, effect considerable savings in manpower. Various remote-control systems for fire-service use exist, but none of these is suitable for large centralization schemes. A system using voice-frequency signalling techniques has therefore been designed to a facility schedule prepared by the Home Office on behalf of the county fire authorities. The system permits all types of fire calls to be received at the brigade headquarters, and provides facilities for the headquarters staff to alert personnel at any of the remote stations.

INTRODUCTION

THE large county fire brigades in this country serve wide areas, and in the past it has been the practice for the watch rooms in each fire station to be staffed continuously for the purpose of receiving fire calls and, in turn, alerting the appropriate fire parties to man the appliances. There have been exceptions to this arrangement, whereby a fire station is normally unmanned and part-time firemen are alerted when required by means of sirens or by call bells situated in the firemen's houses. The sirens or call bells are operated over a remote-control system from a fully-manned station. A station controlled in this manner is known as a retained station.

In order to utilize the available manpower more efficiently many county fire brigades now wish to receive all fire calls at one central point within their county and from there alert, i.e. call out, the appropriate fire station, which may be a fully-manned one or a retained station. It was to meet this demand that the system described was designed.

REQUIREMENTS OF A CENTRALIZED-CONTROL SYSTEM

A system designed to control a large brigade from one central point must by nature of its use be very reliable and have built-in safeguards so that the operating staff in the control room are made instantly aware of any breakdown of communications. Subject to the limitations of the line plant, communication between the control and remote stations should be possible over alternative routes so that no single cable fault can isolate a station.

To keep operating costs to a minimum the system should be simple to work, thus avoiding the need for specially-trained staff. Speed of operation is also essential, and fire brigades take great pride in the speed at which a crew can be mobilized; in practice the time taken may be reckoned in seconds.

Mention has only been made so far of the need for alerting remote stations from the control. There is, however, a need for signalling from the remote stations to the control so that alarms received at remote stations, e.g. emergency calls from telephone exchanges, fire telephones, etc., can be passed on to the control station.

Existing Systems

The types of remote-control system that could be offered were as follows:

(*i*) *System K*, which is intended for use over point-to-point private circuits and is essentially a d.c. system limited to a distance of about 20 miles. It is dependent upon power derived from the public a.c. mains supply for its operation, service being lost in the event of a mains failure.

(*ii*) *System Dx*, which is designed to work over the public telephone network. A telephone connexion is first set up between the two stations concerned, and the remote-control signal is then sent by means of a voice-frequency tone. This system is also mains operated, and service is lost or restricted in the event of a mains failure.

Facilities Required

Neither of the above systems was considered by the Home Office to be satisfactory for large centralization schemes, and, accordingly, a specification was drawn up for a remote-control system to meet the needs of county fire brigades wishing to centralize the control of fire stations. The facilities specified are as follows:

(*a*) Three discrete control signals should be provided between the control and each remote station; these signals would be used as required by local conditions. Typical uses would be: alerting different fire parties by siren or call bells, operating station emergency lighting, and closing station doors after a fire crew has left and the station remains unattended. For convenience the three signals are referred to as "call-out" signals.

(*b*) An answer-back signal should be given at the control station in confirmation that a call-out signal has been received at the remote station.

(*c*) The type of signalling used should allow the system to work over any type of speech circuit.

(*d*) The lines and, as far as possible, the equipment should be continuously monitored and a fault condition made immediately apparent to the control.

(*e*) Bothway telephone signalling and speech should be possible.

(*f*) Fire-alarm calls hitherto received in the remote fire stations should be passed over the remote-control system to the control station.

(*g*) The system should be able to function for a period of at least 48 hours in the event of a mains failure.

(*h*) In the event of a line failure it should be possible to transmit the call-out signals over a reserve circuit.

SYSTEM CHOSEN

As the traffic density between fire stations and their control is very light an omnibus system was chosen, up to a maximum of five stations being connected on a common circuit to the control station. Voice-frequency (v.f.) signalling is used, and equipment of the type required was readily available in the form of the D.C. Multiplex Indicating Equipment, manufactured by G.E.C. (Electronics), Ltd. This equipment consists of a series of 12 v.f. oscillators and receivers. A block schematic diagram of the remote-control system is shown in Fig. 1. Two separate circuits are used to link a group of five stations to the control station. One of these circuits is used for speech and the other for v.f. signalling. As far as possible these circuits are alternatively routed

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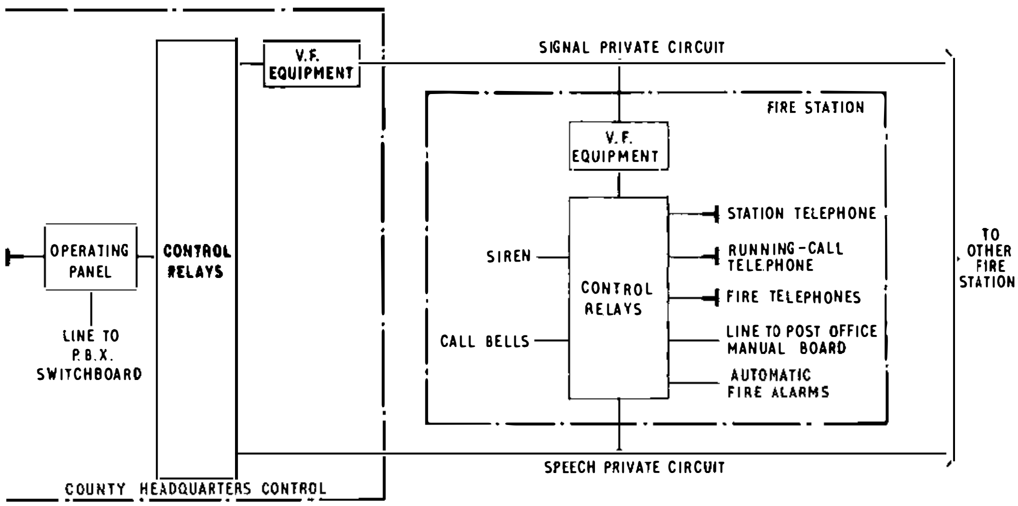
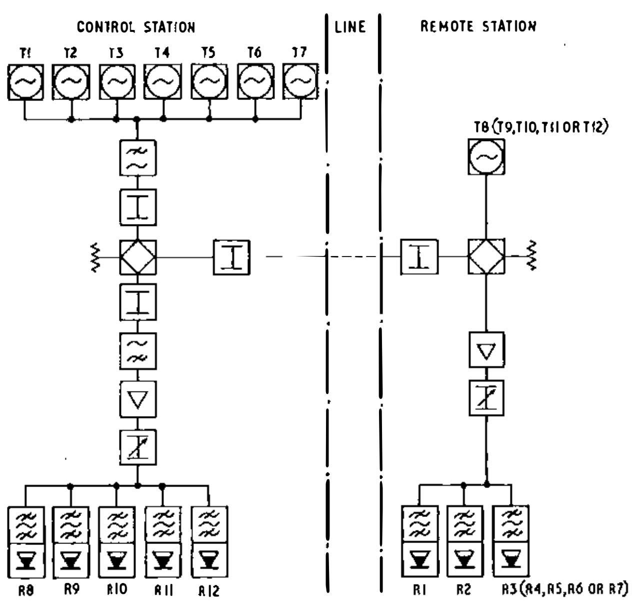


FIG. 1—BLOCK SCHEMATIC DIAGRAM OF REMOTE-CONTROL SYSTEM

so that the possibility of a station being isolated is reduced. Under certain fault conditions the v.f. signals may be transmitted over the speech circuit—this facility is described later.

Two separate pilot frequencies are allocated to each of five remote stations: one is applied to line at the control station and the other at the remote station. The remaining two frequencies are used for common signalling from the control to remote stations. The pilot frequencies are applied to line continuously while the system is idle, thereby affording bothway line monitoring to each station on the signalling circuit.

The v.f. paths at the control and remote stations are shown in Fig. 2; the frequencies used are listed in the table. The purpose of the low-pass filter is to attenuate harmonics of the pilot frequencies that might fall within the pass band of the receivers at the control station.



T1–12: v.f. oscillators. R1–12: v.f. receivers.
FIG. 2—VOICE-FREQUENCY SIGNAL PATHS THROUGH SYSTEM

Frequencies Used in Remote-Control System

Signal Channel	Frequency (c/s)
1	540
2	780
3	1,020
4	1,260
5	1,500
6	1,740
7	1,980
8	2,220
9	2,460
10	2,700
11	2,940
12	3,180

The high-pass filter isolates signals at the fundamental frequencies of the control-station oscillators from the control-station receivers where inter-modulation products could be produced that would interfere with the performance of the receivers.

The receivers are designed to operate at an input-signal level of between −28 dbm and −48 dbm. The signal power transmitted to line is limited to a total of 64 μW, i.e. a level of −20 dbm per tone. The system is intended to work over circuits with a nominal loss of 20 db between the control and each remote station, the attenuators at the control and remote stations being adjusted to compensate for differing line losses.

All the equipment is mounted on standard 19 in. wide racks, one rack being required at the control station and one rack at each remote station. Fig. 3 illustrates the control-station rack; the remote-station rack is generally similar.

Control Panel

A control panel having the layout shown in Fig. 4 is provided on each control rack. This panel can be used both for operating the system and for maintenance purposes. At control stations having several remote-control systems, however, a second type of control panel is provided. The layout of this type of panel is shown in Fig. 5, and the panel is mounted in a console. Several such panels can be coupled together under the control of one

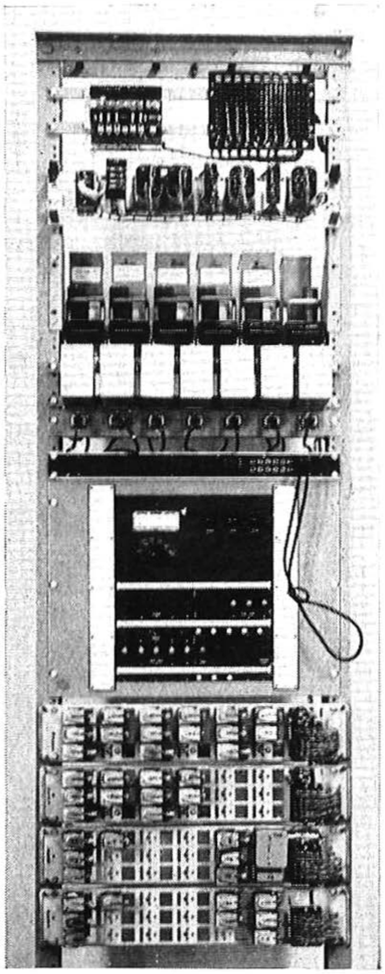


FIG. 3—CONTROL RACK

operator. In the description that follows it is assumed that the control panel on the control rack is being used.

Two keys are provided for each of the remotely-controlled stations: one key is used to select a station for the purpose of signalling or speech, and the other is used to silence a fault-alarm signal from the station. Three master CALL OUT keys are provided in order that the appropriate call-out signal can be sent to the selected station, and a common RING CONNECT key is used for signalling on telephone calls. The SYSTEM CHANGE-

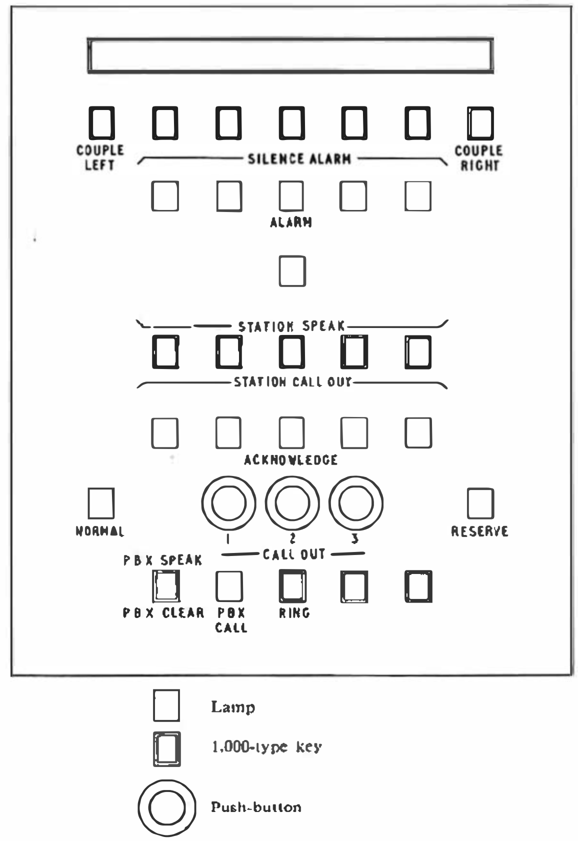


FIG. 5—LAYOUT OF CONSOLE-MOUNTED CONTROL PANEL

OVER key is used to interchange the functions of the main and speech circuits, i.e. should the signalling circuit fail, signalling can be carried out over the speech circuit.

Two lamps are provided for each remotely-controlled station. One lamp is designated ALARM and the other ACKNOWLEDGE. An incoming call from a remote station is indicated by the appropriate ALARM lamp flashing. A fault that affects a remote station is indicated by a continuous glow of the ALARM lamp. The ACKNOWLEDGE lamp is flashed as an indication that a call-out signal has been received at a remote station.

The coupling circuit used with the second type of control panel is designed to prohibit the tandem connexion of two systems since the transmission levels on

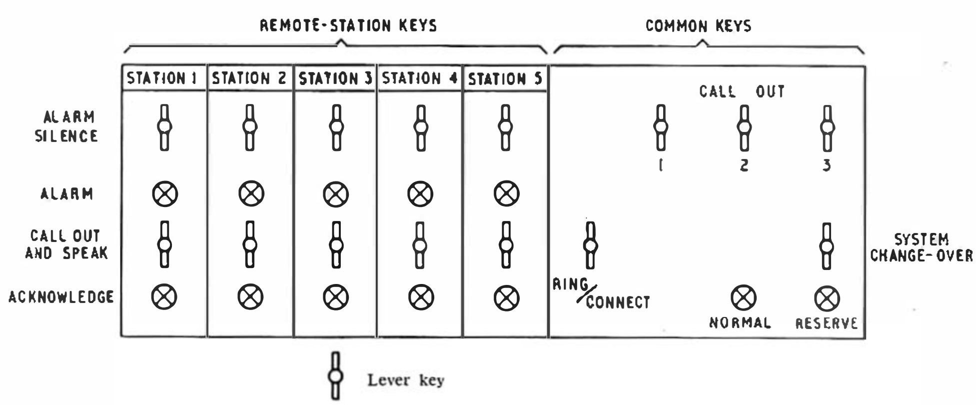


FIG. 4—LAYOUT OF CONTROL PANEL ON CONTROL RACK

calls between stations on different systems would be unsatisfactory.

Connexion can be made to the system speech circuit from the control station P.B.X., allowing headquarters staff to have telephone access to all fire stations. The system operator in these circumstances has complete control over the connexion and can readily take over the circuit for emergency use.

OPERATION

The operation of the systems can best be considered by taking each function in turn, i.e. the call-out operation, telephone calls in either direction, and the line monitoring and change-over arrangements.

Call Out

The prime function of the system is to enable any of three distinct call-out signals to be passed to each or all of the remote stations. Accordingly the call-out operation has been kept simple both from the operating and circuit point of view. To call out a station the control operator first selects the required station by operating the station key to the CALL OUT position. The appropriate master CALL OUT key is then pressed until the ACKNOWLEDGE lamp flashes. The ACKNOWLEDGE lamp continues to flash for the period of the call out—nominally 60 seconds. The signalling sequence after the CALL OUT has been operated is as follows.

The appropriate call-out signal frequencies are first applied to the line, i.e. transmitters T1 or T2, or T1 and T2 (see Fig. 2) are energized, and their signals are received at each remote station. The station pilot-frequency (i.e. from one of the transmitters T3–T7) is then disconnected and this commences the call-out operation at the selected station. This principle of working minimizes the chance of a false call out. As soon as the call out commences at the remote station the return pilot signal from this station is pulsed. At the control station the pulsing of the pilot signal is detected, causing the outgoing pilot signal to be re-applied and the call-out signal removed, i.e. the outgoing line conditions are restored to normal. This sequence of operations is completed within 500 ms and the system is then available to pass signals to any other station on the system. At the remote station where the call-out signal has been received it continues for a period of 60 seconds irrespective of any changes in the line conditions. The time-out period is obtained by using the operate and release times of a thermal relay.

If necessary the same call-out signal may be sent simultaneously to several remote stations by operating the required station keys before operating the CALL-OUT keys.

Calls Incoming to the Control Station

Calls into the control station from a remote station may originate from the following points:

(*a*) The remote-station telephone.

(*b*) The "running-call" telephone—this is a telephone for public use and is situated outside the fire station.

(*c*) Fire telephones—these are telephones situated at fire-risk premises where direct access to the fire brigade is essential, e.g. hospitals. Any number of fire telephones may be connected to a remote fire station.

(*d*) A public telephone exchange switchboard—used when connexion to the fire brigade is requested, e.g. from a 999 call.

Telephone calls from any of the above sources are signalled to the control station by pulsing the outgoing remote-station pilot tone. This causes the ALARM lamp associated with the remote station to flash at the control. Calls originating from the remote-station telephone pulse the pilot at a much slower rate than other types of call, thereby enabling the control operator to distinguish between administrative calls and emergency calls. A calling telephone is not connected to the speech circuit until the control operator accepts the call by operating the station SPEAK key and momentarily operating the RING/CONNECT key, causing a 250 ms disconnexion of the outgoing pilot tone from the control; this is detected at the remote station and causes any calling telephones to be connected. In the event of simultaneous calls being received from two or more stations these calls are individually signalled and the operator can select which one to answer or, alternatively, answer the calls together.

When a call is originated over the system from a telephone exchange the Post Office operator receives standard supervisory conditions from the fire-brigade control operator via the remote station.

As several fire telephones can be connected to a remote station there is a danger that congestion on the speech circuit might occur unless the control operator has some means of disconnecting from the circuit the fire telephones at remote stations; this is done by a second operation of the RING/CONNECT key. A lamp indication is given at the remote station that a fire telephone has been "locked out." This lock-out is dependent upon the fire-telephone loop; when the fire-telephone handset is replaced the circuit is restored to normal.

Telephone Calls Outgoing to Remote Stations

The control-station operator may originate telephone calls to any remote station, or to all of them collectively for a conference type of call. The operation is similar to that of accepting an incoming call, the 250 ms disconnexion of the pilot causing the station telephone bell to ring and also lighting an alarm lamp. If the telephone is not answered at the end of 60 seconds the calling signals cease.

Line Monitoring and Change-Over

As mentioned earlier, the signalling circuit is continuously monitored in each direction by v.f. signals. If a remote station fails to receive its pilot tone then, after a delay of 6 seconds, an alarm condition is indicated, the v.f. signalling equipment at the remote station concerned switches automatically to the speech, or reserve, circuit, and the outgoing pilot from the station is disconnected. If the control station fails to receive a pilot tone from any remote station the alarm lamp appropriate to that station glows continuously at the control. The control operator can then, at her discretion, continue to work normally with the stations not affected by the fault or change the system to "reserve" working by the operation of the system CHANGE-OVER key, which disconnects all the outgoing pilots from the control from the main circuit and connects them to the reserve circuit. Any remote stations that have already changed over because of a fault condition now receive the pilot on the reserve circuit; stations which had been working normally then change over to the reserve circuit as a pilot-fail condition is detected on the main circuit.

When a remote station receives its pilot frequency on the reserve circuit the return pilot to the control is restored and the v.f. remote-control signals operate over the reserve circuit as already described. The system can function completely on the reserve circuit except that the main circuit (a fault on which may have initiated the change-over sequence) is used now as the speech circuit. If speech is not possible over the faulty circuit verbal messages to the remote station must be passed over the public network. The vital call-out function is, however, still possible over the system.

In order to prevent a Post Office operator attempting to connect an emergency call over the system under change-over conditions, a busy signal is applied continuously on the circuit to the Post Office manual switchboard during the change-over period.

No continuous line monitoring is provided on the speech circuit, but verification that the speech circuit to any remote station is working is provided by means of an audible answer-back tone that is connected for a short period at the remote station whenever a telephone call is made from the control station.

POWER SUPPLIES

The equipment is designed to work with a 24-volt d.c. supply, from which 12-volt and 2·5-volt supplies are derived for the tuned receivers and oscillators.

The 24-volt supply is obtained from secondary cells maintained on float charge; they have sufficient capacity for the equipment to function for 48 hours in the event of a breakdown in the public mains supply.

TESTING ARRANGEMENTS

In order that the equipment may be as self-contained as possible, simple testing facilities are provided on each rack of equipment. These testing facilities consist of a meter that can be connected by a switch to either the 24-volt supply, the 12-volt supply, the 2·5-volt supply or the test circuit of the amplifier. Another switch position connects the meter as a simple a.c. coltmeter for checking the oscillator outputs.

AUTOMATIC FIRE ALARMS

In many premises having a high fire risk, automatic fire alarms are installed. These are of two types: the first, on detecting a fire, automatically passes a signal over a private circuit to the nearest fully-manned fire station; the second, on detecting a fire, sets up a 999 call over the public telephone network. If a fire brigade wishes to centralize receipt of all fire calls then, for the first type of alarm, the provision of a private circuit between the risk premises and the brigade control becomes necessary. This circuit may be very long causing this type of automatic fire alarm to be uneconomical; a trial is, therefore, to be held whereby calls from automatic fire alarms may be passed over the remote-control system (in much the same way as a call from a fire telephone). One problem to be solved is the necessity for the control to identify the calling premises; it is likely that a recorded announcement will be used.

CONCLUSION

A remote-control system has been designed to meet the operational requirements of county fire brigades wishing to centralize the receipt of alarm calls and the control of the mobilization of their forces. A limited trial has been carried out in Worcestershire for 18 months, and full-scale trials of the final system in Lancashire and Kent for 6 months. The system has proved to be reliable and capable of dealing adequately with the heaviest traffic likely to be encountered by fire brigades.

ACKNOWLEDGEMENTS

The authors wish to acknowledge assistance given by G.E.C. (Electronics), Ltd., and the Home Office Communications Branch.

Book Reviews

"Mathematical Techniques in Electronics and Engineering Analysis." J. W. Head, M.A. (Cantab.), F. Inst. P., A.M.I.E.E. Iliffe Books, Ltd. 265 pp. 64 ill. 45s.

The avowed object of this book, much of the text of which is based on the series "Mathematical Tools" by "Computer" published in *Electronic and Radio Engineer* and *Electronic Technology*, is to make available to engineers, and other users of mathematics, widely applicable techniques which will make their work easier. Although many of the techniques discussed were discovered and invented for the benefit of electrical technology, they can be widely applied in other fields such as mechanics and economics.

The subjects discussed are mainly those which have arisen naturally in the course of the author's work in the Research Department of the B.B.C. Engineering Division. The book falls naturally into two parts. The first half consists of general mathematical techniques: the solution of equations, series and partial fractions, differentiation and integration, versors, vectors and trigonometry, and various labour-saving devices. The second half deals with more specialized applications of mathematics to problems in electrical and electronic engineering: operational calculus, matrices applied to two-port problems or transistor circuits, conditions for minimum variation in a function, analytical geometry and impedance calculations, and stability criteria.

"The Propagation of Electromagnetic Waves in Multiconductor Transmission Lines." P. I. Kuznetson and R. L. Stratonovitch, U.S.S.R. Academy of Sciences. Pergamon Press, Ltd. xvi + 190 pp. 7 ill. 105s.

This is a translation from the Russian of a series of 12 mathematical essays published as individual articles in "Applied Mathematics and Mechanics of the Institute of Mechanics in the U.S.S.R. Academy of Science," and various other Russian scientific journals, since 1947. The preface states that the authors have "spent years making a close study of the whole problem of the propagation of electromagnetic waves along transmission lines using all the resources of matrix calculations and mathematical analysis, and in particular making extensive use of cylindrical functions." These essays, although short, are involved and make no concessions towards the interpretation in engineering terms of the theoretical results. An engineer interested in electromagnetic wave propagation on transmission lines will probably already have simpler methods of attack at his command which may be less rigorous because of the assumptions involved, but which will produce answers of acceptable trustworthiness for practical purposes with much less difficulty.

There are a number of references at the end of each essay, some of them being in English. The translation into English is good, and familiar mathematical conventions have been adopted by the Editor. It is a book for a mathematical reference library rather than an engineer's personal bookshelf.

C.F.F.

The Post Office Network of Radio-Relay Stations

Part 2—Reliability, Performance and Maintenance

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U.D.C. 621.396.7:621.396.65

Part 1 of this article described typical modern radio-relay links and the network of them that is now being constructed in the United Kingdom. Part 2 describes the reliability, performance and maintenance of such links. The limits specified for noise and interference are discussed in relation to television and telephony systems, and the effects of various types of distortion are also dealt with.

RELIABILITY

To achieve the high standard of reliability required for trunk broadband microwave systems, stand-by, or so-called protection, broadband channels are provided that are automatically switched to replace a faulty working channel, with a break in transmission of only 1 ms, or even less (1 μs) where switching is carried out at the intermediate frequency. From an economic standpoint it is important that, wherever possible, common equipment should be shared between several broadband channels, and, within the limits of adequate overall reliability, this principle is now being extended to the use of common protection channels.

Until about 1959, protection channels were provided on a basis of one per working channel, as most routes had not developed sufficiently to require more than one working channel. Now that multiple-microwave-channel routes exist, the protection channels are shared between several working channels, with a consequent economy in cost of provision of circuits and in the use of the radio-frequency spectrum. It may, on certain routes, be possible to share one protection channel between five working channels, switched end-to-end over five repeater sections, without any significant reduction in reliability. Further experience will indicate how nearly this degree of sharing can be approached. It is probable, however, that, for systems requiring an exceptional degree of reliability, e.g. international connexions for telephony or television and main city-to-city routes carrying a large number of telephone circuits or serving a number of national television-broadcast transmitters, two protection channels will be used for groups of up to six working channels.

Switching is controlled by pilots associated with the baseband signals transmitted; control signals operated by pilot detectors, and supervisory signals to operate remote indicators, are sent between the intermediate and terminal stations of a link over a 4-wire line telephone circuit of nominally zero loss, or, alternatively, over a separate auxiliary radio channel operating in the same frequency band as the main broadband channels and using the same aerial system.

Arrangements are made at each station on a radio-relay route for a stand-by power supply to become operational when the normal mains power supply fails. On routes which are of minor importance and carry television only, the stand-by power plant normally used consists of an automatically-started diesel-driven generator-set. On main television routes and on routes carrying multi-channel telephony, continuously running continuity-type power-supply sets are used and no break in transmission occurs if the mains supply fails. The present trend in radio-equipment development is, however, towards "all solid-state" operation; it is expected that by 1967 links will be in operation with equipment powered entirely by low-voltage batteries.

PERFORMANCE

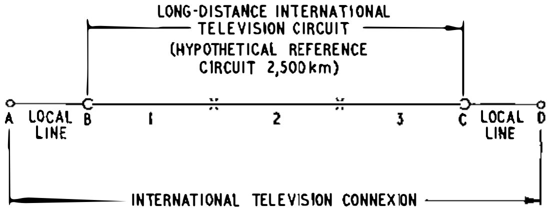
Early radio-relay links in the United Kingdom were suitable only for 405-line monochrome-television transmissions, but the advance in design and techniques of microwave systems in the past 10 years has been such that the Post Office now specifies that new microwave links shall be able to carry satisfactorily, as an alternative to a 625-line colour-television signal, 960 telephone channels or, on certain main routes, 1,800 telephone channels.

International Requirements

To facilitate the interconnexion of national microwave communication networks to form international networks, a large measure of standardization of the characteristics of the links forming national networks is required. The international organization responsible for co-ordinating this work is the International Radio Consultative Committee (C.C.I.R.), which works under the auspices of the International Telecommunications Union. The C.C.I.R. has now recommended standards[1] for most of the important characteristics of long-distance microwave systems, and the British Post Office, which takes a leading part in the work of the C.C.I.R., specifies its own microwave links to comply with these recommendations. Two of the most important aspects covered are the pattern of use and the precise value of the radio frequencies to be used within the frequency bands available for microwave links; the bands allocated in this country to the Post Office for such links are in accordance with international agreements of the Administrative Radio Conference. Other aspects are the nature of the signals which the links are to carry and the amount of noise and distortion that may be permitted. These last two aspects have been carefully co-ordinated with the international body dealing with line systems in order that line and microwave-radio systems may be readily interconnected and that the same overall quality of transmission may be achieved regardless of whether line or radio is used.

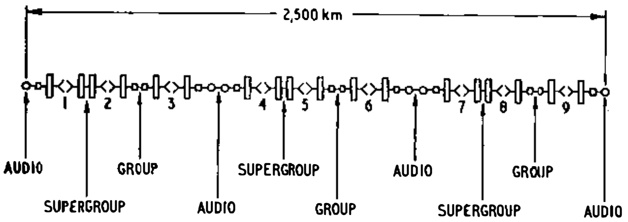
The C.C.I.R. recommendations for the performance of international television circuits are given in terms of the performance of a hypothetical reference circuit (h.r.c.) consisting of three equal sections (Fig. 12(*a*)), inter-connected at video frequency and totalling 2,500 km in length. Such a circuit is too long for direct use in planning television links in this country, where the average circuit length is approximately 100 miles, so division of the h.r.c. is used with consequent adjustment to the overall performance requirements. The fact that many microwave radio systems are required to carry frequency-division multiplex (f.d.m.) telephony signals is

†Inland Radio Planning and Provision Branch, E.-in-C.'s Office.



O Terminal video points
X Intermediate video points

(*a*) Television



Channel modulator — Supergroup modulator

Group modulator — Radio modulator or demodulator (with baseband input or output)

(*b*) Telephony

FIG. 12—INTERNATIONAL STANDARD HYPOTHETICAL REFERENCE CIRCUIT

also considered when deriving performance targets from the C.C.I.R. recommendations. For this purpose a h.r.c. (Fig. 12(*b*)) of the same overall length (2,500 km) forms the basis of the performance requirements but is divided into nine sections at the junctions of which there are telephony multiplexing equipments; this arrangement simulates the building up of a typical international circuit.

The more important performance standards for international radio-relay systems have been determined by Study Group IX of the C.C.I.R. The recommendations of this Group cover such aspects as:

(*a*) overall transmission performance for telephony, television and telegraphy,

(*b*) baseband characteristics,

(*c*) intermediate-frequency characteristics,

(*d*) modulation characteristics of the radio-frequency carrier,

(*e*) radio-frequency characteristics in multi-channel systems, and

(*f*) characteristics of the supervisory, control and monitoring systems needed for maintenance purposes.

Modulation Characteristics

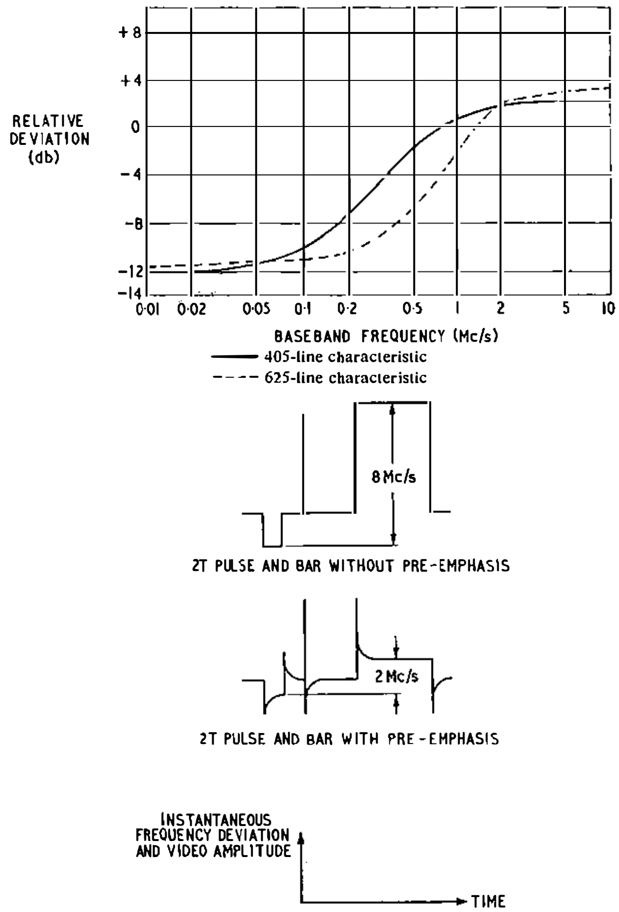
Frequency modulation (f.m.) is universally employed. Briefly, the advantages of f.m. may be summarized as follows:

(*i*) The signal-to-noise ratio in a television channel is greater than can be obtained using amplitude modulation (a.m.) under comparable conditions. In addition, the human eye can tolerate a greater total noise in a television picture when the noise has a triangular spectrum, as is broadly so in f.m. systems, than when the noise spectrum is uniform, as with a.m. systems. This tolerance is of the order of 4 db for both 405-line and 625-line systems.

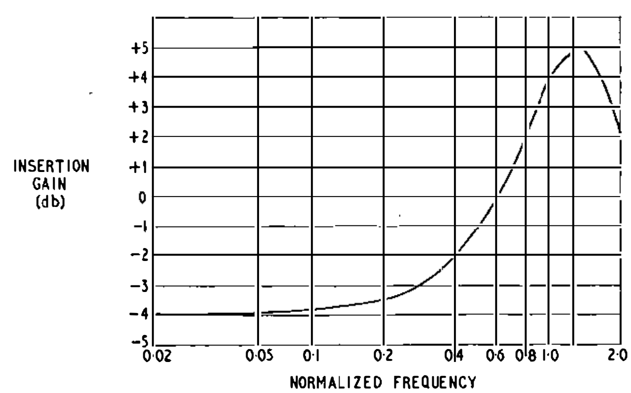
(*ii*) The high degree of linearity in the overall input-to-output relationship, which is particularly necessary to avoid intermodulation in a multi-channel telephony system, is more readily achieved using f.m. than it is when a.m. is employed.

(*iii*) Limiting in receivers and repeaters can be used to prevent changes in the level of the baseband output signal when fading occurs in the transmission of the microwave signal.

Television Systems. The standard frequency deviation used for all modern systems carrying television is 8 Mc/s peak-to-peak, with either sense of modulation. This deviation characteristic is modified by the use of pre-emphasis (Fig. 13(*a*)), which has the effect of increasing



(*a*) Pre-Emphasis Characteristics for 405-Line and 625-Line Television Systems



0 db insertion gain corresponds to an r.m.s. deviation of 200 kc/s and a normalized frequency* of 0·608

(*b*) Pre-Emphasis Characteristic for Telephony

FIG. 13—PRE-EMPHASIS CHARACTERISTICS

*Normalized frequency $= f/f_0$, where f is baseband frequency of any telephone channel in a f.d.m. assembly, and f_0 is the highest frequency in the f.d.m. baseband spectrum.

the symmetry of the vision waveform about a fixed datum level and, thus, the symmetry of the f.m. power spectrum of the radio carrier. This is of considerable value in reducing distortions originating in the i.f. and r.f. sections of the radio system, thus greatly facilitating the transmission of colour signals or a sound program by means of a sub-carrier. Pre-emphasis also enables a single type of modulator to be used alternatively for television and f.d.m. telephony.

Telephony Systems. The standard r.m.s. deviation of the r.f. carrier due to test-tone (power 1 mW) at a point of zero reference level in any telephone circuit is 200 kc/s for links carrying 960 telephone circuits and 140 kc/s for links carrying 1,800 telephone circuits. For the reasons given below, these values are modified by the use of pre-emphasis. In the absence of pre-emphasis, the fluctuation noise in the baseband output of a frequency-modulation system has a substantially "triangular" distribution, i.e. the noise voltage in a given narrow band is proportional to the centre frequency of that band. Thus, in f.d.m. telephony systems the signal-to-fluctuation-noise ratio in the telephony channels would vary in accordance with the position of the channel in the baseband, and the telephone channels situated in the lower part of the f.d.m. baseband would have an appreciably better signal-to-noise ratio than is necessary. It is reasonable, therefore, to attempt to obtain a more economical system, having a uniform signal-to-noise ratio in all the channels, by increasing the carrier frequency deviation for the upper channels relative to that for the lower channels. However, if this process is carried too far, the level of intermodulation noise in the lower-frequency channels becomes excessive. A compromise is therefore necessary, and the preferred pre-emphasis characteristic shown in Fig. 13(*b*) has been adopted for f.d.m. multi-channel systems with capacity up to 1,800 telephone channels.

Noise and Interference

Any consideration of signal-to-noise ratio on the radio link is, because of occasional fading, a statistical one relating noise with time. The amount of fading that can be tolerated is an economic compromise between grade of service and the cost of provision of the radio link, and the C.C.I.R. recommendations for signal-to-noise ratios reflect this compromise.

Fluctuation Noise in Television Systems. The actual recommendations for the 2,500 km reference circuit are, for a television system of 5 Mc/s video bandwidth, that the signal-to-weighted-noise ratio* should exceed 56 db for more than 20 per cent of any month† when fading is severe, 52 db for 1 per cent of any month, and 44 db for 0·1 per cent of any month. From a knowledge of typical fading characteristics it is possible to specify the noise that could be permitted at the output of a given link under (*i*) the ideal conditions of free-space propagation over every section of a link, and (*ii*) a condition when a 30 db fade existed on any one section, so that the recommended statistical performance for a 2,500 km reference circuit made up of such links may be met.

For a typical inter-city link these considerations lead to a required signal-to-weighted-noise ratio under free-space propagation conditions of 69 db, dropping to not less than 50 db when a fade of up to 30 db occurs on any one section of the link.

Periodic Noise in Television Systems. Periodic noise, or interference, shows on a television picture as a stationary or moving pattern, depending on the frequency of the interference, and has to be suppressed to a very low level. A suppression of 55 db below picture signal, falling to 30 db at the higher frequency end of the baseband, is typical of a modern monochrome link. The requirement for a colour system is more severe, and there should be at least 55 db suppression over the whole baseband spectrum.

Noise in Telephony Systems. The total noise power at a point of zero reference level in any telephone channel of a 2,500 km reference circuit should not exceed 7,500 pW for more than 20 per cent of any month and 47,500 pW for 0·1 per cent of any month. The noise power specified is the total of fluctuation noise and noise arising from intermodulation between the signals in individual telephone channels. Fluctuation noise is mainly contributed by the input stages of microwave repeaters and receivers, and is a function of signal level. Intermodulation noise arises from:

(*i*) non-linearity of the voltage/frequency transfer characteristics of modulators and demodulators,

(*ii*) departures from uniformity in the group-delay/frequency and amplitude/frequency characteristics of i.f. and r.f. portions of the radio links, and

(*iii*) feeder echoes and multi-path propagation effects,

and is a function of traffic loading, being at maximum during the busy hour. Fluctuation noise is assessed under free-space propagation conditions and without traffic passing over the link; for a main link the level of this noise should not exceed 125 pW weighted (— 69 dbm0) in any telephone channel.

The total of fluctuation and intermodulation noise is assessed by applying to the input of the link a uniform spectrum noise signal[2] (of level equal to $-15 + 10 \log_{10} N$ dbm0, where N is the number of telephone circuits) which extends over the baseband spectrum normally occupied by the telephone circuits and simulates busy-hour traffic. Under these conditions the total noise level should not exceed 400 pW weighted (— 64 dbm0) in any telephone channel.

Distortion

Television Linear Waveform Distortion. The transmission performance of television links is now measured and specified in terms of their response to standardized test waveforms.[3] The test waveform used is the now well-known sine-squared pulse and half-line bar, and the result of the test is expressed by a rating factor, *K*. A *K* factor not exceeding 1 per cent is required for a main radio link.

Television Non-Linear Waveform Distortion. A non-linear input-voltage/output-voltage relationship for television transmission links results in brightness gradation faults in the reproduced television picture. Two forms of non-linearity are of importance, and for convenience are distinguished as "static" and "dynamic" non-linearity distortion. Static non-linearity concerns the low and medium baseband frequencies of the vision signal and affects the coarse picture detail, while dynamic non-linearity concerns the higher baseband frequencies and affects the fine picture detail gradations.

In f.m. radio-relay links the distortions arising in the

*Expressed in terms of peak-to-peak picture signal (excluding synchronizing pulses) to r.m.s. noise voltage.

†A month typical of severe fading conditions should be envisaged.

course of transmission, and which result in non-linear distortion of the vision signal, are extremely complex but can be classified under two heads:

(*i*) those caused by the modulation and demodulation processes, and

(*ii*) those originating in the i.f. and r.f. portions of the equipment.

The first named are caused by non-linearity of voltage/frequency transfer characteristics of modulators and demodulators and give rise to "static" non-linearity distortion of the video signals, so-called because the distortion is substantially unrelated to baseband frequency.

The second named arise from linear distortions in those sections of the radio link carrying frequency-modulation signals (e.g. variation in group-delay/frequency and amplitude/frequency characteristics) and result in non-linearity of the video signal received by frequency-to-voltage transfer in the system demodulator. The degree of non-linearity of the video signal is a function of baseband frequency, being most severe at the highest frequency, and is consequently known as "dynamic" or "frequency-dependent" non-linear distortion.

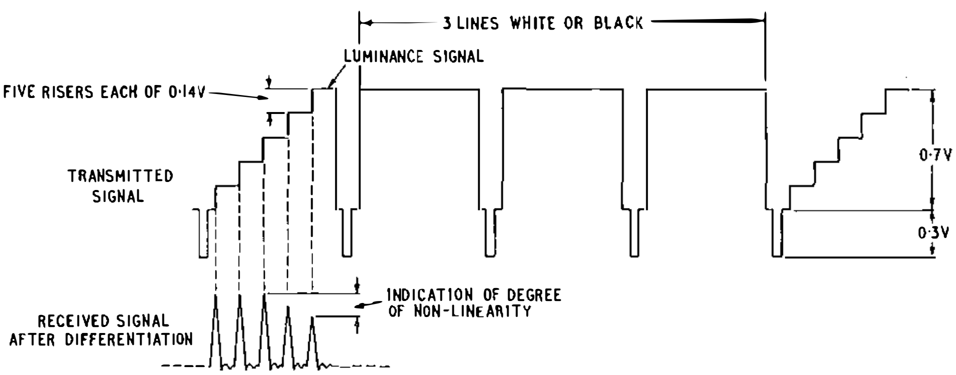
The subjective effect of dynamic non-linearity is relatively small for monochrome television, hence this form of distortion is not at present specified. Static non-linearity is decisive in determining the gradation of a television picture and is assessed by means of the waveform shown in Fig. 14(*a*). At the output terminal of the link, differentiating and shaping networks transform the staircase into an array of pulses of sine-squared shape and 2μs half-amplitude duration. The baseband frequency spectrum of the pulses is substantially confined below 500 kc/s, and they are not substantially affected by linear distortions in the frequency-modulation sections of the radio link. In a perfect transmission system the relative amplitudes of the "risers" would be unchanged by transmission through the link and the pulses would all be of equal height; for a real transmission system the degree of non-linearity is expressed as the difference between the largest and smallest pulses as a percentage of the largest. For a main-line link this distortion should not exceed 4 per cent. Additional requirements are that the amplitude of the synchronizing pulses should not vary by more than ± 2 per cent for any variation in picture content.

Additional Distortion Relevant to Colour Transmission

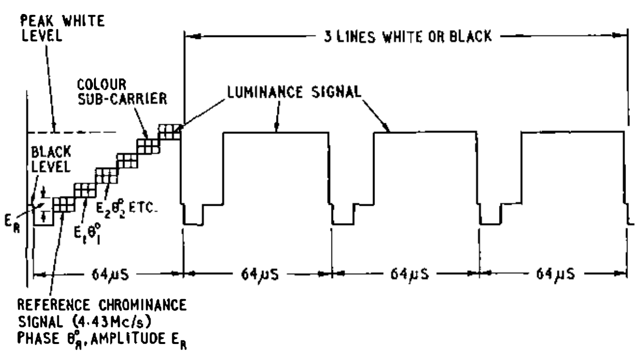
(*a*) *Luminance–Chrominance Crosstalk.* The assessment of dynamic non-linearity distortion assumes great importance when considering the transmission of colour-television signals. This arises from the fact that for the N.T.S.C.‡ system the colour information is conveyed by a double modulation of a 4·43 Mc/s sub-carrier in the baseband frequency spectrum. Colour "hue" is represented by the instantaneous phase of the sub-carrier relative to a reference burst of unmodulated sub-carrier oscillation located at black level in the "back-porch" of the vision waveform. Colour saturation (or the extent to which the hue is undiluted by white) is represented by the amplitude of the sub-carrier.

Changes in either the amplitude or phase of the sub-carrier may occur when the luminance (monochrome) signal level changes (these are known as differential gain and phase changes) and they may thus lead to "hue" and "saturation" errors in the reproduced colour picture. This distortion is known as luminance–chrominance crosstalk and is caused by non-uniformity of the group-delay/frequency and amplitude/frequency characteristics of the i.f. and r.f. circuits of the radio link. It can be minimized by the use of suitable equalizers, provided that the characteristics of the radio link are sufficiently stable. To measure the amount of this distortion, a burst of colour sub-carrier is superimposed on each luminance tread of the staircase waveform as shown by Fig. 14(*b*), all bursts having the same phase and amplitude. After transmission, the sub-carrier signal is filtered from the luminance signal and the amplitude and phase of each burst is compared to that at black level. The tentative limits for a main link are 2 per cent for differential amplitude and 1° for differential phase change.

(*b*) *Other Distortion.* Other forms of distortion that have to be considered are luminance/chrominance gain and delay inequalities. These distortions result in changes in the general saturation and mis-registration of



(*a*) Television Non-Linearity Distortion Test Waveform



In the test signal, $E_1 \angle \theta^\circ_1$ etc. $= E_R \angle \theta^\circ_R$.
At the receiver, differential phase shift $= \theta^\circ_R - \theta^\circ_1$ etc.,
and differential amplitude $= (E_R - E_1/E_R) \times 100$ per cent, etc.

(*b*) Colour Television Non-Linearity Distortion (Luminance-Chrominance Crosstalk) Test Waveform

FIG. 14—NON-LINEAR DISTORTION TEST WAVEFORMS

‡N.T.S.C.—American National Television System Committee.

colours in the final picture. The effect can be measured by transmitting a "scaled down" pulse-and-bar waveform over the luminance channel and a double-sideband amplitude-modulated version of the same waveform over the chrominance channel,[4] and comparing the amplitudes and times of arrival of the two pulses. Suggested target limits are $\pm$ 4 per cent for gain inequality and $\pm$ 40 ns for delay inequality.

Gain Stability

The overall stability with time of the transmission gain of a microwave television link is of great importance, particularly with the growth of network switching, which enables programs for a given transmitter to be taken from many different sources in the course of an evening. Limiters fitted in receivers and repeaters, backed up by rapid-acting automatic gain control, maintain output-signal levels constant for all but the most severe fades, and long-term equipment deterioration is checked and corrected by regular maintenance. Also, power-supply variations may cause the gains of video amplifiers to vary, and equipment designers make every effort to minimize this effect.

British Post Office stability requirements are that the overall transmission gain of a television link for any frequency between 10 kc/s and 6 Mc/s shall not vary by more than $\pm$ 0·3 db per day or $\pm$ 0·7 db per month, and, in general, these limits are achieved.

Stability of the transmission gain with time is also important for multi-channel telephony, and the requirements for a link of any length up to 175 miles are that the gain variation shall not exceed $\pm$ 0·25 db per day or $\pm$0·5 db per month. Certain earlier links required automatic baseband gain-regulation to achieve the requisite stability, but this is unnecessary for modern equipments.

MAINTENANCE

One of the most noteworthy improvements that has occurred as microwave radio-link equipment has been progressively developed has been the reduction in the amount of routine maintenance work necessary. Links are now being installed that require only one-third of the maintenance attention needed by older links still in service, and as confidence in the new designs grows it should be possible to reduce maintenance effort still further. The improvement in reliability that makes such saving possible stems from two lines of development which have been proceeding together since the exploitation of microwaves for communication purposes first began.

In recent years, refinements in technique and the gradual introduction of equipment operating in the higher microwave-frequency bands have led to considerable reductions in equipment size so that, for a given standard of performance, the actual volume of equipment to be maintained is now very much less than hitherto. This trend, coupled with the general improvement in circuit design and of electronic components that is taking place, should improve reliability still further.

The second line of development that has made for reduced maintenance has been the improvement of the testing methods used. Early testing methods were unrelated to the nature of the traffic to be carried, and performance limits were set which related the link parameters in an empirical way to the tolerable distortions of the traffic. Such methods have now been replaced almost entirely by tests in which the test signal simulates the traffic carried by the link, and the distortions measured are those which affect the type of traffic carried. In this way no effort is expended in unnecessarily maintaining those aspects of the link performance which are without significance to the type of traffic involved. Such pragmatic testing methods give results that are easily interpreted in terms of day-to-day performance, and permit the use of test equipment that is easy and quick to operate.

CONCLUSIONS

Progressive developments in microwave-radio techniques during the last 15 years now enable the Post Office to provide microwave radio-relay links as a practical alternative to coaxial line links for the transmission of multi-channel telephony or television, and the construction of a national network of microwave radio-relay links is now in hand to meet the growing demands for trunk telephone circuits and for the distribution of 625-line television.

International standards for most of the important characteristics of microwave systems have now been recommended by the C.C.I.R., and the British Post Office, which takes a leading part in the work of this body, specifies its own links to comply with these recommendations.

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On-Site Adjustment Checks of Telephone Exchange Equipment Installed by Contract

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U.D.C. 621.395.722:621.395.6.001.41

The methods adopted for checking the adjustment of equipment during the acceptance tests of the earlier automatic exchanges are recalled, and the difficulties associated with these methods when applied to the later 2,000-type equipment are discussed. The evolution of on-site testing methods that have enabled these difficulties to be avoided is described.

INTRODUCTION

FROM the early days of automatic telephone exchanges, when the need for a clearly defined method of accepting equipment from the manufacturers became apparent, adjustment checks have been made on a proportion of the mechanical devices used for automatic switching. The first scheme, which consisted of a check of a small percentage of the equipment, was introduced in conjunction with a series of acceptance-testing specifications and acceptance testers at the start of the conversion of the London area to director-type automatic-exchange working.

Early Methods

In the early days of automatic switching equipment each manufacturer installed equipment to his own design, and, hence, there were no Post Office specifications with reference to which the equipment could be examined and, if unsatisfactory, rejected. Nevertheless, at each exchange, small quantities of equipment were checked for correct adjustment using the manufacturer's bulletin, and if in the opinion of the Post Office Clerk of Works the results were unsatisfactory then the attention of the manufacturer's installer was drawn to any discrepancies found. In the latter part of this pre-2,000-type equipment era, agreement was reached with the manufacturers that the Post Office maintenance-adjustment instructions should be used as criteria for accepting adjustments.

With the introduction in the mid-1930s of Post Office standard equipment such as the 3,000-type relay, the No. 1 type uniselector and the 2,000-type two-motion selector, for which standard manufacturing specifications with adjustment requirements were produced, it became possible to take more positive action on site when specification requirements were not met. During this period it was usual to examine 5 per cent of all uniselector and selector mechanisms and 1 per cent of all relays except 3,000-type red-label relays; these relays were given special treatment and 20 per cent of each code type were examined. Additionally, of all types of relays 20 per cent were examined for visible buffer-block clearances. However, as with the earlier types of equipment of the manufacturers' own designs, it was left to the Clerk of Works to decide whether the results of the examination could be considered satisfactory and the mechanisms accepted, or the quantity of adjustments failing to meet the specification was excessive and likely to cause trouble in service; in the latter circumstances he was able to reject the mechanisms affected. This rejection might apply only to certain features, but, if the adjustments were generally bad, the complete exchange would be rejected as unsatisfactory for the type of mechanism under consideration.

This method of treatment, whilst reasonably satisfactory for items such as relays requiring only a small number of adjustment checks per item, became a serious problem when the 2,000-type selector mechanism was considered. There are over 100 different adjustment checks for this item, and if the installer was given a general rejection for a whole exchange he had a most difficult task to decide how best to clear up the trouble to the satisfaction of the Clerk of Works. This could seriously delay the completion of an installation, and, as a result, the Clerk of Works tended to accept selectors in a poor state of adjustment. This became more apparent in the post-war period when 2,000-type equipment was installed in larger quantities.

The method of acceptance of adjustments was severely criticized by the maintenance staff in many different parts of the country, and in some instances, immediately after the equipment had been accepted from the manufacturer and before the exchange was put into service, the exchange-maintenance staff were completely overhauling selectors and adjusting them in accordance with the Post Office maintenance adjustment instruction. It was doubtful in many instances whether this was justified, but the position was made worse by the fact that this type of selector was still affected by minor design problems, and the standard of adjustment offered by the different contractors varied considerably. It was obvious that this situation could not be allowed to continue, and consideration was given to a scheme of acceptance testing whereby the Clerk of Works would be able to reject the equipment if a required standard of adjustment was not reached.

INTRODUCTION OF A SAMPLING METHOD

To assist Clerks of Works to apply a consistent check a sampling method of acceptance testing was introduced, the basis of which was to check a fixed percentage of items of each type on a rack before the equipment was subjected to functional tests. In order to obtain a reasonable size of sample it was necessary to increase the percentage of all types of items checked, except 3,000-type red-label relays; the percentages used were 5 per cent of all other relays and 10 per cent of uniselector and two-motion-selector mechanisms. Acceptance of each particular adjustment was dependent upon the number of faults found, but, if this figure was reached or exceeded, a "general rejection" was made for this feature only. In these circumstances the contractor was expected to check over all items on the rack for this adjustment before re-offering it to the Post Office for further examination. The second examination consisted of a check of items previously found faulty plus a check of a further sample of similar size. To safeguard the position, where the adjustments were generally bad, an overall rejection for all adjustments was made if the total number of faults exceeded 4 per cent of the checks made.

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The scheme suffered from the fact that the samples in many cases were too small to obtain reliable results, mainly because the tests were done on a rack basis—a convenient "unit" of equipment for most other tests, and the normal quantity for a contractor to offer for test. It also doubled the time previously spent on these tests. In the circumstances, however, the scheme fully justified itself, as, apart from producing a more consistent standard for accepting adjustments throughout the country, at first it resulted in many rejections being made, bringing to light a considerable variation in the standards of the adjustments on equipment supplied by different manufacturers. At about the same time the manufacturers abandoned the practice of making final adjustments on site and agreed to the introduction of a quality-control sampling inspection scheme for selectors at their works. As a result of the improved methods of acceptance testing both at the factories and on site the overall quality of adjustment was substantially improved about 1954–55, and the practice of readjusting equipment before it was put into service died out. Having thus achieved the main object of a consistent and improved quality of adjustment, thought was then given to improving the method of sampling and reducing the amount of acceptance-testing time spent on site.

PRESENT SAMPLING METHOD

With the present sampling method, which was first tried out on 2,000-type selectors in 1956, all the two-motion selectors supplied on a contract are treated as one batch, and from this batch a sample is taken and used to assess the quality of the adjustments for the whole exchange. The principle of rejecting the batch of mechanisms in respect of individual adjustments is retained, but the general rejection of the batch of mechanisms in respect of their total faultiness is abandoned; an adjustment is considered to be faulty if it does not meet the requirements of the manufacturing specification. It does not follow, however, that adjustments which are outside the limits of the specification will necessarily prevent a selector from working, although they could cause early service failure.

One important difference of the present sampling method from previous methods is that the check is made before the selectors are jacked into the racks and as early as possible in the installation period of the contract. This gives the contractor ample opportunity to examine and correct any adjustments that have been found unsatisfactory, and delays at a late stage in the installation due to faulty adjustments are, therefore, largely avoided. If the deliveries of selectors are delayed then it may be necessary to sample items in more than one batch as the deliveries are made. This is avoided as far as possible, as it increases the amount of time spent on the check by Post Office staff. The sampling method is divided into two parts: (*i*) initial check, and (*ii*) final check.

Initial Check

For the initial check a double sampling scheme is used in which 25 mechanisms from each batch are first examined for all features except wiper adjustments and those adjustments that can only be checked with the selector on the rack. These are considered as part of the "final check" described later. When the check of the 25 selectors has been completed, the results are summarized for each adjustment check and compared with the "accept" and "reject" figures. Most of the adjustments checked occur only once on each mechanism, but a few adjustments occur three times on average on each mechanism, e.g. some mechanically-operated spring-sets. Hence two sets of figures are used:

	Accept	*Reject*
For adjustments occurring once	0	2
For adjustments occurring three times	2	6

If the number of faults for particular adjustments are between the accept and reject figure a second sample is taken and only these adjustments checked. All other adjustments are either accepted or rejected without further tests. If during the second sample check the reject figure is reached, i.e. by summing the first and second sample check faults, then no further tests are made for this adjustment and it is rejected. On the other hand, if by the end of the second sample check the rejection figure has not been reached then these adjustments are accepted For the adjustments which are rejected the contractor is expected to examine, and correct where necessary, every selector in the batch from which the sample was taken, before installing the selectors on the racks. Any individual faults found during the initial check and which were insufficient to justify rejection are cleared by the contractor.

With the above figures, it can be shown that if the percentage of mechanisms faulty for a particular adjustment is 2 per cent or less then there is a 90 per cent or better chance of acceptance. On the other hand, if the percentage of mechanisms faulty is 10 per cent or more then there is a 90 per cent or greater chance of rejection.

Final Check

In order to be sure that the contractor has taken the appropriate action following the initial check, a further check of the adjustments that were rejected is made when the contractor hands over the racks to the Post Office for functional testing. A similar size of sample is taken, i.e. 25 selectors, and these are spread over as many racks as possible, so as to reduce the amount of final checking. If any faults are found for a particular adjustment then the test is abandoned and the equipment returned to the contractor for further action.

The second part of the final check, which consists of a wiper check, is not made until the first part described above has shown the selectors to be acceptable; at this stage the selectors are unlikely to be removed from the rack for further attention. A 100 per cent examination is made of the wiper adjustments. However, a preliminary examination of two shelves of selectors is first made to assess the general quality of the wiper adjustments, and if this shows the adjustments to be unsatisfactory the Post Office does not proceed with the remaining shelves until the contractor has given the wipers further attention.

CONCLUSIONS

The above method was introduced in 1959 as a new standard form of adjustment check for both 2,000-type and 4,000-type selectors, uniselectors, motor-uniselectors and regenerators, and the introduction of a similar method for relays is being considered. For selectors the method shows a saving of Post Office time of 30 per cent for an installation with 500 selectors and of 70 per cent for an installation of 2,000 selectors, when considering an installation for which the adjustments are of average standard.

Third Plenary Assembly of the International Telegraph and Telephone Consultative Committee (C.C.I.T.T.), Geneva, June 1964

U.D.C. 061.3:621.395

THE Third Plenary Assembly of the International Telegraph and Telephone Consultative Committee (C.C.I.T.T.) was held in Geneva from 15–26 June 1964; it had been immediately preceded by meetings of most of the Technical Study Groups between 25 May and 12 June 1964. A total of approximately 309 delegates, experts and observers attended, representing 67 International Telecommunications Union (I.T.U.) Member Administrations, 14 Recognized Private Operating Agencies, and 6 International Organizations. The United Kingdom delegation of 12 was under the leadership of the Post Office Deputy Engineer-in-Chief, Mr. D. A. Barron, C.B.E. The increasingly world-wide character of the C.C.I.T.T.'s work, which had become apparent at the Second Plenary Assembly,[1] was again in evidence—even more countries being represented for the first time at this Plenary Assembly.

The Plenary Assembly was opened at a formal inaugural session by the Director of the C.C.I.T.T., Mr. Rouviere, and was also addressed by Mr. A. F. Langenberger, head of the Swiss delegation, who had been elected Chairman of the Plenary Assembly, Mr. Gross, Secretary General of the I.T.U., and Mr. Wettstein, Director General of the Swiss P.T.T. All the speakers emphasized the value of the work being accomplished by the C.C.I.T.T.

In addition to the inaugural meeting 11 full sessions of the Plenary Assembly were held. At the first meeting four committees were set up to make recommendations on specific matters:

(*a*) Committee A for questions of working methods and organization of Study Groups.

(*b*) Committee B to examine, and allocate to Study Groups and Working Parties, questions proposed for study during the next 3 years, and to prepare a proposed program of meetings for such Study Groups and Working Parties.

(*c*) Committee C to deal with budget control.

(*d*) Committee D to deal with technical assistance to new and developing countries.

These Committees, each of which had a heavy program of work to complete, met between the formal meetings of the Plenary Assembly.

ORGANIZATION

Study Groups

Appreciable changes in the number and terms of reference of the Study Groups of the C.C.I.T.T. were made at the Second Plenary Assembly of the C.C.I.T.T., and, although some discussion took place on the terms of reference of certain Study Groups, no changes were, in fact, made to the arrangements set up at New Delhi. The 19 Study Groups remain as before.[1]

Plan Committees

Some changes were made in respect of the Plan Committee and its Regional Sub-Committees. The Plan Committee had, up to this Plenary Assembly, acted in a dual capacity: as a Regional Sub-Committee for Europe and the Mediterranean Basin, and as a Co-ordinating World Plan Committee. It was, therefore, decided to reorganize the Plan Committee and its Regional Sub-Committees as follows:

(*i*) World Telecommunication Plan Committee,

(*ii*) Telecommunication Plan Committee for Africa,

(*iii*) Telecommunication Plan Committee for Asia-Oceania,

(*iv*) Telecommunication Plan Committee for Latin America, and

(*v*) Telecommunication Plan Committee for Europe and the Mediterranean Basin,

it being understood that the Regional Committees, as previously, should report to the World Telecommunication Plan Committee.

Joint Working Parties

As some questions requiring study are rather broad and fall within the province of more than one Study Group, it was decided to set up a number of Joint Working Parties, the membership of which would be drawn from representatives of each of the Study Groups concerned, one of those Study Groups being nominated as the Controlling Study Group. Eight such Joint Working Parties were set up as shown in the following table.

Name	Study Groups Involved	Controlling Study Group
1. Costs	I, II, III	III
2. Use of Lines for Telegraphy	IX, XV	IX
3. Message Retransmission	I, VIII, X	I
4. New Telegraph Alphabet	I, VIII, Special A	I
5. World Routing Plan for Telex and Gentex Traffic	I, IX, X	X
6. Synchronous Telegraphy	VIII, IX, X	IX
7. Automatic Maintenance of Telegraph Circuits	VIII, IX, X	X
8. Efficiency Factor	I, VIII, X	X

Standing Joint Working Parties

At the Second Plenary Assembly, a Working Party of Study Group XI was set up to deal with Question 8, which was worded as follows:

"Considering the provisions of Article 13, paras. 177, 178 and 179 of the International Telecommunications Convention, Geneva, 1959.

What guiding principles can be established to assist Administrations in the comprehension, examination and analysis of the problems associated with the development of national telephone switching networks and the determination of the suitable equipment, taking into account the various local, inter-local, and international aspects concerned?

[1]Second Plenary Assembly of the International Telegraph and Telephone Consultative Committee (C.C.I.T.T.), New Delhi, December 1960. *P.O.E.E.J.*, Vol. 54, p.130, July 1961.

What general recommendations can be given with regard to special items such as the accommodation for the equipment, power plant, air conditioning, etc.?"

To provide an answer to this question, matters outside the terms of reference of Study Group XI had to be considered, and, in fact, portions of the answer to the first part of the question (which has been produced in the form of a printed manual comprising some 241 pages) were provided by other Study Groups.

In the light of the experience gained in handling this question, and the undoubted success achieved by the Working Party, Committee D suggested, and Committee A agreed to, the setting up of four Joint Standing Working Parties to deal with different aspects of problems associated with national networks. These Working Parties will be autonomous—that is, they will report direct to the Plenary Assembly. The four Joint Standing Working Parties are as follows.

(*i*) National Automatic Networks—this is the one which started as a Working Party of Study Group XI; it now has to provide material for the second part of the question quoted above.

(*ii*) Local Networks—Study Groups V, VI, VIII, XII and XV may be interested in this matter.

(*iii*) Comparative, Technical and Economic Studies on Transmission Systems—Study Groups IX, XV and XVI of the C.C.I.T.T., and Study Groups III, IV and IX of the C.C.I.R.* may be interested in this matter.

(*iv*) Primary Power Sources.

Other aspects of questions of concern to the new or developing countries were left with the Plan Committees, as had been decided at the Second Plenary Assembly. In addition, it was proposed that after each meeting of a basic Study Group a digest of what had been achieved, and what it was hoped to accomplish, should appear in the I.T.U. Journal. It was also suggested that the principal Consultative Committee recommendations should be summarized and extracts therefrom published in clear and practical form.

WORK OF STUDY GROUPS AND WORKING PARTIES

One of the most important functions of a Plenary Assembly is to consider the work carried out by the individual Study Groups since the last Assembly and to approve any new or amended recommendations proposed by these Study Groups. The following is a brief summary of the work of the Study Groups.

Study Group I (*Telegraph Operation and Tariffs*)

The most important achievements were acceptance of the reports of two joint Working Parties, one on the codes and operating procedures to be adopted for the automatic retransmission of telegraph messages, the other on a world-wide numbering plan for telex and gentex and the basis of an intercontinental transit-switched telex and gentex network.

The agreed message-retransmission format provides codes for number checking, routing, classification of priorities of telegrams, and accounting, leaving administrations free to determine their own engineering solutions and the degree of sophistication they desire. Some problems are still to be studied including those of interface between circuit-switching and message-switching procedures.

Among other points of interest were the following:

(*i*) The Study Group decided against adopting a uniform moment in the telex signalling sequence when charging should begin since the speed of subscriber selection varies with different conditions. A uniform moment of charging would have necessitated complicated adjustments by administrations between subscribers' and inter-administration accounts.

(*ii*) A recommendation was agreed revising the rates of remuneration for telex terminal and transit services on the basis of a cost study undertaken earlier.

(*iii*) It was decided to study further the basis of charging for automatic telex calls made over automatically error-corrected (ARQ) radio and mixed cable and radio circuits, and, as a separate question, the pattern of intercontinental telex rates.

(*iv*) Agreement was reached on operating procedures for intercontinental photo-telegraphy. Some questions remain for further study.

Study Group II (*Telephone Operation and Tariffs*)

New operating instructions for the intercontinental telephone service were adopted. They provide for the eventual introduction, by bilateral agreement, of station-to-station calls, and the replacement of the present person-to-person call service by a somewhat different personal call service carrying a fixed surcharge for each call in addition to the station-to-station call charge.

The Study Group also dealt with the operating procedure and charges for collect calls, but the study of the use of credit cards is to be continued.

New questions were set for study concerning methods of accounting for calls in semi-automatic and automatic service, especially in view of the difficulty of recording the route followed under conditions of automatic alternative routing.

Study Group III (*General Tariff Principles. Lease of Telecommunication Circuits*)

A new recommendation was approved on the subject of conditions and rates for leased circuits. Another recommendation was issued on costs and services rendered when rates are fixed. It was also decided to set up a working party to study the economic aspects of telecommunications, such as, for example, the proportion of a national investment plan, or of an economic budget expressed in terms of national revenue, set aside for telecommunications.

Study Group IV (*Maintenance of the International Network*)

Study Group IV has extensively revised the maintenance recommendation for international circuits which will be published in the new Volume IV of the C.C.I.T.T. Blue Book. A major part of the work of Study Group IV has concerned the modification of the existing recommendation and drawing up new ones to cover the needs of very long circuits, groups, etc., in the intercontinental telephone network. The study of automatic testing, to replace manual testing for circuits, has continued and a specification for automatic transmission-measuring equipment has been drawn up. There is to be a field trial of the latter equipment in Europe during the coming session of the C.C.I.T.T. In the future, automatic testing will replace the present manual methods for routine testing on international circuits, and this will result in significant savings in man-power and reduce the

*C.C.I.R.—International Radio Consultative Committee.

time that circuits are taken out of service for testing. The field-trial equipment will enable circuit losses to be measured at 400, 800 and 2,800 c/s, and the circuit noise to be checked; the results of the measurements will be printed out automatically on teleprinters at each end of the circuit being tested. Experience on batch-testing methods of large groups of circuits has been accumulating, and these methods are now being used for routine testing of circuits in the international network.

Study Group V (Protection Against Dangers and Disturbances of Electromagnetic Origin)

The main effort has been to make available two additional parts of the Directives for approval and publication.[2] These are: Chapter XVIII—compensating effects of rails, booster transformers, and return conductors in the case of alternating-current electric-traction lines; and Chapter XXII—protection of telecommunication installations against the adverse effects of high earth potentials in the neighbourhood of electric installations. Both these subjects have current and world-wide interest.

Other work in hand but not completed includes, in co-operation with Study Group VI, the preparation of a new set of instructions on measures of protection against lightning, and, in co-operation with Study Group XV, the protection of power-feeding systems on small-diameter coaxial cables against the effects of lightning and of magnetic induction from power systems.

There is a general expansion in the work of the Study Group because of the problems associated with increasing use of electric power in industry and for traction, coupled with the wider application of telecommunication cables with plastic sheaths. Both these factors call for watchful attention to interference and earthing problems.

Study Group VI (Protection and Specifications of Cable Sheaths and Poles)

When revision of the text of the recommendations for the protection of underground cables against corrosion was agreed at New Delhi in 1960 certain parts were not then complete and the main work of the Study Group in the interim period has been to make outstanding sections available. Additional parts submitted for Plenary approval were:

Chapter IV—stray currents and how to reduce them,

Annex to Chapter VII—protective measures against explosive gases and toxic gases which may be encountered in cable chambers or other underground structures,

Chapter VIII—arrangements, other than cathodic protection, for protecting cable networks against stray or other harmful currents,

Chapter IX, Part B—cathodic protection against stray currents, and

Chapter X, Part B—stray currents. Measurements of special application to the determination of the value of stray currents and also of earth currents.

The pattern of the Study Group's work is necessarily changing to some extent due to the increasing use of plastic cable sheathings and the need for considering their physical and mechanical properties and related jointing problems. There is also an increasing interest in methods of keeping cable sheaths under gas pressure.

Study Group VII (Means of Expression)

Study Group VII is responsible for the C.C.I.T.T. "List of Essential Definitions" (Yellow Book). The International Electrotechnical Commission (I.E.C.) also publishes an "International Electrotechnical Vocabulary," which covers the whole field of electro-technology, and has been working for some years on a section dealing with telephony and telegraphy. Both organizations agree that for concepts of common interest, there should be, so far as possible, a single international wording approved by each of the bodies concerned, although progress so far has been slow.

It was therefore proposed to, and accepted by, the Plenary Assembly that the Director of the C.C.I.T.T. should investigate with the I.E.C. an organization, and the working methods to be used, for drawing up a common vocabulary of telecommunication terms and definitions.

In the meantime, as supplies of the Yellow Book were running low, it was proposed to the Plenary Assembly, and agreed, that a new volume should be published incorporating:

(*a*) Part I (2nd impression 1961), in English and French,

(*b*) Supplement I to (*a*),

(*c*) additional terms and definitions approved at the Third Plenary Assembly,

(*d*) items (*a*), (*b*) and (*c*) in Russian and Spanish, and

(*e*) terms only in German, Italian, Dutch, Polish and Swedish.

In addition, a separate publication should contain terms and definitions concerning data transmission in English, French, Russian and Spanish.

An earlier recommendation that the I.T.U. and its Administrations should use the system of units known as the M.K.S.A. (or Giorgi) System was brought up to date. The recommendation is now in respect of the "Système International" (abbreviated as S.I.).

Study Group VIII (Telegraph Apparatus)

A recommendation was issued on the technical standards for start-stop telegraph apparatus suitable for operation at 75 bauds, to International Alphabet No. 2. The characteristics for start-stop apparatus with modulation rates of 100 and 200 bauds (to Alphabet No. 2) will be studied.

To enable a subscriber's telex number to be included in the answer-back code, agreement was reached to make one additional character available for this purpose.

The Working Party on Synchronous Telegraphy was maintained and given a wider question for the study of the characteristics of a synchronous telegraph system using the full bandwidth of the bearer circuit.

For ARQ systems a modified recommendation corresponding to No. 342 of the C.C.I.R. was adopted: the changes mainly relate to the abandonment of the 5-character repetition cycle and to the adoption of automatic phasing. Interest was also expressed in character-storage devices and in the need to fix the minimum storage capacity.

The Study Group felt that it was desirable to hold an early meeting of the Joint Working Party for the New International Telegraph Alphabet. The study of a Regional Alphabet was abandoned, the proposal having elicited insufficient interest.

Study Group IX (Telegraph Transmission)

The study of 15 questions was completed. Greater

[2]The C.C.I.T.T. Directives. (In this issue of the *P.O.E.E.J.*).

precision was given to some of the definitions and procedures for measuring telegraph distortion and error rates. Some outmoded recommendations were deleted while others were amalgamated. In conjunction with Special Study Group A (see report below), a draft list of terms and definitions for data transmission was drawn up.

For v.f. telegraph systems, a series of recommendations was issued for f.m. systems capable of operation at 100 and 200 bauds, and also for a composite system providing circuits for operation at 100 and 200 bauds in existing 50-baud systems. A recommendation was also issued on the maintenance of f.m.v.f. telegraph systems.

In conjunction with the C.C.I.R., further study was given to the preferred methods of operation for various types of radio-telegraph circuit, e.g. h.f., line-of-sight, and tropospheric scatter.

New questions set for study included permissible noise limits and distortions for various types of telegraph transmission, and limits to mains-frequency harmonics in telegraph bearer-circuits.

The Working Party on Use of Lines for Telegraphy was maintained. Transmission planning was added to the functions of the Working Party for the World-wide Telex and Gentex Numbering and Routing Plan. A Joint Working Party was set up to study Automatic Routine Testing on International Telegraph Circuits.

Study Group X (Telegraph Switching)

Agreement was reached on a number of new recommendations and the amendment of some existing ones. The new recommendations agreed were concerned with the establishment of an automatic intercontinental transit-switching telex network, including the allocation of a list of telex destination codes for a world-wide numbering plan, and the standardization of a new signalling system (Type C) for the transit network. This new signalling system was originally proposed by the British Post Office and the detailed development has been almost wholly done by the British Post Office. This was acknowledged by the Chairman of the Study Group when he gave his report to the Plenary Assembly in specially expressing his thanks to the British Post Office for the leading part they had taken.

Further new recommendations which were agreed were concerned with the message re-transmission network, specifying the message format and factors concerning the operation of the network, and also with a list of destination indicators. The recommendation concerned with telex signalling generally (Types A and B) was amplified to cover access to switchboard and service points, whilst that concerned with telex signalling over ARQ radio circuits was amended to include provision for fully-automatic operation. A new question on the use of the efficiency factor, alone or together with other facilities on radio circuits operated with ARQ equipment to ascertain whether they can be used for automatic switched calls, was set for study.

Study Group XI (Telephone Signalling and Switching)

The main task completed by this Study Group during the period was the production of a specification for an intercontinental signalling system suitable for both semi-automatic and automatic operation over either 3 kc/s or 4 kc/s spaced channels, whether equipped with time assignment speech interpolation (T.A.S.I.) systems or not. Incidental to this, recommendations were also made in respect of the inter-working between this system and the European international 2 v.f. system. Recommendations were also made with regard to the changes required in the latter system to cater for the new world-wide numbering scheme (see report on Study Group XIII below). The new intercontinental signalling system was based on the system which had been designed primarily for semi-automatic operation over transatlantic T.A.S.I.-equipped circuits. Modifications have been incorporated in this system to make it more suitable for subscriber dialling and more attractive for use on non-T.A.S.I. circuits.

The second major task completed was the production of the first two parts of the Manual on National Automatic Networks, which has been referred to earlier.

Other matters covered included recommendations with regard to the frequency-response characteristics of the guard circuits of in-band voice-frequency signal receivers, and interim recommendations as to the limits of psophometric and unweighted noise generated in an international or national 4-wire-switched exchange. Matters carried over for further study include all aspects of the noise performance of exchanges, and the question of control of the insertion and removal, or disablement, of echo-suppressors in a multi-link international connexion.

The main new question for the current period is the specification of a new intercontinental signalling system which will provide more facilities both for administrations and subscribers. Another matter which will be of great interest relates to the possibility of internationally standardizing subscriber push-button telephones, both as regards the layout of the buttons and the signalling system used.

Study Group XII (Telephone Transmission Performance)

The study group has now established a new reference system (NOSFER)* which will, in future, provide the basis for measuring reference equivalents, the old SFERT† having now been discarded. Reference equivalent values to be respected for 95 per cent of calls from or to any given country have been fixed in co-operation with Study Group XVI.

Work is in hand on the performances of artificial mouths, ears and voices that should eventually lead to an instrumental method for measuring reference equivalents that could replace the present subjective method.

The effects of long propagation time and the performance of echo-suppressors have been studied and this has led to provisional recommendations.

Study Group XIII (Semi-Automatic and Automatic Telephone Networks)

The principles of a world-routing plan were approved, based on the concept of automatic alternative routing of traffic through a hierarchy of automatic transit-switching centres. Extension of these principles will be studied to permit the maximum flexibility of routing, taking into consideration the effect of time differences in inter-continental relations and also the concept of network management in relation to fluctuations of traffic flow. A world-numbering plan was also approved.

It was appreciated that some changes might have to be made at a later Plenary Assembly, and in the meantime

*NOSFER—Nouveau système fondamental pour la détermination des équivalents de référence (New fundamental system for the determination of reference equivalents).

†SFERT—Système fondamental Européen de référence pour la transmission téléphonique (European fundamental telephone transmission reference system).

the World Plan Committee and the various Regional Plan Committees were to study what changes might be made without infringing the decisions taken by the Third Plenary Assembly.

Study Group XIII at an earlier meeting had decided to recommend that, as the objections to its use for fully-automatic service were relatively minor, the telephone signalling system used for semi-automatic service on transatlantic calls should, with some relatively small modifications, be standardized as C.C.I.T.T. Signalling System No. 5; the Plenary Assembly, with the support of Study Group XI adopted this recommendation. It was believed that this system might be in service for a long time, perhaps 10 years, before it would be superseded by a new standard system (No. 6). It was decided, however, that because System No. 5 did not provide sufficient scope for full advantage to be taken of all the signalling facilities planned or foreseeable in national networks, the study of a new signalling system (No. 6) should be started immediately. This study is being conducted by Study Group XI, and a question has been set for study by Study Group XIII so that it can keep in touch with progress and consider facilities and cost questions that may arise in the course of development.

Other matters dealt with included checks on the quality of service, including maintenance questions, and recommendations dealing with the measurement of traffic flow, definition of the busy hour, determination of the number of circuits required in automatic service, and automatic methods of recording and analysing traffic.

Study Group XIV (Facsimile Telegraphy)

The study of two questions, dealing, respectively, with the use of f.m. for phototelegraphy and the remote control of facsimile receivers for weather-maps (in conjunction with the W.M.O.), was concluded.

A new recommendation was issued on the characteristics of apparatus for black-white facsimile telegraphy over circuits permanently used for this service.

Other questions relating to facsimile-transmission problems were left for further study, together with a new question relating to phototelegraph transmission over long submarine cables.

Study Group XV (Transmission Systems)

Study Group XV has completed standardization of the small-diameter coaxial cable, 1·2/4·4 mm, corresponding to the 174A Coaxial Cable now standard in the British Post Office network. Considerable progress was made in defining the characteristics of systems for use on this cable covering the transmission of 960 or 1,260 telephone channels, with repeater spacings of 3 or 4 km.

Orderly expansion of trunk networks by radio and cable requires close co-ordination between the standards adopted for cable and radio systems, and general principles and details of the interconnexion of line and radio-relay systems in main repeater stations were formulated during the working period and were taken note of by theC.C.I.R. in time for them to be incorporated in the C.C.I.R. recommendations adopted by the Tenth Plenary Assembly of that organization.

Although the use of group and supergroup reference pilots was agreed as desirable many years ago, their introduction has been gradual, and various difficulties which have arisen have only recently been resolved. Recommendations affecting the protection and suppression of reference pilots have been formulated, and necessary modifications made to the recommendations for translating equipment.

A comprehensive program of bringing the recommendations for symmetrical-pair cable systems up to date on the basis of transistor-type repeaters has been largely completed. Study of the application of transistor-type repeaters to other wide-band systems on coaxial cables will continue during the next study period.

The study of compandors has shown the need for two types of specification: one for compandors to be used on circuits of medium length and a more exacting specification for compandors to be used on very long international circuits. Study of compandor characteristics for telephony continues.

Study of program circuits was concentrated largely on the use of carrier program equipment on long cable or radio-relay systems provided to the standards appropriate to multi-channel telephony. Associated with this study is that of program compandors, and study of these devices continues during the next study period.

Considerable interest has been shown in the use of digital methods of modulation, e.g. pulse-code modulation, for telephony transmission over cables, especially non-loaded audio cables, and a general study of the characteristics of such systems has begun and will continue during the next study period.

The growth in the importance of world-wide telephony had focussed attention on the characteristics of individual circuits which may form part of a complicated chain of circuits in a world-wide connexion. In co-operation with Study Group XVI, study has begun of improvements in the specification of the channel-translating equipment which essentially determines the characteristics of long-distance circuits.

Study Group XVI (Telephone circuits)

The main task of this study group has been to formulate a transmission plan suitable for world-wide telephone connexions, established over as many as 12 circuits in tandem (six of them international circuits) and via 11 intermediate telephone exchanges. The transmission plan takes due account of such factors as attenuation, distortion, noise, echo, delay, crosstalk and instability. The appropriate sections of Volume III for the C.C.I.T.T. Blue Book have been completely redrafted.

The continued expansion of the international network has increased the number of telephone connexions with long propagation times. Long propagation times, particularly when accompanied by echo, seriously impair conversation. This problem has been highlighted by the continuing provision of long transoceanic cable systems and the projected use of satellite communication systems for telephony. A provisional recommendation, based on subjective tests carried out for Study Group XII, has been made which unreservedly permits the use of connexions with up to 150 ms mean one-way propagation time but which prohibits the use of connexions with greater than 400 ms, except in exceptional circumstances. In the range 150–400 ms connexions may be permitted when compensating advantages are obtained. The recommendation effectively prohibits connexions established over two high-level satellite communication systems being offered for public telephony. The problems of successfully integrating satellite circuits into the world-wide network will be studied in the next study period.

In conjunction with Study Group XII, information concerning transmission planning has been provided for the Manual on National Automatic Networks produced by Study Group XI.

Among the many topics to be studied in the future are measuring the loading of transmission systems and reducing the attenuation distortion* on multi-circuit world-wide connexions.

Special Study Group A (*Data Transmission*)

The studies undertaken have covered data transmission over private and switched telegraph and telephone type circuits. Six new recommendations were approved covering the following subjects:

V10 for the conditions for data transmission over the telex network.

V21 for a modem for duplex data transmission at a modulation rate of 200 bauds, primarily for use on the switched telephone network.

V22 for the standardization of modulation rates and data-signalling rates for synchronous data transmission on switched telephone circuits.

V23 for a standard modem for data transmission at modulation rates of 600 and 1,200 bauds.

V24 for the conditions for a standard interface between data-transmission equipment and data-processing equipment.

Special Study Group A thought it desirable to define more clearly its responsibilities for the study of data transmission *vis-a-vis* the International Organization for Standardization (I.S.O.) and the I.E.C., and to this end Recommendation A20 was approved which should avoid overlap of work with these other organizations. An extensive program of the problems yet to be studied was agreed and included the standardization of data-transmission modems for use at signalling rates higher than 1,200 bauds, data transmission over 48 kc/s group and 240 kc/s supergroup bands, error control, and the problems of data transmission in a parallel mode over telephone-type circuits.

Study Group Special B (*Co-ordination of all Matters Requiring Attention for World-wide Semi-Automatic and Automatic Telephone Operation*)

The work of this study group was to ensure that all study groups which would be required to provide information to enable the intercontinental telephone signalling system to be specified, maintained and operated, were apprised of the contributions required from them and the dates by which such information was required. This involved the following aspects: operating facilities and procedures, world-wide numbering and routing plans, intercontinental signalling system, maintenance of intercontinental circuits, and transmission questions having to do with intercontinental working. The success of the work of this study group is apparent from the fact that the new signalling system was specified, world-wide numbering and routing plans were recommended, and general maintenance procedures outlined. The task of this study group for the next period is to effect similar co-ordination in respect of the further development of intercontinental working.

Special Study Group C

Special Study Group C is a joint C.C.I.T.T./C.C.I.R. study group for the special study of problems of circuit noise, co-ordinating the design objectives for carrier systems on cable and radio-relay links.

During the past study period an important feature has been the consideration of world-wide telephony and telegraphy transmission in the light of recent developments in ocean cables and the experiments in communication satellites. Recommendations have been prepared governing the noise performance of plant which may form part of a world-wide connexion.†

Many points of detail have been referred to Special Study Group C by other study groups; design objectives for noise on tropospheric-scatter radio-relay links have been agreed, and general recommendations made for v.f. telegraph transmission.

New topics for study during the next study-period include: the measurement of impulsive noise, including instruments and techniques, with particular reference to data transmission; equipment and techniques for intermodulation measurements on wide-band systems with "white-noise" loading; noise contributions from national circuits.

FOURTH PLENARY ASSEMBLY

An invitation to hold the next Plenary Assembly at Buenos Aires during the first half of 1968 was given by the Government of Argentine, and accepted with acclamation by the Plenary Assembly.

CONCLUSIONS

This note of the proceedings of the Third Plenary Assembly cannot be concluded without referring to the work of the Secretariat under the direction of the Director of the C.C.I.T.T., Mr. J. Rouviere. In spite of organizational difficulties due to the location of various services in different parts of Geneva, the work of the Assembly proceeded smoothly, and documents were produced and distributed with a speed that was amazing. Warm thanks must also be extended to the Swiss Government for providing an interesting and informative day's visit to the Swiss National Exhibition at Lausanne, and to the Canton and City of Geneva who, in collaboration with the Swiss P.T.T., provided a magnificent reception at the Grand Theatre in Geneva.

W.J.E.T.

*Attenuation distortion—defined by C.C.I.T.T. as distortion due to the variation of loss or gain with frequency.

†An important feature of the studies was the establishment of a reference point for the complete connexion to which the total noise power can be referred. This point is the input to the chain of international and intercontinental circuits; at this point the average world-wide call should not encounter a worse noise level than −43 dbm0 psophometric power. The design objectives for the various types of plant involved in world-wide telephone communications have been examined and found to permit this objective being reached. For example, the design of the Commonwealth cable systems (average noise power for all channels of one direction of transmission not to exceed 1 pW/km) and of the associated overland plant (noise power better than 2 pW/km average) is in line with these Recommendations.

New Safety Belt for Overhead Work—Safety Belt No. 3

R. L. HEARSEY†

U.D.C. 614.89:621.315.66

The advent of synthetic-fibre webbing has made it possible to produce a safety belt stronger and more resistant to wear than the conventional leather belt. The design and testing of such a belt, to be known as Safety Belt No. 3, is described.

INTRODUCTION

THE date of introduction of the leather safety belt is obscure; the present specification was written in 1933, but it is thought that similar belts were in use very much earlier. Thus, the design has proved satisfactory over a very long period, but leather is inherently a variable material and very close inspection has always been necessary to maintain a satisfactory quality. In recent years it has become increasingly difficult to obtain the necessary high-grade leather, but at the same time alternative materials have become available with advantages over even the best-quality leather. A new safety belt made of terylene webbing has, therefore, been developed. In view of the long and satisfactory experience with leather belts the general design of the existing Safety Belt No. 1 has been followed for the new belt, but advantage has been taken of the new material to incorporate a number of improvements.

Design Requirements

The points to be considered when designing a safety belt are as follows:

(*a*) The strength must be adequate, and the appearance of the belt must be such as to give the user confidence in it.

(*b*) Resistance to wear and attack by chemicals, sunlight, etc., must be good.

(*c*) The maintenance required must be kept to a minimum.

(*d*) It must be possible to fasten or release the pole belt with one hand.

(*e*) Adjustment of the belt must be as easy and safe as possible.

COMPARATIVE TESTS BETWEEN VARIOUS BELT MATERIALS

During 1961 tests were made to compare the resistance to abrasion and the shock-absorption characteristics of various materials, and the effects of various chemical and physical agents upon them. The materials examined were:

(*i*) leather,
(*ii*) cotton impregnated with balata,
(*iii*) woven nylon, and
(*iv*) woven terylene.

Resistance to Abrasion

Balata belting is used for machine-driving belts; it abrades readily and is, in any case, too stiff to make a comfortable safety belt.

The abradability of leather depends very much on its condition; a dry leather belt can be readily abraded, but a well-oiled one is virtually unabradable. However, since most of the strength of leather resides in the external (or hair) side, abrasion of this surface has a seriously weakening effect on the total strength of the belt.

A woven belt comprising several hundred strands of material retains a high proportion of its maximum strength even after many strands have been cut through. One nylon belt examined had an inner core of red nylon which became exposed when the grey outer layer was worn through; a belt worn to this state was found to have a strength of 40 per cent of the unworn state. Both nylon and terylene have good resistance to abrasion and a high ultimate tensile strength.

Shock Absorption

An important feature when selecting a material for car safety belts is the elasticity of the material: an inelastic belt would stop the motion of the wearer too abruptly for comfort and might damage him in the process; an elastic belt would stretch and rebound with almost the same amount of energy as before and the wearer could be damaged by impact following the backward motion instead of the forward motion. Clearly, the ideal material should absorb the energy in some form less likely to damage the wearer. The synthetic materials do this by plastic deformation and conversion to heat; some of the energy is used in elastic recovery, but the major portion is dissipated in causing permanent stretching of the material. Terylene has more permanent stretch and less elastic recovery than nylon, making it preferable for use as a belt material. Belts made from flax or cotton have low elasticity, as well as very little permanent stretch before they reach the breaking point. In consequence, a relatively small input of energy is sufficient to cause a high-enough stress to break the belt. The synthetic materials, with their much lower deceleration due to the stretching, can absorb a much higher input of energy without reaching their breaking stress. This can be shown diagrammatically by plotting the straining force against the deformation induced by it, as illustrated for three different materials in Fig. 1.

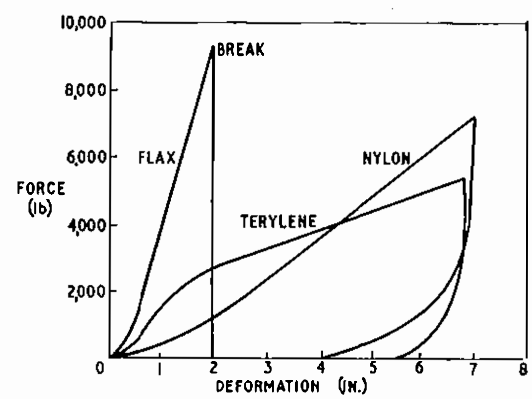


FIG. 1—DEFORMATION CHARACTERISTICS OF FLAX, TERYLENE AND NYLON

In one series of dynamic tests a weight of 170 lb was dropped through a vertical distance of $3\frac{1}{2}$ ft on to a flax belt—the belt broke, but the same weight dropped

†External Plant and Protection Branch, E.-in-C.'s Office.

through 13 ft failed to break belts made of nylon and terylene. These experiments were performed using a metal weight, and it must be realized that a human body, because of its compressibility, would absorb some of the energy; the shock to a belt caused by a human body would, therefore, be correspondingly reduced.

Effects of Chemical and Physical Agents

The materials were tested for resistance to attack by the following agents: water, oil, grease, fungus, sunlight, frost, heat, acid and alkali. Heat, acid and alkali made the leather become brittle. The only condition likely to affect nylon or terylene in service is prolonged exposure to sunlight, which would cause slight deterioration; it would also have the same effect on leather.

These results proved that nylon or terylene is a suitable material for the manufacture of safety belts.

CHOICE OF MATERIAL FOR POST OFFICE SAFETY BELTS

Safety belts are used in the Post Office Engineering Department primarily to prevent a man from falling rather than to break his fall after it has begun. They are, therefore, usually subjected to static load conditions and only rarely to dynamic shock. The sudden whip of a pole when the wires are cut could, however, result in a shock of this type. In such circumstances the terylene belt would be the least likely to break. This, with the high shock-absorption and good resistance to degradation by light, heat and chemicals, makes terylene the first choice as a material for making safety belts, while a serious disadvantage of leather belts is the necessity to dress them at monthly intervals.

It should be noted that if a nylon or terylene belt has become elongated through severe shock loading it should be immediately discarded.

Strength of Webbing

As a result of the tests mentioned earlier, it was decided to set a minimum breaking strength of 5,000 lb for the pole-belt webbing and 2,500 lb for the body-belt webbing of the new safety belt. It was considered undesirable to make use of the greater strength of terylene to produce a much thinner belt than the leather ones; instead a similar size of webbing has been used and this has resulted in a belt having two to two and a half times the strength of the existing type of belt.

Metal Fittings

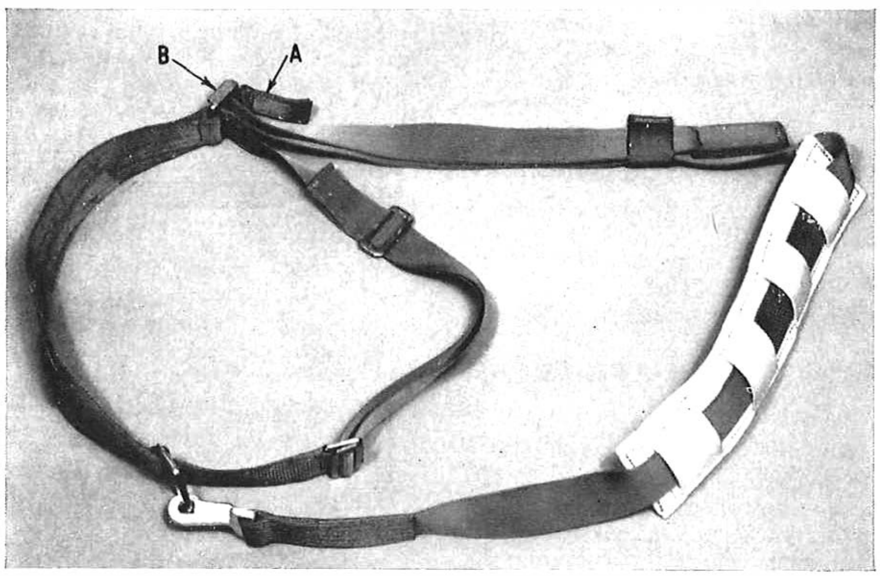
The metal fittings used on the new safety belt are essentially parachute fittings and are designed to be of similar strength to the webbing. With the exception of the snap hook they are manufactured from a nickel-copper alloy. The features of this material are its ability to withstand shock loads, high percentage of elongation before fracture, resistance to corrosion by sea water, and its self-polishing characteristic. The snap hook is a solid forging manufactured from a chromium-molybdenum steel and suitably plated.

The proof loading of these fittings are:

Pole-belt adjuster	2,500 lb.
Triangular D-ring	5,000 lb.
Body buckle	2,500 lb.
Body-belt adjuster	1,500 lb.
Snap hook	2,500 lb.

SAFETY BELT NO. 3

The general form of the new safety belt, Safety Belt No. 3, is shown in Fig. 2. The belt is made from continuous-filament terylene, woven into a webbing $1\frac{3}{4}$ in. wide. It has two parts: a body belt which has a double width of webbing at its back section, and a much longer pole belt. When the Safety Belt No. 3 is to be used the body belt is first adjusted to suit the user's individual requirements by means of the two body-belt adjusters. Although this initial adjustment takes a few minutes, once set it rarely needs to be altered. The body belt is then fastened by two rectangular metal fittings.



A—Release tab. B—Pole-belt adjuster

FIG. 2—SAFETY BELT NO. 3

The pole belt, which passes through a detachable anti-friction pad, is passed round the pole or fixture, the snap hook is engaged with the D-ring—this can be done with one hand—and the anti-friction pad is manoeuvred into position between the pole belt and the pole or fixture. The working position in relation to the pole can be altered, without the user becoming detached from the pole, by means of a self-locking sliding-bar pole-belt adjuster. This adjuster allows the webbing to slide in one direction only, i.e. that required to shorten the loop of the pole belt, and to lengthen the pole-belt loop the locking device has to be released by pulling on a tab attached to the adjuster. As an extra safety precaution the free end of the pole belt is thickened so that it cannot pass through the pole-belt adjuster. Fig. 3 illustrates the operation of shortening the pole-belt loop and Fig. 4 shows it being lengthened.

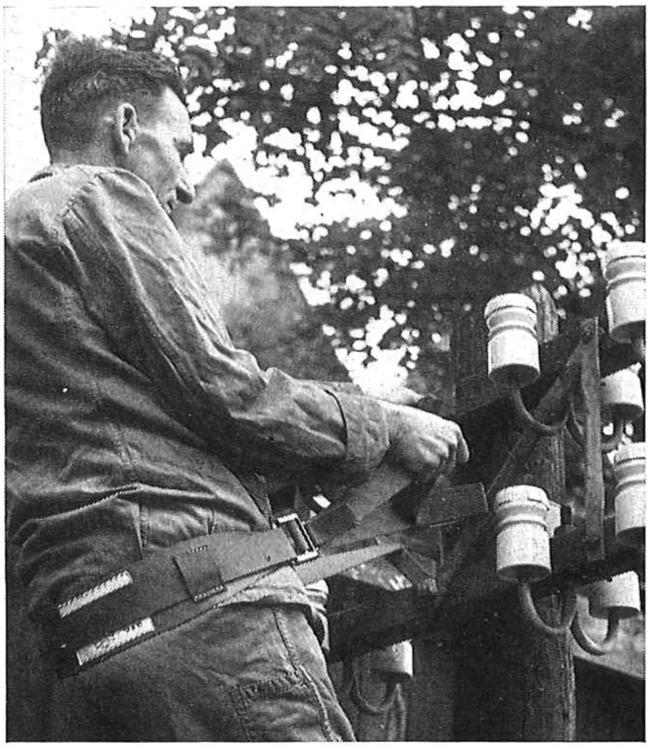


FIG. 3—SHORTENING THE LOOP OF THE POLE BELT

Proof Testing

Apart from a selected number of belts that are tested to destruction, every Safety Belt No. 3 will be tested before use as follows. The body belt will be buckled and the loop subjected to a load of 500 lb. The snap hook on the pole belt will be engaged with the D-ring, and the loop formed will be subjected to a load of 2,240 lb. Any belt showing signs of damage by these tests will be rejected.

FIG. 4—LENGTHENING THE LOOP OF THE POLE BELT

Care in Use

The belt requires no special treatment or dressing during its entire life. It can be cleaned with soap and water, and persistent stains can be removed with white spirit.

CONCLUSIONS

The Safety Belt No. 3 is intended to supersede both Safety Belt No. 1 (for work on poles) and Safety Belt No. 2 (for work on steel radio masts). Field trials have shown that it is more convenient in use than the superseded belts, because of the improved fittings and the greater flexibility of the belt material. Laboratory tests show that it is stronger and more durable than the old belts and that there should be less difficulty in maintaining a uniform standard of quality. There is no longer the need for the 2-slot and 3-slot slides on the new belt with its increased safety factor.

ACKNOWLEDGEMENTS

Messrs. Irvin Air Chute and Messrs. Barrow Hepburn & Gale co-operated in the design of the new safety belt and produced the prototypes used for testing and field-trial purposes.

The measurements of strength and resistance to deterioration were made by the London Materials Section of the Engineering Department's Test and Inspection Branch, who also advised on the materials used.

C

The Selective Tray Conveyor at the Accountant General's Department, Chesterfield

J. H. ALDERSON, M.A., A.M.I.E.E., and F. G. CUMMINGS, A.M.I.E.E.†

U.D.C. 621.867: 651.4

The selective tray conveyor described is the first conveyor of this type to be installed in the British Post Office, and is particularly suited for the transmission of documents from point to point in large buildings. The principal features of the conveyor are the flexible construction which enables it to ascend and descend steeply and to negotiate sharp bends without loss of efficiency and the simple mechanism for selecting the discharge points for the trays.

INTRODUCTION

A NEW building at Chesterfield to accommodate a large part of the Accountant General's Department was officially opened by the Postmaster General on 28 November 1963. This building, known as Chetwynd House, is named after a 19th century Head of that Department who is remembered as the originator of the Postal Order. Chetwynd House was designed at the outset to accommodate mechanical equipment to reduce porterage to a minimum and to facilitate the various clerical and other processes to be performed there.

A selective tray conveyor (see Fig. 1) plays a vital part in the organization of the work of the office and is the first of its type to be used by the British Post Office. This conveyor is provided to assist in the handling of paid postal orders, postal drafts, money orders, pension and allowance forms, and cash accounts returned to the Accountant General's Department by Head Postmasters. The work involved is the sorting, checking, and subsequent storing of these documents for appropriate periods, after which certain documents are returned to other Government Departments and others destroyed by a shredding process. Between eight and nine million documents may be handled in a normal working week, and the majority of them are conveyed on the tray conveyor. The capacity of the conveyor is more than adequate to deal with the present volume of work, and any large increase could be handled by increasing the speed of the conveyor.

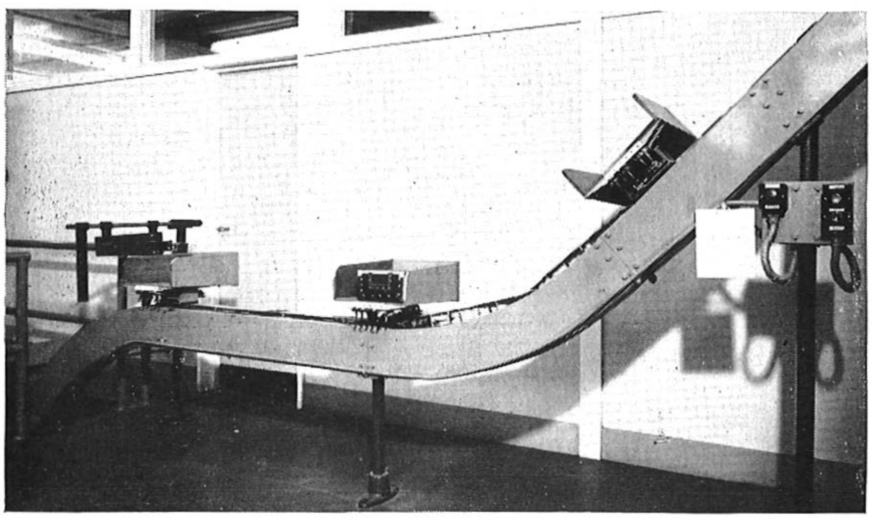


FIG. 1—TYPICAL SECTION OF CONVEYOR WITH LOADING GAUGE

The documents are brought into the building through the reception block on the ground floor, adjacent to the loading bank, where sortation into the different types is carried out at 18 specially-designed sorting desks adjacent to the conveyor (see Fig. 2). The documents are packed in fibre boxes having a total weight ranging from 3–13 lb. The main flow of work is from the reception block to discharge stations on the ground, first, and second floors, and provision is also made for the return of empty boxes and certain documents from the first and second floors to the reception block.

When the problem was first studied, it was apparent that, to meet the functional requirements within the limitations dictated by site and building considerations, a flexible conveyor system able to ascend and descend steeply and to change direction in the horizontal plane was necessary. Noise, headroom and appearance were factors of especial importance in the office-type accommodation, and a high degree of reliability was essential, since it would be extremely difficult to operate a portering system in a building economically designed and staffed for mechanical conveyance.

Automatic discharge at six preselected stations was called for, and five of these stations required automatic storage capable of receiving and storing boxes from the conveyor without manual intervention.

The foregoing considerations led to the adoption of a conveyor that is basically a chain equipped with tipping trays each having a selection mechanism. In order to meet the requirements of the installation, the design of the conveyor departs radically from that of the conventional chain conveyor used for carrying mail.*

A spiral chute has also been installed; it links the first and second floors directly with the shredding and baling room so that documents from the files due for destruction can be readily dispatched in bags, thus minimizing handling.

DESCRIPTION OF CONVEYOR

The conveyor is 732 ft long with trays at 4 ft pitch. It consists of a 6,000 lb 3 in. pitch hollow-bearing-pin chain to which are attached carriers running in guides. The chain, which is sprocket-driven at 30 ft/min, is fitted with "bi-planar" links every 2 ft along its length, and, hence, has horizontal articulation at 3 in. intervals and

†Power Branch, E.-in-C.'s Office.
*SMITH, W. J., and ROGERS, J. D. Chain Conveyors in Postal Engineering. *P.O.E.E.J.*, Vol. 51, p. 53, Apr. 1958.

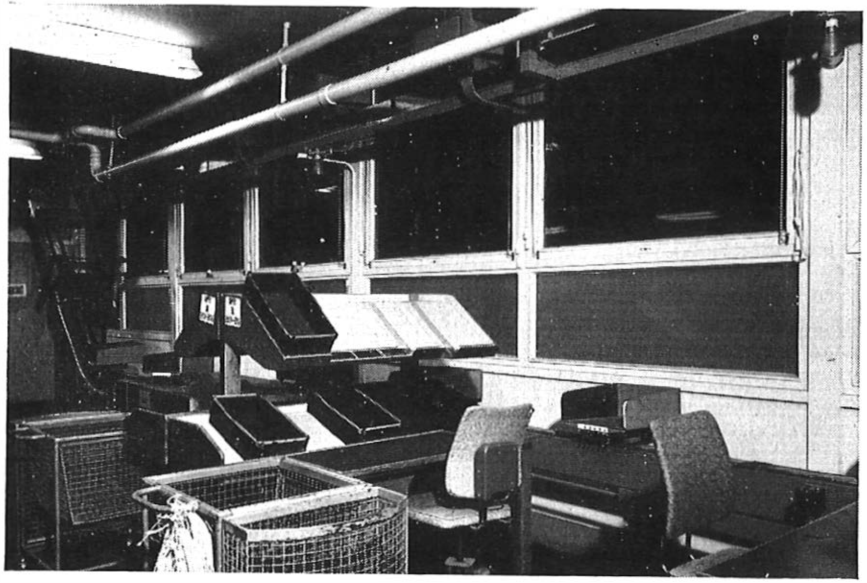
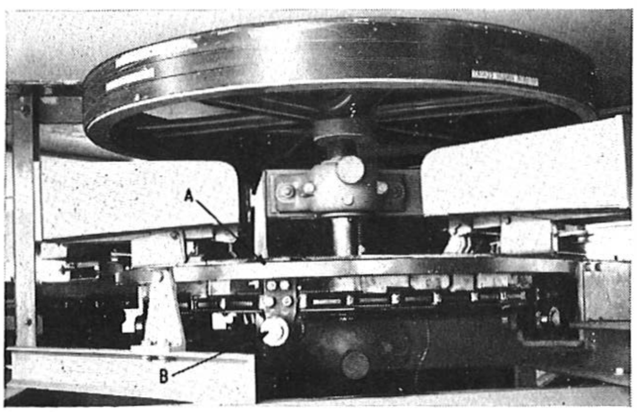


FIG. 2—PART OF RECEPTION BLOCK, SHOWING SORTING DESKS AND LOADING SECTION OF CONVEYOR

vertical articulation at 2 ft intervals. At each bi-planar link a casting known as a trolley carrier is supported above the chain. Suspended below the chain from each carrier is a trolley (see Fig. 3) fitted with two wheels



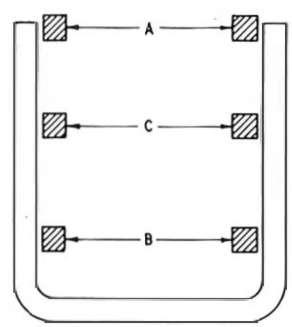
A—Trolley carrier. B—Two-wheel trolley
FIG. 3—DRIVING GEAR, SHOWING CHAIN AND 2-WHEEL TROLLEYS

having sealed ball-bearings. Alternate trolley carriers support the conveyor trays, and 12 of the carriers, approximately equally spaced, are fitted with oil-impregnated felt pads for lubrication of the top guides of the track.

The action of the conveyor is unusual by comparison with a normal chain conveyor since it is the carriers, rather than the chain itself, which are guided in the track (Fig. 4). At low conveyor levels the carriers are suspended from guide rails, A, at the top of the track, the sides of the rails preventing lateral movement. When the conveyor is in motion, carriers slide along these rails and bearing noise in the vicinity of working positions is thus eliminated. If this sliding action were retained throughout the length of the conveyor, however, frictional resistance would be considerable and a large driving torque would be necessary to overcome it. At high levels, therefore, the conveyor is supported by the trolleys running on guide rails, B, fitted at the bottom of the track, the entry to and exit from the guides being tapered so that the carriers are gently lifted clear of the top of the track when the trolleys are in action.

Sliding action is also adopted for a short length of the track in the immediate vicinity of each discharge station. At these points a check rail is provided on the discharge side of the conveyor to prevent tipping of the carriers due to the forces applied by the tray-tipping mechanism. At certain points on the vertical bends it is necessary to add a third pair of guide rails, C, over the trolley wheels to counteract the tendency of the trolleys to move out of the track due to the tension of the chain.

The majority of chain conveyors of conventional design "bend" with equal facility in the vertical and horizontal planes, being guided by the track contours. With the selective tray conveyor, however, as the trolley carriers are rigid and run between guides, changes of direction in the horizontal plane are achieved by suitably diverting the chain around sprockets of 1 ft 3 in. radius, the clearance between the sides of the carriers and the top guide rails being increased to permit "chording" around the bend. Between sprockets the conveyor route, in plan, is always a straight line. Three sprockets fixed to the ground-floor ceiling are used in this manner at Chesterfield. In addition, sprockets are used at 90° and 180° bends, which is more in accordance with normal conveyor practice. At vertical bends the 2 ft spacing between bi-planar links permits the chain to chord around a minimum radius of 4 ft, allowing a maximum angle of slope of 45°.



A—Guide rails from which trolley carriers are suspended at low conveyor levels. B—Guide rails on which trolleys run at high conveyor levels. C—Check rails over trolley wheels.
FIG. 4—SECTION OF TRACK

Hardwood blocks, approximately $2\frac{1}{2}$ in. thick, and suitably shaped to cater for the bi-planar articulation, are fixed to the upper surface of the chain to fill in the space between the top of the chain and the top of the track. These effectively prevent access to any portion of the conveyor contained within the track, and present a smooth and finished appearance consistent with the office decor.

To cater for a range of box sizes the conveyor trays are 12 in. (in the direction of the track) by 16 in. (at right angles to the track) and 6 in. high. They are of hardwood, sheet metal, and pressboard construction, open at the discharge side and wax polished where necessary to minimize friction. In the unoperated position the bottom of the tray slopes slightly backwards to retain the box in the tray. When operated, the tray tips at an angle of 45°.

Each tray is fitted with a row of six keys or "triggers," each key being coloured to correspond with the colour of the label on the fibre box which it is desired to discharge at the station corresponding to that selection.

At loading positions the height of the conveyor from the floor is such that the bottom of the tray at the open side is about 2 ft 6 in. from the floor. The main loading section is in the reception block on the "outward" side of the conveyor and there are also short loading sections on the first and second floors, on the "return" side of the conveyor.

The headroom available in the office is restricted and, to allow the necessary clearances for tray tipping, the distance from floor to centre line of the track at high level was fixed at 7 ft $6\frac{1}{2}$ in., providing headroom of 6 ft 11 in. under track hangers and 6 ft $7\frac{1}{2}$ in. under drive units.

Tray Selection and Tipping Mechanism

The mechanism for effecting discharge of a box from a conveyor tray at a selected station is entirely mechanical; the mechanism is illustrated in Fig. 5 and 6.

Each station is equipped with a primary lever, A, and a secondary lever, B, which are mechanically coupled so that they rotate about their respective pivots. The upper portion of the primary lever is approximately triangular in shape but with a projection at each end of its top edge. Each tray on the conveyor carries a projecting striker, C, which engages the front projection of the primary lever and rotates the primary and

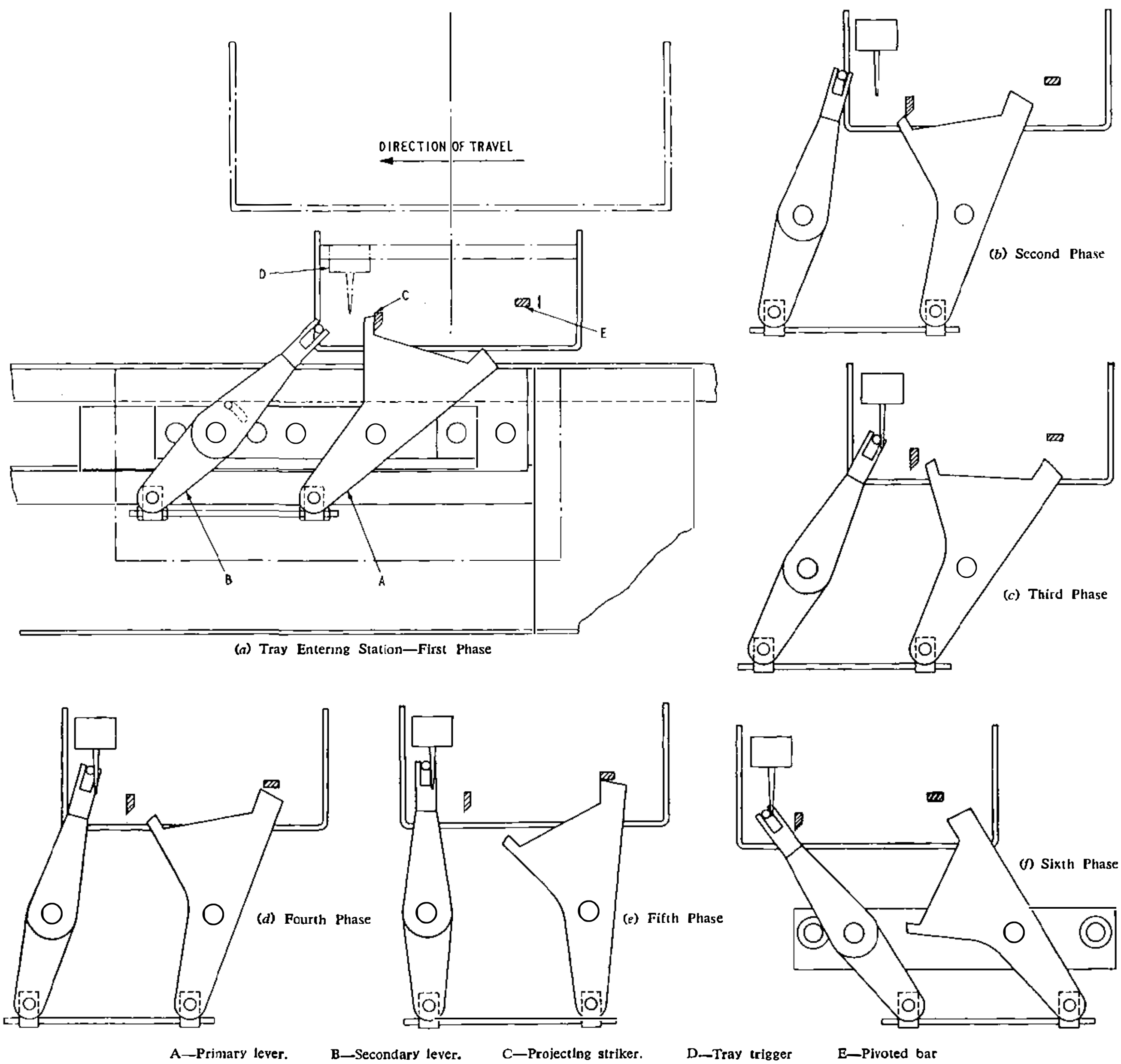
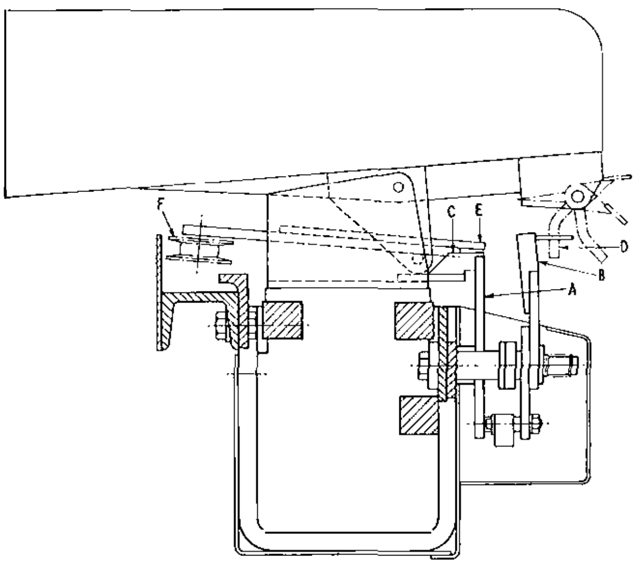
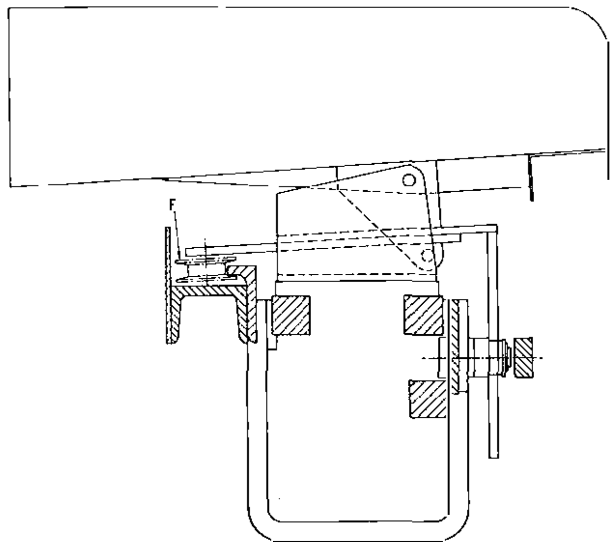


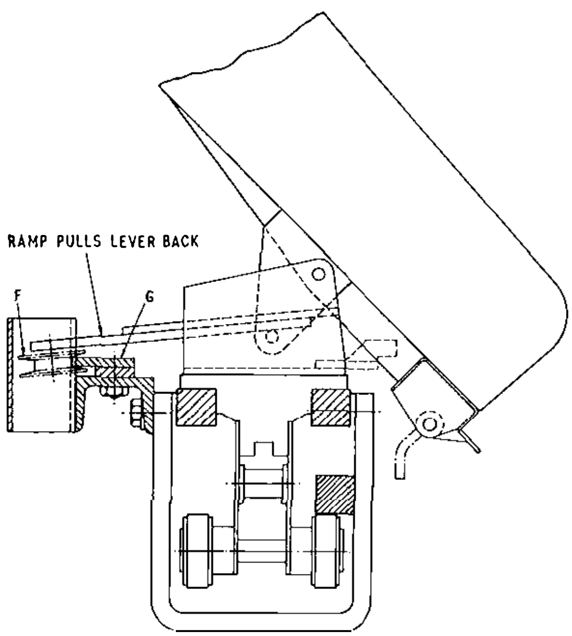
FIG. 5—TRAY DISCHARGE SELECTION MECHANISM



(*a*) Tray Approaching Station



(*b*) Roller Lowered to Engage with Ramp



(*c*) Roller Engaged with Ramp

A—Primary lever B—Secondary lever. C—Projecting striker. D—Tray trigger. E—Pivoted bar. F—Roller. G—Horizontal steel ramp

FIG. 6—TRAY TIPPING MECHANISM

secondary levers at each station through an arc of a circle, the levers restoring under spring pressure when the tray has not been selected to discharge there.

The characteristics of the selection system are such that the position of the primary lever with respect to the station is fixed, but the distance between primary and secondary levers varies at successive selections by an amount equal to the pitch between tray triggers.

When a tray trigger, D, for a selected station has been pressed, the distance between the striker on the tray and the depressed tray trigger will be such that at that station only, instead of the primary and secondary levers being allowed to restore as the primary lever disengages from the tray striker, the secondary lever engages with the trigger and rotates the coupled levers further. The rear projection on the primary lever raises the front end of a pivoted bar, E (Fig. 5 (*a*)), below the tray at right angles to the track, lowering the back of the bar and permitting a roller, F (Fig. 6), carried at that end to engage with a horizontal steel ramp, G (Fig. 6), fitted at right angles to the conveyor track. The motion of the roller along this ramp provides the necessary lateral motion to tip the tray about its point of pivot, the carrier being prevented from tipping by contact between the discharge-side trolley wheel and the underside of the check rail. The tray restores under combined gravity and spring control.

The discharge chute at each station is provided with a short section, hinged and sprung, which restores the operated trigger to normal when the tray tips.

The sixth key selection on each tray discharges boxes into a chute at the entrance to the reception block. This is for the return of empty boxes and for outgoing despatches from the first and second floors.

Drive Units

Due to the length of the conveyor and the necessity to limit chain tension, two drive units are required. These are identical ceiling-mounted equipments, both installed on the ground floor approximately 280 ft apart. Each drive consists of a $1\frac{1}{2}$ h.p. "super-silent" motor driving, through a hydraulic coupling, a vee-rope reduction drive which in turn drives a 60:1 reduction worm gear. The output of the worm gear is applied to the drive sprocket of the chain through a further vee-rope reduction drive.

Chain tensioning is achieved by separate tension sprockets, one on the "down-stream" side of each drive unit. Each tensioning unit is fitted with a ramp-operated switch that interrupts the chain drive if the tension increases by a pre-determined amount.

Storage Racks

The boxes on the selective tray conveyor are normally discharged at the various stations on to a straight chute or gravity-roller conveyor, and stored until required. The storage capacity of a chute with a slope of 30° is very limited compared with a gravity-roller conveyor with a slope of 4°, but the latter occupies a great deal of floor space. In order to economize in floor space a series of short gravity-roller conveyors, arranged in zig-zag formation one under the other and connected together by gravity-operated hinged tipping sections, was devised for use at Chesterfield (see Fig. 7).

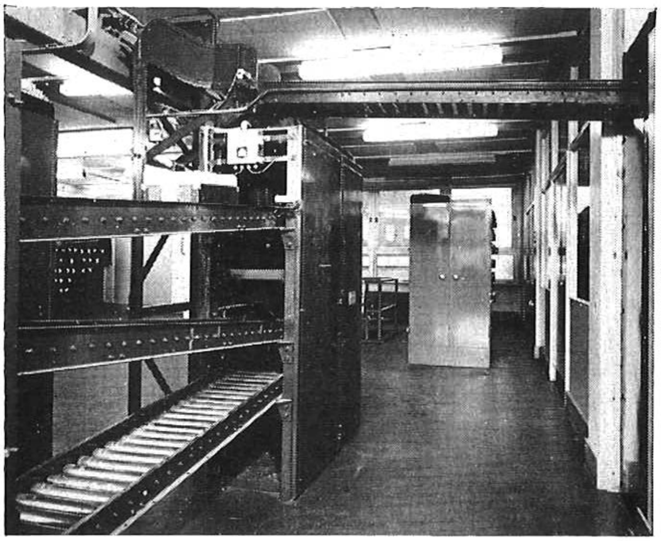


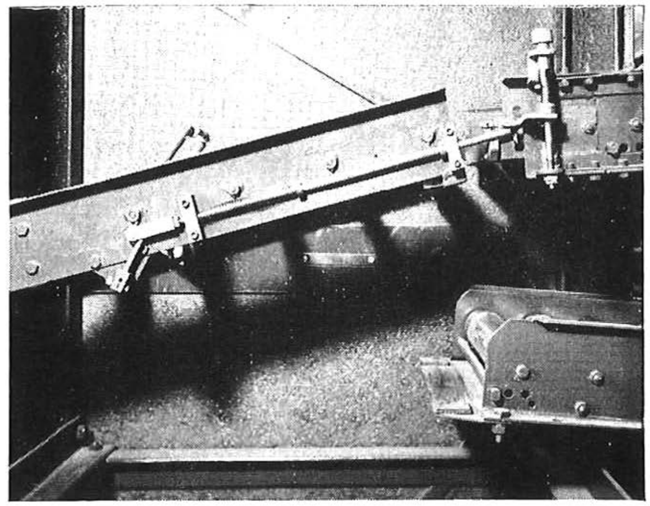
FIG. 7—GENERAL VIEW OF STORAGE RACK, SHOWING LIGHT-RAY UNIT

The hinged tipping sections (Fig. 8) are counter-balanced and arranged so that a minimum-weight box will overcome the counterbalance weight and move the section, transferring the box to a lower level. The box passes through successive tipping sections and thus describes a zig-zag motion until brought to rest at the bottom of the rack. As each tipping section moves away from rest it inserts a stop in the track immediately preceding it. This stop is not restored until, under the control of the counterbalance, the hinged section latches back in position on completion of the transfer, when another box may be received. Two light-ray units are provided on each storage rack to prevent the storage racks becoming completely full and fouling the passing conveyor trays. The first light ray sounds a warning buzzer if it is interrupted for a period of approximately 3 seconds, and the second operates after a similar delay to shut down the conveyor and light an alarm lamp in the reception block. The light-ray units are arranged so that, under normal conditions of operation, shut down occurs if a further four boxes are received with the original alarm condition uncleared. The ends of the racks containing the hinged sections are enclosed within panels lined with sound-absorbing material.

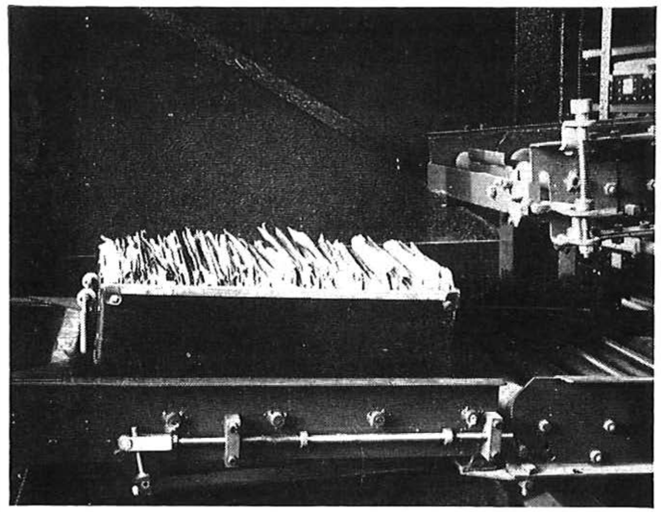
Five storage racks are provided with storage capacities varying between 30 and 37 boxes, except for one rack where storage of 18 boxes is adequate.

Loading Gauges

Where the conveyor runs at the high level, especially at holes in the ceiling and below sprockets and driving gear, the available horizontal and vertical clearances between the trays and parts of the fixed structure or conveyor mechanism are necessarily limited to minimize the space occupied, and jamming may occur if a box is incorrectly loaded on to the tray, or, of course, if incorrect material is placed in the tray. To prevent damage due to this cause, hinged "loading gauges" are fitted at the end of each loading section. Projections above or beyond the tray which would be likely to cause a jam will displace the loading gauge and open a switch in the emergency-stop circuit, bringing the conveyor to rest and lighting the emergency-stop lamps. The loading gauge fitted at the end of the loading section on the first floor can be seen at the left-hand side of Fig. 1.



(*a*) Tipping Section in Normal Position



(*b*) Tipping Section in Bottom Position

FIG. 8—OPERATION OF HINGED TIPPING SECTION

CONTROL GEAR

The main electrical control cubicle is located in the reception block. A "station-full" alarm panel, operated from the station light-ray units, is also located here. Emergency-stop switches are fitted at every loading and discharge point, and at the supervisor's position in the reception block. Operation of the loading gauges functions in a similar manner to an emergency stop. Start and normal-stop controls are provided at the supervisor's position and at the loading points on the first and second floors. A warning buzzer sounds at all points where the conveyor is at low level, immediately before a start. The normal-stop control applies a "delayed-stop" condition for a period of about 14½ minutes to allow the last loaded tray to clear the furthest discharge station; at the end of this period, if no cancelling start condition has been applied, the conveyor stops.

Starting and stopping facilities for the maintenance staff are provided at each drive unit.

PERFORMANCE

The selective tray conveyor has given satisfactory service since it was brought into use and experience to date suggests that a high standard of reliability will be achieved. In particular, the performance from the noise-level point of view has amply justified the care put into the design and installation to achieve this end. In general, the equipment is of more robust construction than would appear to be justified by the loads conveyed, but this is part of the price paid for quiet operation; most of the heavier steelwork used on the storage racks is, however, covered from view by the sound-absorbing panels. The conveyor track is exposed to view, but its finish and appearance is not inconsistent with the office-type accommodation in which it is installed.

ACKNOWLEDGEMENTS

The equipment described in this article was manufactured and installed by Sovex, Ltd., and their sub-contractors. The tray conveyor is the subject of a Sovex patent (Patent No. 591576). The storage racks, for which patent application has been made, were the result of original Post Office Engineering Department development, in the Power Branch Laboratory.

The Ninth Plenary Conference of the Commission Mixte Internationale, Paris, October 1964

U.D.C. 061.3:621.391.82:620.197

THE Commission Mixte Internationale (C.M.I.)—comprising the international co-ordinating bodies of the telecommunications, railway, electricity and gas industries together with various national bodies all having interests in the protection of external plant against electrical interference and corrosion—met for their 9th Plenary Conference in Paris from 19–23 October 1964. Nearly 60 delegates from 10 countries attended.

The technical meetings were devoted to reports of practical demonstrations held at Freiburg in Germany and Bournemouth in England, together with general reports from section "rapporteurs."

The Freiburg meeting had been concerned with:

(*a*) measurement of cable-screening factors,

(*b*) measurement of telephone-equipment unbalance,

(*c*) interference caused by an a.c. electrified railway,

(*d*) demonstration of measurements for corrosion investigation,

(*e*) measurement of disturbing currents and voltages in the traction circuits of an a.c. electrified railway,

(*f*) measurement of disturbing currents and voltages in an electricity line, and

(*g*) circuit protection by lightning arrestors.

The Bournemouth meeting* had been concerned with:

(*a*) joint construction—low and high voltage lines with Post Office lines,

(*b*) single-wire high-voltage earth-return power lines,

(*c*) cathodic-protection installations embracing water, gas and Post Office plant, and

(*d*) Post Office polythene cables and joints.

The section rapporteurs covered a wide range of subjects, reporting on the present state with regard to a large number of outstanding questions and proposing some additional subjects for study.

In addition to the technical meetings, budgetary proposals and amendments to the constitution were approved. The constitutional amendments were small but directed to ensuring that a wider variety of problems affecting users of pipes, conduits, etc., could be ventilated. In particular, it is hoped that there will be greater participation by water and oil interests.

Since its inauguration in 1927 there has been a tendency for the C.M.I. to undertake work based very much on the initiative of the International Telegraph and Telephone Consultative Committee (C.C.I.T.T.) Study Groups V and VI which deal, respectively, with interference and corrosion matters. Although the C.M.I. will obviously continue to be concerned with these problems, it seems possible that the exchanges of views and information which take place at the practical demonstrations—or "Validations" as they are called—might gradually lead to a more co-ordinated use of the earth for the various distribution networks with which the members are concerned. In the meantime, the C.M.I. remains a valuable forum for the exchange of practical information.

D.W.R.C.

*Meeting of the Commission Mixte Internationale, Bournemouth, September 1961. *P.O.E.E.J.*, Vol. 54, p. 258, Jan. 1962.

Developments in Overhead Construction

G. E. HAINES, B.Sc.(Physics), A.M.I.E.E., and W. T. WILSON†

U.D.C. 621.315.17 +621.315.24

The standard methods of overhead construction have, for many years, utilized both cable and open wires. The use of plastic sheathed and insulated cables now makes it practicable to dispense with open wires; the ways in which this can be done economically on various types of route are described.

INTRODUCTION

FOR many years the standard methods of overhead construction have included the use of both cables and open wires. Due to the increasing use of plastic sheathed and insulated cables, it is now economic to dispense with open wires. A description is given in the following paragraphs of some of the items now being used with this end in view. Several other items which, although not on large-scale trial, are being developed to improve the appearance of overhead plant or make its construction simpler are also described.

Overhead routes may be divided into four broad categories:

(*i*) long rural routes,
(*ii*) suburban routes,
(*iii*) subscribers' drops, and
(*iv*) overhead spurs.

Each type of route has its own problems and will be dealt with separately.

LONG RURAL ROUTES

Long rural routes are characterized by long sections with no change in the number of circuits. Junction routes are often of this type, and so are some subscribers' routes where the spurs are more than ½ mile apart, or where, for example, the underground-cable network has been extended by an overhead route to a remote cluster of houses.

The main advantages of open wire over cable for such routes have hitherto been

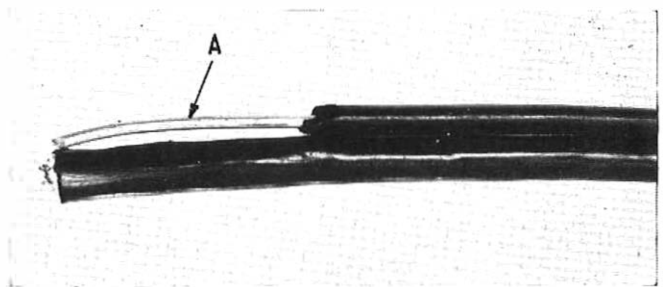
(*a*) low resistance,
(*b*) spreading of capital costs, as wires and fittings can be added as needed and do not all have to be provided initially, and
(*c*) appearance—open wires are nearly invisible against a dark background.

With the increase in permissible exchange-line signalling resistances, advantage (*a*) is now of lessening importance.

Small-sized self-supporting cables, such as the type mentioned below, can make aerial cable cheaper than open wires where more than one pair is required, especially if the lower maintenance charges are taken into account. A cable is admittedly more conspicuous in some circumstances than open wires, but shorter poles, lower routes, and much less conspicuous pole furniture, since no arms or insulators are necessary, more than compensate for this.

For subscribers' work, combined-type cable in which the steel suspension wire and the cable core share a common plastic sheath* can be used. This type of cable, in the range 10–75 pairs, has been used for local work since 1959. The range has recently been extended to include 4-pair and 7-pair sizes, and it will, in future, also include cables larger than 75 pairs. Ultimately, it is intended that all new aerial cables should be of the self-supporting type.

The 4-pair (Fig. 1) and 7-pair cables differ from the other combined-type cables in having a single 12-gauge



A—Suspension wire
FIG. 1—FOUR-PAIR AERIAL CABLE

suspension wire with a breaking weight of 1,300 lb instead of a stranded wire with a breaking weight of 3,500 lb. The breaking weight of the 12-gauge suspension wire is equivalent to that of only six 40 lb cadmium-copper conductors, and the cable can therefore be erected on existing routes of the lightest construction without additional strengthening of the route being necessary. The low erection tension (200–300 lb) of this type of cable permits it to be erected with the same tensioning equipment as that used for the larger line wires, and, if flagmen are not required, only two men are needed.

SUBURBAN ROUTES

Suburban overhead routes occur in areas of low telephone density, where arm-type distribution poles (d.p.s) may feed routes of about six spans serving 10 or 12 subscribers (Fig. 2).

The advantages of open wire in this situation used to be flexibility and economy: a pair is run from the d.p. to the subscriber's premises and no further, and only when required. On the other hand, an aerial cable must usually be run the full length of the route at the outset. However, aerial cable has the advantage of using smaller and hence cheaper conductors, and cheap and simple fittings suffice instead of the arms, spindles and insulators, etc., needed for open wires. Therefore, as for rural routes, aerial cabling can now be cheaper than open wiring.

Several types of aerial cable exist that could possibly be used for suburban routes. These types include:

(*a*) sheathless cable with a central suspension strand,
(*b*) cable with high-strength conductors, e.g. hard-drawn cadmium copper,
(*c*) polythene-insulated underground-type cable used as a self-supporting aerial cable, and
(*d*) combined-type cable.

Type (*a*) is much larger than any of the others, and is therefore the most unsightly; it is also the most expensive.

†External Plant and Protection Branch, E.-in-C.'s Office.
*BLURING, J., and SNOW, H. F. Experiments in Aerial Cable Construction. *P.O.E.E.J.*, Vol. 52, p. 47, Apr. 1959.

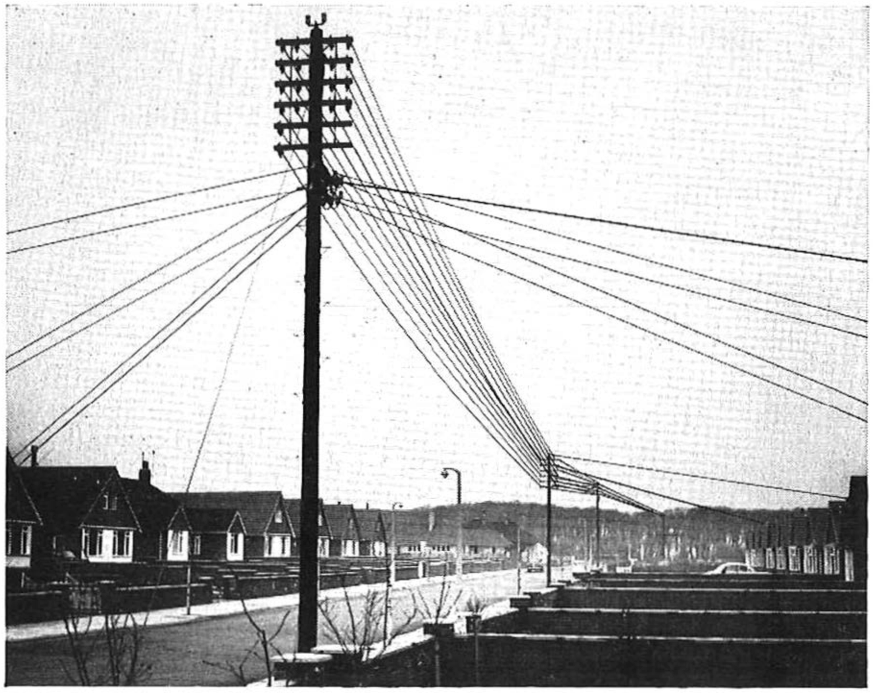


FIG. 2—TYPICAL SUBURBAN ROUTE WITH ARM-TYPE DISTRIBUTION POLE

Type (*b*) can be difficult to joint, and has the disadvantage common to all cables in which the conductors also do duty as the suspension strand: a joint weakens the cable, which, therefore, has to be mechanically terminated at every pole where a joint may occur—on this type of route, at every pole.

The use of types (*a*) or (*b*) would also entail the introduction of an additional type of cable, when the aim is to reduce the number of overhead items to a minimum.

Although type (*c*) is the cheapest and smallest, it suffers from the same disadvantage as (*b*) as regards the necessity for mechanical terminations; it is also mechanically weak, and the elastic limit of the soft-copper conductors is very low. This means that only light initial tensions can be used, and when the cable is subjected to stress it stretches and remains stretched, thereby increasing its sag. Hence, large and increasing dips must be allowed for, especially in long spans, and this requires the use of tall poles, with added cost and unsightliness. The use of this type of cable is therefore limited to unexposed sites; where sag is important, such as at road crossings, the cable is supported by a suspension strand.

Type (*d*), although a larger cable than types (*b*) or (*c*), is smaller than type (*a*), and the strength given by the suspension strand enables the cable to be used in all situations, with minimum sag. It is therefore considered the best cable for suburban routes.

There remains the problem of jointing the cable pair to the feed to the subscriber's premises. In the past this has generally been done by providing a few d.p.s along the aerial-cable route and running wires along the route above the cable until the subscriber's spur is reached. This practice is undesirable for several reasons: a multiplicity of wires and cables is unsightly, taller poles are necessary and, especially where the extra circuits parallel unused pairs in the main cable, it is uneconomic.

The alternatives to this "parallel" method are to provide block terminals at a number of poles along the route, or to use a suitably-designed method of jointing. Terminal blocks have the disadvantage that they must either be provided initially at any pole from which an individual service may be required, or be introduced subsequently, an operation which may sometimes even require the renewal of a span of the aerial cable to give adequate jointing length; in any event considerable rearrangement is involved. Both these methods are inflexible, and although this disadvantage could be overcome by some form of teeing, connecting a circuit to a number of terminal blocks increases the fault liability.

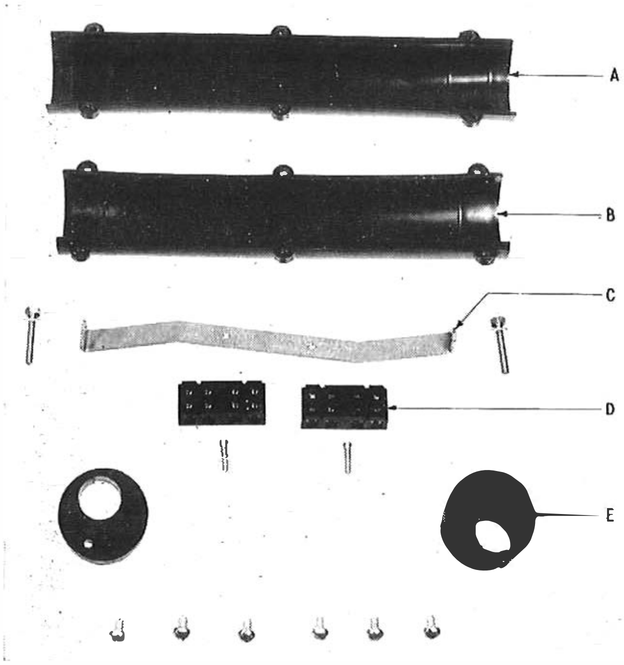
The most desirable jointing method is one with which it is possible to connect the subscribers' spurs directly to the aerial cable as required, without any need to renew spans to obtain jointing lengths. Couplings have therefore been designed that enable this to be done, and it is now possible to use an aerial cable for continuous distribution, using drop-wire for subscribers' spurs, and to take out small cables from the main cable either to feed a subsidiary route or a terminal block.

The couplings, which can be used on lashed polythene cables as well as on combined-type cables, are made in two sizes. The larger size (coded Coupling, Aerial Cable, No. 1) for cables up to 0·840 in. external diameter, enables up to four drop-wires to be connected as well as spur cables of up to 7-pair 10 lb/mile in size. The smaller coupling (No. 2), for use on cables up to seven pairs in size, enables two drop-wires to be connected.

A coupling (Fig. 3) consists of two semicircular sections of high-density polythene which fit over the cable, the longer section being uppermost. The two sections are drawn together by self-tapping screws, and the ends of the joint are enclosed by rubber plugs that fit between ridges near the end of the upper semicircular section. This section projects beyond the outer faces of the rubber plugs and protects them from rain.

The rubber plugs for the larger-type coupling are each provided with a hole for the main cable, and the plug is split from the hole to the outside of the plug. Each plug has a subsidiary cable-hole and two holes for subscribers' leads, shaped and stepped to provide a tight fit for various sizes of drop-wire; ebonite plugs are fitted in holes not occupied by leads or cables. The rubber plugs for the smaller couplings are similar, but have no subsidiary cable hole, and one plug has no holes for subscribers' leads; this plug is fitted to the coupling-end remote from the pole.

A metal spacing-bar is bolted to the rubber plugs inside the coupling. The aerial-cable pairs are connected to drop-wires by connectors screwed to the underside of the spacing bar. The connectors are small ebonite blocks with metal inserts in which four single-way connexions (two pairs) are made under the leading ends of grub screws. The inserts and grub screws are designed



A—Top section of coupling
B—Bottom section of coupling
C—Spacing bar
D—Connectors
E—Rubber plugs

FIG. 3—AERIAL-CABLE COUPLING

to grip a conductor as small as a $6\frac{1}{2}$ lb/mile wire without cutting through the wire. One or two connectors are used in the larger coupling, and one in the smaller coupling. When cable pairs are jointed together in a coupling, normal polythene-insulated-wire jointing methods are used.

The joint is made within reach of a pole (Fig. 4). For combined-type cable the suspension wire is separated from the cable by cutting through the web and using wedges to hold the suspension wire away from the cable. A length of sheath equal in length to the spacing bar is removed to give access to the cable pairs. The cable is placed in the split holes of the plugs, after it has been built up by adhesive rubber tape as necessary to be a reasonable fit in the holes. Connexions are then made and the coupling assembly completed. Spur cables and drop-wires are bound into the main cable to give a neat appearance.

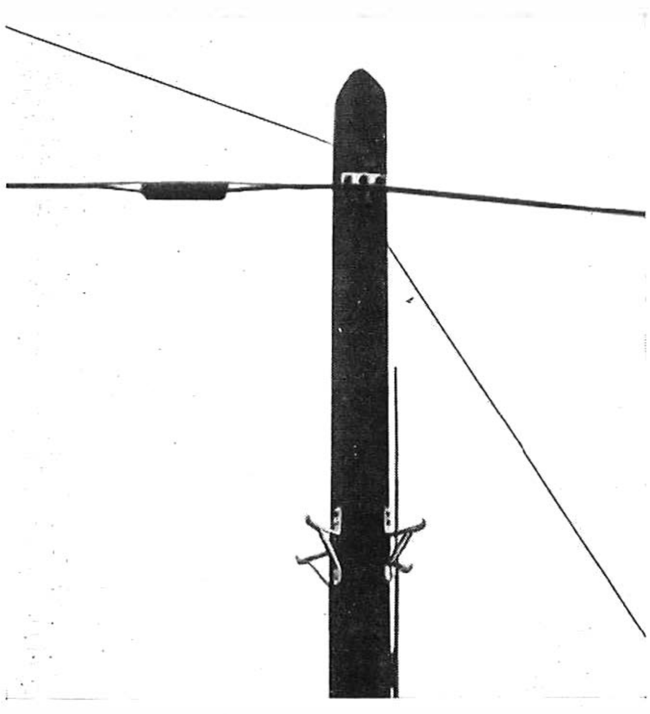


FIG. 4—AERIAL-CABLE COUPLING INSTALLED

The method is suitable for use with an aerial-cable route in which the number of pairs required gets progressively less along its length, but for cables larger than 15 pairs subscribers' spurs are connected to the outer layer of the cable. The inner layers are connected to the next smaller-size cable to feed subsequent d.p.s, thus overcoming the difficulty of gaining access to the inner layers of an aerial cable that is under tension.

In suburban areas, the aerial cables may link ring-type d.p.s (Fig. 5).

SUBSCRIBERS' DROPS

The section between the pole and the subscriber's premises is usually known as the subscriber's "drop". Where several pairs are needed, service is best provided by means of a self-supporting aerial cable of one of the types already described.

The great majority of subscribers' drops are single pairs only, and, hitherto, to take two wires into a subscriber's premises, there has been a choice between using two types of drop-wire, two sizes of bare conductor, two types of insulated single conductor, seven different types of brackets and five types of spindle and insulator, besides a number of miscellaneous items. There are hundreds of possible combinations of these items, and most of them are in use.

The reduction of these various arrangements to the use of two sizes of drop-wire (one for power crossings), requiring only one size of house-bracket and two sizes of clamp, therefore offers obvious advantages both in reducing the variety of items in use and in standardizing construction methods.

A single drop-wire is quicker to erect than two open wires, it can be run from the coupling or terminal block straight to the termination of the subscriber's internal wiring, thereby saving labour and avoiding the fault liability of intermediate terminations of leading-in cables. For these reasons, drop-wire is considerably cheaper than open wire both in stores and labour, but the obstacle to its universal use in the past has been its appearance. The house and pole furniture for drop-wire items are much smaller than those for open wire, but the cable has unfortunately been much larger than bare wires.

Before the use of open wire could be abandoned, therefore, a smaller alternative to the existing type of drop-wire was needed. For such a cable both insulation and conductor had to be made thinner. Cadmium copper, as used in earlier drop-wires, was not strong enough in the required diameter (0·025–0·028 in.), and an alternative had to be found. Two types of conductor were tried: steel and bimetallic, the latter having a high-tensile steel core with a thick (0·0016 in.) copper coat. Both types gave a cable with a breaking weight of approximately 150 lb. The bimetallic type was finally adopted, because plain steel, although cheaper, had a

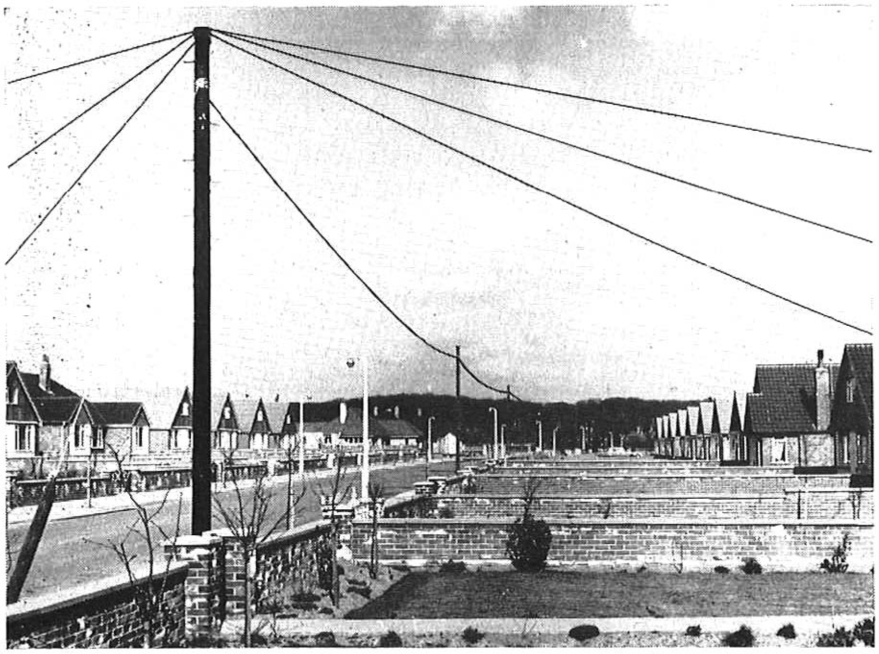


FIG. 5—AERIAL CABLE USED TO LINK DISTRIBUTION POLES

much higher resistance (1,280 ohms/mile loop compared with 550 ohms) and it also had a tendency to rust.

The sheath of the new cable (coded Cable, Drop-Wire, No. 3) is of grey or black p.v.c. of double-D formation. It was 0·010 in. thick in the original version, but this proved too thin for cleating on rough-faced walls and the thickness was increased to 0·015 in. minimum. The cross-sectional area of the cable is less than half that of the No. 1 type.

The greatest difficulty with the new cable was in finding an effective means of clamping it. The insulation being thin and the conductor of small diameter, too great a pressure cannot be exerted at any one point, or the wire will cut through the insulation. At the same time, the force of the clamp must be transmitted to the wires and not taken by the sheath, or the sheath will be stripped off.

Over 500 hand-made clamps involving various principles were tested in an attempt to find a satisfactory design. The majority either failed to hold the cable up to its breaking weight or only did so with damage to the sheath. Three types passed laboratory tests: a 2¼ in. diameter reel, a spirally-grooved rod, and a plastic-coated helical wire. Of these, the first failed in field trials, and the other two were successful; the wire type was adopted as being the least conspicuous. The present version (coded Clamp, Drop-Wire, No. 3) is 18 in. long, and is of p.v.c.-coated stainless steel (Fig. 6). A short helical tail is twisted back on the main helix to form a closed eye round a pole ring-head, as shown in Fig. 7, or round a house bracket.

The cable is fixed to the wall by means of U-shaped plastic cleats which surround the cable and cushion it against the roughness of the wall when the cleat is being nailed. Masonry nails are used to fix the cleats to the wall.

The new cable has severely limited use at power crossings, and the present type (Cable, Drop-Wire, No. 2) is only suitable for use at low-voltage crossings, and, moreover, is of 3-layer construction: rubber, fabric and synthetic rubber. Experiments are, therefore, being made with single-material sheathed cables of double-D cross-section using bi-metallic conductors and having a breaking weight of 600 lb, in the hope of producing a drop-wire suitable for use near high-voltage power lines and for line-of-route work, at a cost not greatly in excess of the existing type of drop-wire.

OVERHEAD SPURS

Overhead spurs are small routes of one or two circuits diverging from a main route. They are best dealt with in the same way as long rural routes. Sometimes, where transmission and signalling limits allow, drop-wire can be run in the line of route.

FUTURE DEVELOPMENTS

Poles

The new drop-wire cable, which has a lower breaking weight than previous drop-wire cables, enables light poles to be used with safety for d.p.s. This also means that steel poles, similar to the type used for lamp standards, might be suitable for use as d.p.s. One such pole, now being tried, is only 4½ in. in diameter, except for

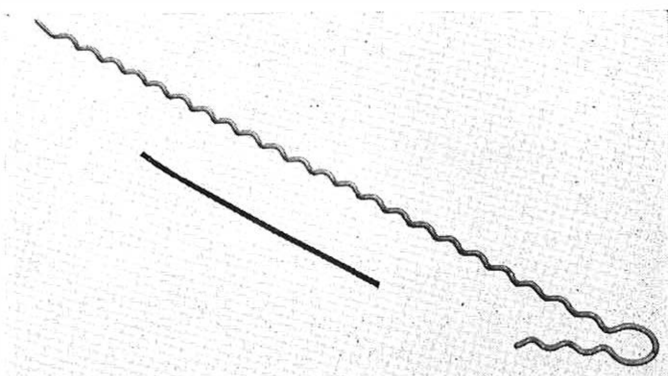


FIG. 6—DROP-WIRE CLAMP NO. 3 WITH LENGTH OF DROP-WIRE CABLE NO. 3

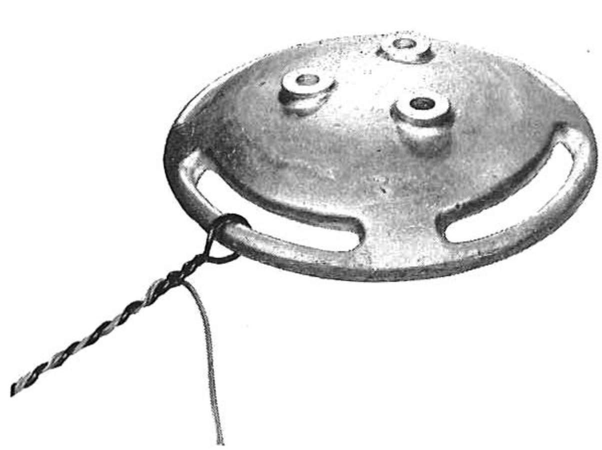


FIG. 7—SKULL-CAP RING AND DROP-WIRE CLAMP NO. 3

the bottom 3 ft, which is 7 in. in diameter. The drop-wire is fed down the hollow centre of the pole to a terminal block fitted in the base, thus giving a tidy appearance. The chief disadvantage is likely to be cost.

Pole Caps

As an alternative to the old-type ring, a fitting that sits on top of the pole like a skull cap (Fig. 7) is being tried. This cap is neater than previous rings, does not waste pole height, and makes conversion from arm-type to ring-type distribution easier.

Stays

In an attempt to reduce the high labour costs associated with the present type of stay, experiments are being made with a variety of stay anchors and driven-rod type stays suitable for installation with mechanical aids or by hand.

CONCLUSIONS

Overhead telephone plant has had many changes in the past. The change-over from open wire to self-supporting cables is probably the last major change that will be made to the overhead line, although improvements in materials will no doubt produce smaller and cheaper cables in time. The next major developments will undoubtedly be in the supports, i.e. in poling and in staying.

Some Aspects of Data Transmission

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U.D.C. 621.394.4:681.142

Flexible multi-speed data-transmission connexions by means of switched networks or by point-to-point circuits are important to the future of data-processing systems. A detailed consideration of future system requirements will enable internationally agreed standards to be formulated and economic use to be made of the public telecommunication network.

INTRODUCTION

In most people's minds the term "data transmission" is associated with the transmission over the telecommunication networks of information for computers in a digital form. This will be the general assumption in this article. However, it is well to remember that digital transmission has been used for a considerable period of time. Most telegraph systems transmit information in this way, and many telephone signalling systems are also concerned with the transmission of digits. Is the transmission of speech signals data transmission? Perhaps not—nevertheless, a recently developed data-processing system accepts binary signals, processes them, and sends the results back as synthetically produced speech!

THE PROBLEM

It is generally accepted that the major limitation affecting the design of an automatic data-processing (a.d.p.) system lies in getting the data into the system. In many instances the locations of the sources of data generation are widely scattered, and at present the chief problem in developing more ambitious and efficient a.d.p. systems is to transmit the data from these sources with speed and flexibility.

Data-processing installations can be compared with a general-purpose factory that utilizes processes from the very simple to the highly complex, and employs these to produce a variety of different products each requiring quite different amounts of raw material to be supplied to maintain the output of the products. The raw material of data processing is the data itself. A large and powerful data processor, when employed on business applications, may, typically, demand to be fed at the data-transfer rates shown in the table.

The figures for total processing times shown in the table are the integrated times for which the central processor is actually being used, and therefore a 100 per cent utilization of available processing time is assumed. The total volumes of data refer to changes or to variable data incoming to or outgoing from the system; they do not include movements of fixed or existing data within the machine, e.g. internal magnetic-tape-file movements. The average rates of input or output of data indicate the steady flow required from a single source to keep the computer fully occupied. This assumes that a suitable reservoir, e.g. paper tape, cards, magnetic tape or core-

Average Data-Transfer Rates for Input and Output

Job	Total Processing Time (Hours)	Total Volume of Input Data (Bits)	Total Volume of Output Data (Bits)	Approximate Average Rate of Input of Data (Bits/second)	Approximate Average Rate of Output of Data (Bits/second)
Stores Accounting, Job A	4	84×10^4	364×10^4	60	250
Stores Accounting, Job B	1	90×10^4	14×10^4	250	40
File Updating, Job A	15	70×10^6	350×10^6	1,250	6,500
File Updating, Job B	2·1	57×10^6	—	7,500	—
Reconciliation of Accounts	1·5	56×10^6	9×10^6	10,000	1,600

†Telegraph Branch, E.-in-C.'s Office.

store buffering, is used to cater for the peaky nature of the computer demands (which may be up to 500,000 bits/second for very short periods of time).

If a reservoir is used for such a purpose, it will by its nature introduce a delay into the system. The delay that can be tolerated will depend upon the particular job. However, in some modern computers a number of different jobs can be time-multiplexed, and this facility can act as an alternative to the reservoir to smooth out the demands on a particular data source. Generally, systems working in real time* can only tolerate a small amount of delay, and in these circumstances the peak demands for sending and receiving data may have to be catered for by the data-transmission system. If the example of one computer having direct access to the contents of the internal store of another remote computer is considered, then the peak transmission rate required is likely to be of the order of several millions of bits/second.

Consideration of the table entries showing the volumes of data involved indicates that unless a very low error-rate in preparation and transmission of the data is maintained the effect on the results of the data processing may be disastrous. For example, if the error-rate due to data transmission alone is 1 in 10^4 bits, e.g. due to a telephone-switched connexion without error control, there would be 90 errors and 7,000 errors, respectively, fed into the system during the processing time of the stores accounting Job B and file updating Job A shown in the table.

The main factors to be considered, therefore, are the volume of data, the total delay in transmission and in the reservoir, and the error-rate that can be tolerated. All these factors have to be weighed in assessing the most economical method of data transmission to be adopted. For example, in a particular application, about 100,000 bits could be transmitted by a telephone line with error control for a total cost of 2s. 6d., whereas the same amount of information recorded on punched paper tape could be sent by unregistered post for about 1s. 9d.; the times of transmission would be approximately 1½ minutes and 24 hours, respectively. The error risk in many practical applications would be regarded as comparable in the two methods, but in other applications the possibility of loss in the post would be unacceptable. For small or relatively simple a.d.p. systems postal transmission or similar methods are justified if the delay can be tolerated, the main advantages being that the volume of data can be high and the costs of transmission may be low.

Nevertheless, it seems that automatic data generation and transmission from the source is likely to be essential for the future of fully integrated a.d.p. systems. The justification of quick methods of transmission over the telecommunication network is then not that of competing in price in the narrow sense, e.g. with the cost of transmission by post, but of being essential to an overall efficient and economic solution of a.d.p. problems.

FACILITIES AVAILABLE

The telex network as well as private point-to-point circuits provided by the British Post Office enable data to be transmitted at 50 bits/second, and later, on some private circuits, this rate will be extended to 100 bits/second.[1] Over the switched telephone network, work to date indicates that reliable transmission at 600 bits/second, and on many connexions at 1,200 bits/second, will be possible.[2] On speech private circuits, depending upon the elaboration of the techniques used, practicable rates of up to 2,400 bits/second have been achieved. On wider-bandwidth communication systems, including coaxial-cable systems, up to 1 megabit/second has been achieved, and, clearly, with more elaborate techniques, much greater rates are possible.

The limitation of data-signalling rates on the switched network is partly due to having to cater for the "worst-case" transmission characteristics that may be encountered on subscriber-to-subscriber connexions. In addition, a particular limitation on telephone trunk circuits is the presence of in-band voice-frequency signalling systems using the band 500–900 c/s or the voice-frequency spectrum above about 2,100 c/s. This confines practical high-speed data transmission broadly to the band 1,000–2,000 c/s.

Consideration of the average data-transfer rates shown in the table indicates that most of these are of the same order as the rates achievable on telegraph or speech-bandwidth circuits. For the higher average data rates shown, buffering could be arranged by time-multiplexing of the data sources or computer programs, thereby reducing the effective average data-transfer rate required from a particular source.

For the foregoing reasons, and also because utilization of existing telegraph and speech bandwidth-circuits on the national and international telecommunication networks makes for an economic solution, most of the applications of data transmission have been concentrated on telegraph or speech circuits.

STANDARDIZATION

To permit a number of differently located data sources or receiving devices (sinks) to communicate via the existing telecommunication network to a remote data processor, perhaps employing equipment made by different manufacturers and routed on connexions of different telecommunications administrations, technical standardization of the method of operation is required.

For this reason the C.C.I.T.T.† have agreed various Recommendations for data transmission,[3] including the following:

Recommendation V 10: Use of the Telex Network for Data Transmission at the Modulation Rate of 50 Bauds.

Recommendation V 21: Two-Hundred-Baud Data Transmission on Telephone Circuits.

Recommendation V 22: Standardization of Modulation Rates and Data-Signalling Rates.

Recommendation V 23: 600/1,200-Baud Standardized Modem for Use in the Switched Public Telephone Network.

Recommendation V 24: Standardization of the Type and Form of Signals to be Exchanged at an Interface Between Data-Processing Terminal Equipment and Data-Communication Equipment.

Three of these Recommendations are particularly important and are summarized below.

(*i*) Recommendation V 21 lays down the modulation conditions for a simultaneous bothway modem for data-signalling rates up to 200 bits/second over the switched

*Real-time working—an operation of a data-processing system which proceeds at a sufficient speed to analyse or control external events happening concurrently.

†C.C.I.T.T.—International Telegraph and Telephone Consultative Committee.

telephone network. The modem uses frequency modulation with mid-band frequencies of 1,080 and 1,750 c/s; the frequency deviation is ± 100 c/s.

(*ii*) Recommendation V 23 deals with simultaneous bothway transmission where the forward channel can work at 600 or 1,200 bauds and the return channel at 75 bauds. The modem uses frequency modulation, the frequency allocations being 1,500 ± 200 c/s for 600 bauds, 1,700 ± 400 c/s for 1,200 bauds and 420 ± 30 c/s for 75 bauds.

(*iii*) Recommendation V 24 lays down standards for the signals to be exchanged at the junction or interface of items of data-transmission equipment. This Recommendation gives a list of standard interchange circuits and the form of the signals that may appear on them. From this list, appropriate interchange circuits may be selected to appear at the interfaces between the data source (e.g. computer), error-control equipment and modem.

The agreements so far have dealt with serial modulation methods up to 1,200 bauds for speech-bandwidth circuits. Study within the C.C.I.T.T. and elsewhere continues on the many other aspects of data-transmission systems, including higher data-signalling rates, parallel transmission, error-control and automatic answering and calling, etc. Some of these aspects are briefly discussed in the following paragraphs.

Higher Data-Signalling Rates

The maximum theoretical modulation rate in a serial binary channel whose characteristics are such that signal elements do not mutually interfere is $2W$ bauds, where W c/s is the bandwidth of the channel.[4] However, according to Shannon,[5] a channel has a capacity of

$$C = W \log_2 (1 + S/N) \text{ bits/second},$$

where S/N is the signal-to-noise power ratio.

On this basis, for C to have a value of $2W$ bits/second, the ratio S/N would have to have a value of 3, i.e. a signal-to-noise ratio of approximately 5 db. On practical circuits the signal-to-noise ratio is much better than this for most of the time, and the possibility of data-signalling rates in excess of $2W$ bits/second, therefore, exists. One way of achieving this is by limiting the modulation rate to $2W$ bauds, as with serial binary transmission, but making each signal element represent one of, say, four conditions, i.e. a quaternary channel. The capacity is then increased to $4W$ bits/second. The price of this is that the theoretical signal-to-noise ratio must now be approximately 12 db, i.e. 7 db better. Modulation systems using such multi-condition coding have been tried with four, eight and 32 conditions. A practical system using a 4-phase double-sideband method of modulation within a bandwidth of 1,200 c/s has worked satisfactorily at 2,400 bits/second.

Parallel Transmission

The systems discussed so far have all been serial. These are affected particularly by group-delay frequency distortion and impulsive noise. To offset these effects it has been proposed that a number of narrow-band channels, say n, working in parallel be used. The signal and noise power per channel (assuming white noise) will then both be reduced by a factor n. The signal-to-noise ratio, therefore, remains the same. If W bits/second is the data signal rate in the serial channel, then for n parallel channels the rate in each channel need only be W/n bits/second for the same total traffic capacity. Due to the longer signal element and the narrower band, the effects and magnitude of group-delay/frequency distortion will be reduced. Also, the amplitude of voltage peaks of impulsive noise will be attenuated. However, the effect of periodic or single-frequency interference compared with that of the serial system will be worse. Non-linear distortion will produce intermodulation products, and these will be worse for the parallel channels.

Multi-Frequency Transmission

Systems using a multi-frequency method of transmission have usually been proposed for relatively cheap low-speed applications. Actually, a combination of the basic ideas of the two previously described methods of transmission is used in an attempt to benefit by the lower signal-to-noise ratio demanded by slower systems by employing a cruder and cheaper method of modulation. One form of the system utilizes two oscillators each switchable to one of four frequencies under the control of the data signal. Each of the four frequencies represents one of four conditions, and the frequencies in each group of four frequencies are different. The two groups together can, therefore, signal one out of 16 conditions, which is equivalent to 4 bits of information. The oscillators are simple and usually directly switched by the data source. Systems proposed have a data signalling rate of 80–160 bits/second. The receiver basically consists of eight filters and detectors to detect the two times one-out-of-four frequencies.

Error Control

The need for error control has been indicated. It is an ever-present requirement throughout a data-processing system and not simply of the data-transmission link. Error control as applied to the data-transmission link may be analogue or digital. The term "analogue error-control" here refers to any method of determining that the received signal has departed from an acceptable form, but does not include checks involving the significance or value of the demodulated digital signals. Such a check would be digital error-control.

Most analytical work on error detection has been concerned with the introduction of digital redundancy into the data, and various methods of coding have been devised. Due to the fact that a high proportion of disturbances on telephone lines used for data transmission affect adjacent signal elements, simple parity-check digits do not give sufficient protection. However, by interlacing the signal elements of a number of parity-check groups the effect of an interference burst can be spread over several such groups. This reduces the chances of the burst affecting more than one element in a group. Different ways of doing this, including a rather more general approach by means of cyclic codes,[6] have been tried. Cyclic codes enable protection to be arranged against specific types of error bursts and are highly flexible. The name derives from the method of generation, which is by means of a cycling shift-register.

Error correction, after an error has been detected, is achieved by requesting the transmitting end to repeat that part of the message containing the error. Error-correcting codes are not economic nor do they give sufficient protection where interference-burst types of error occur.

In practical analogue error-detection systems three techniques have been used. These are sometimes used simultaneously, and consist of:

(*i*) checking that the level of the carrier of the received signal exceeds a predetermined datum level,

(*ii*) checking that, in a multi-frequency system, *n* and only *n* carriers are above a datum level, and that all others are below a lower datum, and

(*iii*) checking that the demodulated digital signal is sustained without change of state for a given minimum time.

Failure of any of these three requirements would initiate a request for a repetition.

Data Switched Network

Where the transmission of data between two stations connected to a data-processing complex is fairly continuous, direct connexions are likely to be economic. However, the major requirement in the future is likely to be for a large number of dispersed stations, originating or receiving short data messages, either regularly or at random. Where the data-signalling rate at the data source or sink is less than 1,200 bits/second the existing telephone switched network will be suitable if there is adequate error control. Automatic call origination and answering facilities will probably be required in order to reduce the time required for access to the computer.

As mentioned earlier, in the case of direct connexion between computer stores or between data locations operating at rates in excess of 1,200 bits/second in real time, the switched connexion will have to be capable of dealing with the peak data-signalling rates. It has been proposed that a switched 4-wire network specifically for data transmission, making full use of the bandwidth available and using high-speed switching techniques, could be the solution if the volume of traffic made it economically justifiable.

CONCLUSIONS

The future exploitation of data-processing systems is likely to be very dependent on the data-transmission facilities available. Such facilities will have to be closely related to the overall system considerations. For the most effective use of the telecommunication networks and techniques, a proper understanding of data-processing system requirements is needed by the transmission engineer.

Standardization through the C.C.I.T.T. and other international bodies is important in order to produce a flexible network so that, ultimately, any computer may "talk" to any other computer.

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[4]NYQUIST, H. Certain Topics in Telegraph Transmission Theory. *Transactions A.I.E.E.*, Vol. 47, p. 617, Apr. 1928.

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Book Reviews

"Current Papers." A monthly guide to current papers on electrical and electronics engineering. No. 1, August 1964, 4 pp. Published by the Institution of Electrical Engineers, Savoy Place, London, W.C.2. Annual subscription £1.

The number of published articles in the field of electrical and electronics engineering is increasing so rapidly year by year that anyone wishing to keep abreast of developments must find the task more and more time-consuming. The production of "Current Papers," a new monthly publication in broadsheet form, is a very praiseworthy attempt to help the electrical and electronics engineer in this task.

It is claimed that each issue of "Current Papers" will contain 600–700 references selected mainly from over 150 of the current and more important British and foreign periodicals. It is also claimed that, generally, each issue will list titles of articles which have appeared within the month prior to its publication. The references, which are listed in five columns on each of the four pages, are arranged under some 20–30 broad subject headings. The bibliographical details are brief but sufficient for the location of the article, while the titles are printed in block capitals to facilitate quick scanning.

One of the prime aims in the production of this publication has been to keep the subscription rate down to a very low level, and by so doing the publishers hope that every engineer will want to have his own personal copy.

D.C.G.

"Automatic Voltage Regulators and Stabilizers." G. N. Patchett, Ph.D., B.Sc., M.I.E.E., M.Brit.I.R.E. Sir Isaac Pitman and Sons, Ltd. x + 468 pp. 273 ill. 65s.

This book covers the whole field of voltage regulation from the control of large power systems to small electronic apparatus. The author classifies automatic voltage regulators into two categories: those which control generators and those designed to correct variations in the normal supply voltage. Both classes of regulator are dealt with, a.c. and d.c. types being included.

The subject is dealt with under three broad headings, the first three chapters covering the fundamental principles which apply to all types of regulator, two chapters are devoted to voltage regulators of the electro-mechanical type and three further chapters deal with regulators incorporating purely electrical or electronic circuits with no mechanical moving parts. In addition, there is a chapter devoted to the special requirements of generator regulators including the measurement of three-phase voltage, parallel running, voltage-drop compensation and hunting.

First published in 1954, this book has now been brought up to date with the addition of sections on the Zener diode and transistor stabilizers. The section dealing with alternator regulators has also been extensively revised to take account of the more widespread use of electronic and magnetic amplifier regulators for machine regulation. There is a list of over 1,300 references in addition to author and subject indexes.

M.H.J.

The C.C.I.T.T. Directives

U.D.C. 061.6.055:621.391.823

WHEN, in 1924, the International Advisory Committee for Long Distance Telecommunications (at first called the C.C.I., then the C.C.I.F.†, and later the C.C.I.T.T.‡) was set up, its work of investigating the many problems of international telephony was divided amongst eight study groups, each of which was made up of engineering experts drawn from many telecommunications administrations. Of these eight groups, the First Group was entrusted with the task of investigating, among other problems, those relating to the coexistence of telecommunication lines with electric power lines and electrified railways.

It was not, of course, possible for telecommunication engineers alone to resolve many of the problems posed by the phenomena of power induction, and the advice and experience of experts in the fields of high-power transmission and electric traction were essential. Consequently, since 1925 the problems have all been examined in conjunction with representatives of the International Union of Railways (U.I.C.), the International Union of Producers and Distributors of Electric Power (U.N.I.P.E.D.E.), and the International Conference on Large Electric Systems (C.I.G.R.E.).

In order that the results of its work in the field of power induction could be made readily available, the First Group of the C.C.I., with the advice and concurrence of the representatives of the other organizations mentioned above, published in Paris in 1926 its first "Guiding Principles Concerning Measures to be Taken in Order to Protect Telephone Lines Against the Disturbing Influence of Heavy Current or High Tension Power Lines," which subsequently became known as "The Directives."

With the development of high-power transmission lines, electrified railways and telecommunication networks, the Directives proved of immense value in the avoidance of interference that would otherwise have been inevitable, and did much to promote between power and telecommunication engineers an understanding of each other's problems.

The coexistence of telecommunication lines with power-transmission and electric-traction lines can pose somewhat difficult problems, and in the course of its work the First Group of the C.C.I. found that in order to resolve some questions, actual tests involving both power and telephone lines were necessary. To facilitate these tests, an International Mixed Commission (C.M.I.) was set up in 1927. This Commission included representatives of the C.C.I., U.I.C., U.N.I.P.E.D.E., C.I.G.R.E. and other bodies. Since its inception, the C.M.I. has staged many demonstrations, the last in the United Kingdom being at Bournemouth in September 1961* when the joint use of poles, for power and telephone lines, and the cathodic protection of underground plant were demonstrated.

In the years following the publication of the 1926 Directives, theoretical studies and experimental work, to which latter the C.M.I. largely contributed, indicated that it was desirable to prepare a new edition. This new edition was published in Paris in 1930 and remained current until the mid-1930s, when further revision was undertaken and the title of the document changed to "Directives Concerning the Protection of Telecommunications Lines Against the Adverse Effects of Electric Power Lines." This edition, which became known as the Rome 1937 Edition, received further modification at a meeting in Oslo in 1938. There was then an interval until 1952 when further minor modifications were made. At this time it was decided, however, that a major revision was desirable and, at a meeting in Paris in March 1955, a specially constituted sub-group of the First Group of the C.C.I.F., under the chairmanship of M. J. Collet of the French P.T.T., commenced the work.

The Administrations of Chile, Czechoslovakia, Denmark, France, Germany, Italy, Switzerland, the United Kingdom, the U.S.S.R. and Poland were represented on the Committee and there were, in addition, representatives of the U.I.C., C.I.G.R.E. and U.N.I.P.E.D.E. The Directives Revision Group thoroughly revised and brought up to date the text of the Directives, which now include a Foreword explaining that technical guidance only is given and that questions of administration or economics, especially those concerning regulations and legislation, are outside the scope of the Directives. Immediately following the Foreword is an Introduction stating that the object of the Directives is to set out measures to mitigate the harmful effects on telecommunication systems of electric power lines and electrified railways, which can cause danger to personnel or equipment, a reduction in the quality of telephone transmission, or a disturbance to signalling. However, the effects of contacts between the power and telecommunication systems are not taken into account. There is then a list of definitions of terms used in the Directives, followed by eight Parts and 21 Chapters. The new Directives are published by L'Union Internationale des Télécommunications and are obtainable from le Service des Publications du Secrétariat Général de l'U.I.T., 2 rue de Varembé, Geneva 20, Switzerland. At present a French edition only is available but a translation in English will shortly be published.

S.J.L.

†C.C.I.F.—International Telephone Consultative Committee.

‡C.C.I.T.T.—International Telegraph and Telephone Consultative Committee.

*Meeting of the Commission Mixte Internationale, Bournemouth, September 1961. *P.O.E.E.J.*, Vol. 54, p. 258, Jan. 1962.

Application of Program Evaluation and Review Techniques to P.A.B.X. Installation

Part 2—Development and Installation Programming for a Large Non-Standard P.A.B.X.

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U.D.C. 658.5:621.395.25

The critical-path method of program control described in Part 1 of this article is currently being applied to the development and installation of a 5,500-line cordless P.A.B.X. with magnetic-drum register control. An outline of the project is given together with details of the method by which a logical network was developed and the way in which this is used to control progress on the project.

INTRODUCTION

When a request is made by a customer for the provision of P.A.B.X. service, the normal Post Office practice is to meet the customer's requirements from the range of standard P.A.B.X.s available, either on rental terms for the smaller sizes or by purchase from an approved manufacturer for installations with 50 or more extension lines. Exceptionally, as an interim measure pending the introduction of the standard P.A.B.X. No. 4, demands for large installations with an associated cordless manual board are met by recommending the customer to purchase from the appropriate manufacturer one of the five different "pre-standard" versions of the P.A.B.X. No. 4* that have been individually approved. From time to time requests are made for the provision of additional facilities, and, subject to approval on policy and engineering grounds, these may be incorporated into standard or pre-standard installations.

When the Post Office was approached by the B.P. Trading Company for permission to install in their proposed new headquarters building a very large non-standard P.A.B.X., it was clear from their outlined requirements that the more complex facilities required could not be provided by any of the standard or approved pre-standard designs available. After considerable discussion at Post Office Headquarters of the administrative and engineering aspects of the requirements, permission was given to proceed with a proposal by the Automatic Telephone & Electric Co., Ltd., to develop a 5,500-line cordless P.A.B.X. based on conventional 4,000-type switching equipment with register control using magnetic-drum stores and transistor logic circuits. In addition to the standard facilities of the P.A.B.X. No. 4 the design would provide for:

(*a*) push-button signalling from all extension instruments,

(*b*) short-code calling (4-digit) to enable extensions to call an initial total of 2,000 (ultimately 3,000) selected local, national (S.T.D.) or international (I.S.D.) numbers by keying a 4-digit code,

(*c*) short-code calling (2-digit) to enable each of 50 specified extensions to call a maximum of 40 selected local, S.T.D. or I.S.D. numbers by keying a 2-digit code,

(*d*) automatic re-routing of private-circuit calls to remote P.B.X.s when route-busy conditions are encountered, the call to be re-routed over the public-exchange network,

(*e*) visual indication to the P.A.B.X. operator of the identity of the calling line on assistance calls,

(*f*) direct dialling-in from the public-exchange network to extensions or to the P.A.B.X. switchboard,

(*g*) absent-extension service to enable an extension user to arrange for incoming calls to be automatically re-routed to an alternative extension, and

(*h*) mechanized accounting of outgoing calls to the public-exchange network.

CONTROL OF THE PROJECT

The function of the Post Office Engineering Department in the provision by an approved contractor of a P.A.B.X. purchased by a customer is normally restricted to approval of the proposed installation as suitable for connexion to Post Office lines and for subsequent maintenance by the Post Office. Such approval includes verification of all documents required for installation and maintenance, and once approval has been given responsibility passes to the Post Office Region and Telephone Area concerned for all subsequent activities such as provision of block wiring and power plant, supervision of installation and cabling of equipment, acceptance testing and fitting of telephone instruments.

The normal procedure was clearly not appropriate to the project under consideration, since, in addition to the extensive introduction of techniques which were novel to subscribers' installations, the time scale of the provision was such that design and development of a large proportion of the equipment would have to proceed concurrently with manufacture. For some items, action by the Region and Area was required in anticipation of approval by the Engineering Department. For example, planning of block wiring by the City Telephone Area on a 3-wire basis had to be commenced at an early stage, on the assumption that the push-button signalling system, which had not then been submitted for laboratory tests, would subsequently be approved, and that a satisfactory telephone instrument would be developed from the prototype and manufactured in time to be fitted. These conditions required close association of the Engineering Department with the Region, Area, customer and contractor throughout the period of development and installation of the equipment.

Following approval in principle by the Post Office of the contractor's proposals, a committee was set up with representation of all parties concerned, and the Post Office Engineering Department became responsible for co-ordinating all activities to ensure that the installation was completed as speedily as possible in an endeavour to meet the ready-for-service (R.F.S.) date required by the customer.

Past experience had shown that the delays which occurred in the provision of large P.A.B.X. installations usually arose from difficulties that were not apparent until a late stage in the program when it was too late to introduce remedial measures to avoid the completion

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*Marchant, P. A. An Introduction to Large Cordless P.A.B.X.s. *P.O.E.E.J.*, Vol. 53, p. 231, Jan. 1961.

date being postponed. To control the program for the B.P. Trading Company installation and at the same time to gain experience of the application of modern control techniques it was decided to make this project the subject of a critical-path exercise.

DEVELOPMENT OF LOGIC DIAGRAM

As described in Part 1 of this article the first step in the application of PERT control is the production of a logic diagram or network showing in strict time-sequence the various activities required to progress from the start to the finish of the project and the common events which link these activities. For the B.P. Trading Company project the starting event (order placed by customer) had already occurred, and a date had been fixed by the customer for the final event (P.A.B.X. ready for service). It was now required to construct sequences of activities linking these terminal events. This process was carried out in three stages, as follows:

Stage 1. The work was broadly divided into a number of concurrent activities, represented as parallel paths, e.g. provision of power plant, manufacture and installation of electromechanical equipment, etc. This preliminary stage of representation is shown in Fig. 6, and it will be seen that although the divergence of these paths from the starting event "order placed" is definite, the convergence from the terminal events of each path, e.g. "staff trained," "building ready," etc., to the end event "P.A.B.X. R.F.S." is indefinite. More detailed knowledge of each path is required before the ends can be interconnected.

Stage 2. Each main line of activity shown in Fig. 6 was then examined to determine to what extent it should be subdivided into a number of consecutive activities and whether the start of any of these activities was dependent on the completion of activities in other paths. The extent to which each main path is broken down into separate activities, either consecutive or concurrent, depends on the level of control that is to be applied to that part of the project. For example, the main activity shown in Fig. 6 as "provision of electromechanical equipment" can be subdivided into the consecutive activities: design, approval of design, manufacture, shipment to site, installation, and testing. Considering from these the activity "design of electromechanical equipment," this equipment may be treated as a whole and represented by a single activity, or, alternatively, it may be broken down to the extent of showing a separate activity for each different type of selector and relay-set. While such sub-division into ultimate individual activities would be necessary for the control of actual manufacture of the equipment, it would not be appropriate for control at the level proposed for this project and would add unnecessary complexity to the logic diagram. For this reason it was decided to treat the electromechanical equipment as an entity and only to show such consecutive activities as were required by interdependence with other paths. Similar reasoning was applied to the expansion of the other paths shown in Fig. 6. As a typical example, the effect on the path "provision of power plant" is shown in Fig. 7. Synthesis of the expanded parallel paths produced a first draft logic diagram.

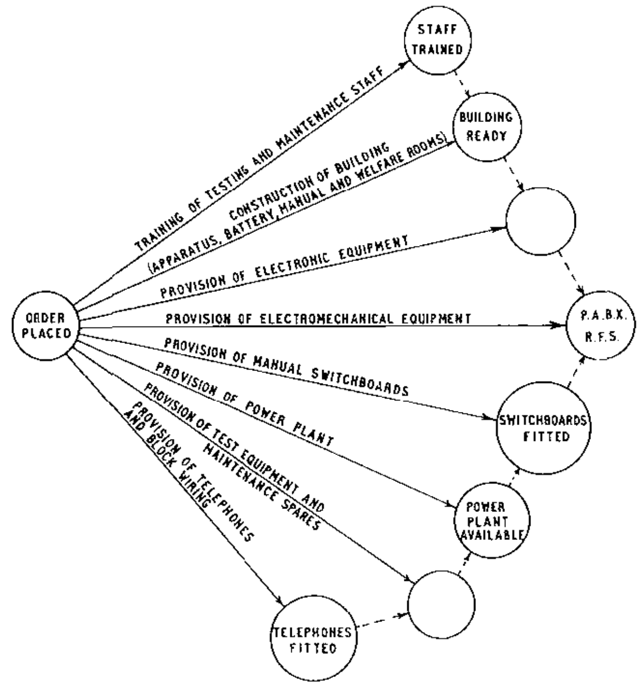


FIG. 6—DIAGRAM SHOWING BROAD DIVISIONS OF CONCURRENT ACTIVITIES

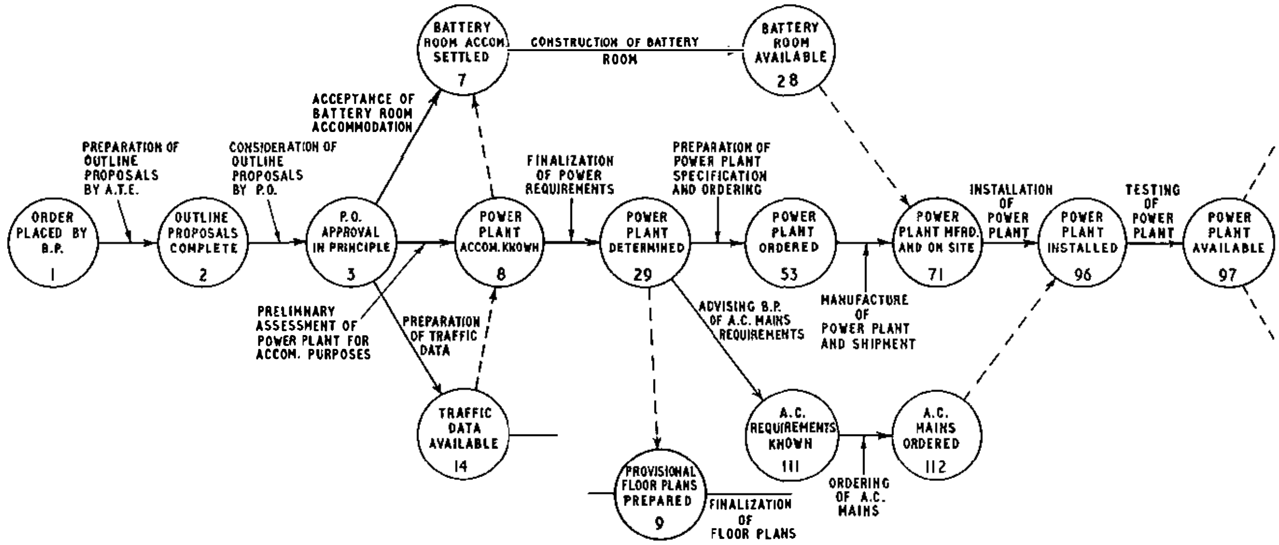


FIG. 7—"PROVISION OF POWER PLANT" PATH AFTER STAGE 2 CONSIDERATIONS

Stage 3. The draft diagram was circulated to all parties for comment. This was particularly necessary for development and manufacturing activities, since it was required to check that the outline activities shown were consistent with the contractor's internal organization. The order in which apparently separate concurrent activities could be started would depend on factors such as availability of manufacturing plant and manpower. Similarly, the rate at which proposed circuits could be passed to a developing team could depend on the load on the manufacturer's testing laboratory. While details of these internal activities were not required for overall control, it was essential that the overall logic should satisfactorily match the detailed organization.

In fact, a number of changes to the Stage 2 draft logic diagram were necessary as a result of comments by the contractor. For example, the activity "approval in principle of electronic documentation" had been shown as one continuous activity, but after discussion with the contractor it became known that the provision of documents was tied to the program for equipping the electronic installation for factory commissioning ("test set-up") and that this would be split into four consecutive phases. Thus, submission of documents for approval would also occur in four phases. Although estimates of time required for the various activities had not been made at this stage, it was clear that there was a possibility of submission phases overlapping approval phases, and it was necessary to amend the logic diagram for this activity by adopting the configuration shown in Fig. 8.

ESTIMATION OF ACTIVITY TIMES

The overall duration of the project to the required ready-for-service date was approximately $3\frac{1}{2}$ years, but some of the individual activities were expected to be of short duration. The unit chosen for estimates of activity times was 1 week. The importance of obtaining the estimate of time required for completion of an activity from the person directly responsible for that activity has been stressed in Part 1 of this article; estimates of activity times were accordingly obtained by direct discussion with the individuals concerned, and the estimates were made as far as possible in isolation, i.e. without reference to other activities or to key dates in the program. The application of these principles to activities outside the direct control of the program authority may, in general, be expected to present some difficulty. For the present project the Post Office was fortunate in having direct access to the leaders of the various design and production groups within the manufacturer's organization, and all estimates were obtained at a round-table conference at the contractor's works. When all estimates had been obtained, the times in weeks were added to the activity arrows of the logic diagram, which was then produced in its final form. Fig. 9 shows part of this diagram, corresponding to the lower left-hand portion of Fig. 4.

PROCESSING OF INFORMATION

Determination of the critical path or paths and calculation of slack time on other paths is a simple arithmetical procedure, but with over 200 activities to be considered the repeated additions and comparisons would be time-consuming, boring, and hence liable to error if carried out manually. The B.P. Trading Company were already using an electronic computer to process the PERT control of the erection of the new building in which the P.A.B.X. was to be installed, and their offer to provide computer facilities for the P.A.B.X. program was gratefully accepted. Since the computer program for PERT processing was already established it was only necessary to transfer the input data from the logic diagram to standard stationery, an example of this being shown in Fig. 10. Each activity is defined by the serial

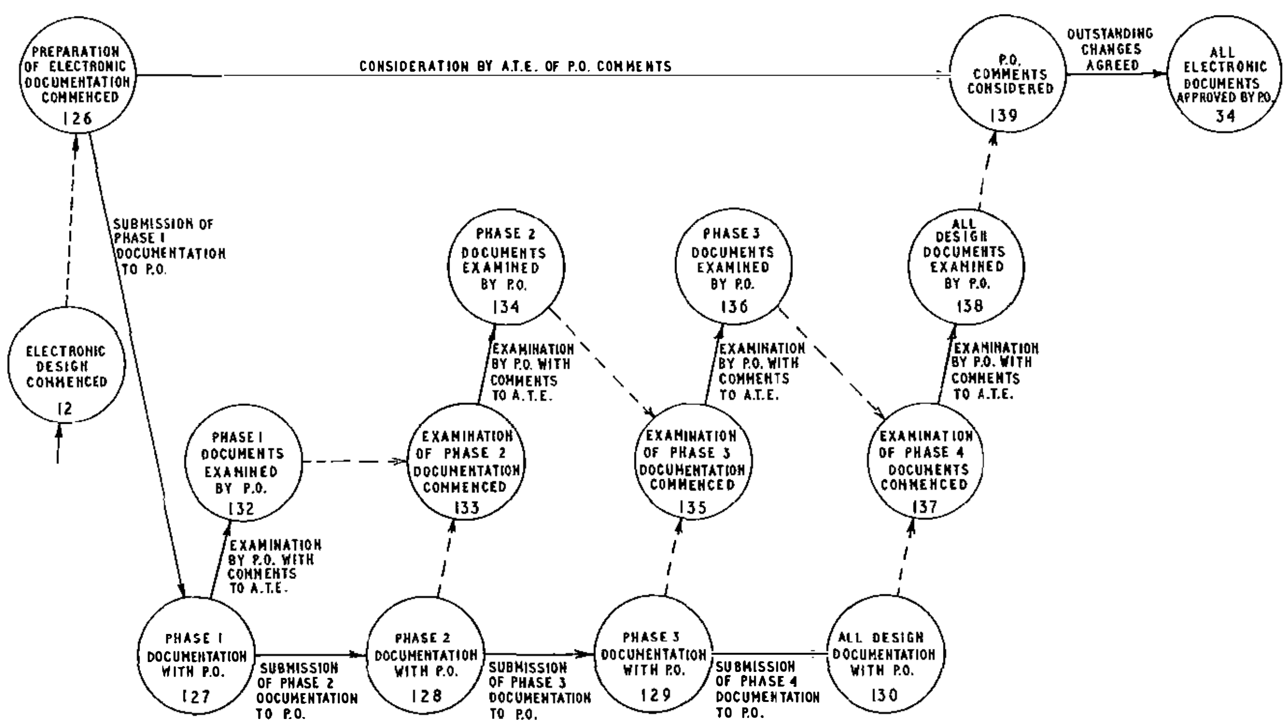


FIG. 8—SUBMISSION AND POST OFFICE APPROVAL OF ELECTRONIC DESIGN DOCUMENTATION

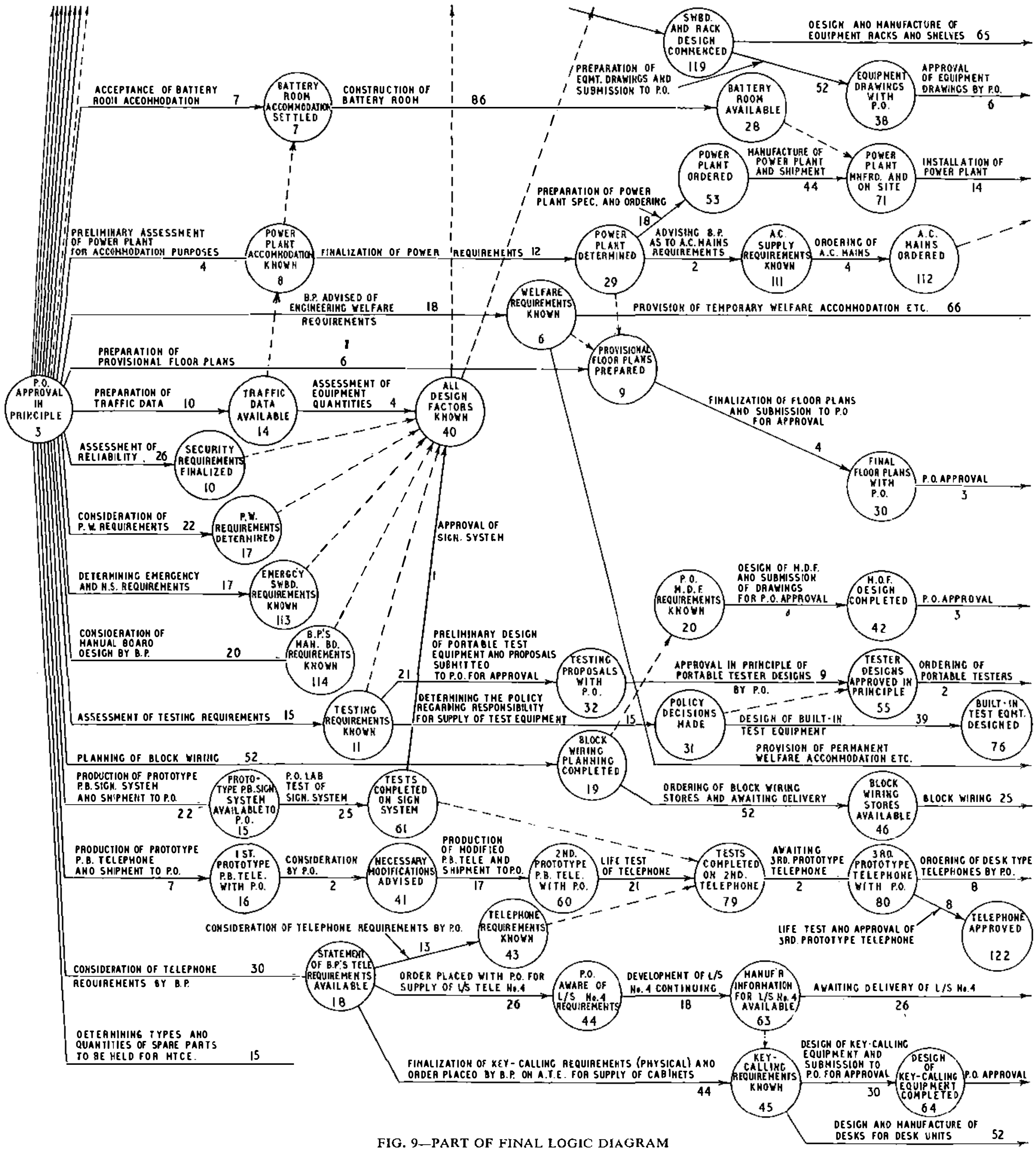


FIG. 9—PART OF FINAL LOGIC DIAGRAM

numbers of its start and finish events, entered in columns i and j, respectively, with the estimated activity duration entered in the adjacent column, y. For dummy activities, i.e. non-time-consuming ones, a zero is entered in column y. For the first computer run all entries were designated B, meaning basic, the designations A, C and D, for Addition, Change and Deletion, being used for subsequent runs. An extract from the computer print-out is shown in Fig. 11. The activities are listed in order of the numbers of their starting events, the activity duration (Y) is repeated from the input data, and the week numbers for earliest start (ST), latest finish (F), and the amount of slack time (SLACK) on the particular path are given for each activity.

CRITICAL PATH

The activities for which the slack time is printed out as zero are those which lie on the critical path, i.e. the path, from start to finish of the logic network, which has the longest duration. To examine this path (or

ACTIVITY SPECIFICATION B.P. P.A.B.X.
ORIGINATOR P.O.E.D. S3/4
PROCTER HOUSE

A B C D	CODE	DESCRIPTION	i	j	y*
B			1	2	4
B			2	3	4
B			3	4	24
B			3	8	4
B			8	29	12
B			29	53	18
B			29	9	0
B			53	71	44
B			71	96	14
B			96	97	5
B			97	115	0
B			3	50	15
B			50	51	15
B			51	52	8
B			3	9	6
B			9	30	4
B				54	3

FIG. 10—TABULATION OF ACTIVITY INFORMATION FOR COMPUTER PROCESSING

PROJECT—BP PABX PO ENG S3-4 CRITICAL PATH PAGE NO 1
RUN NO 9 ACTIVITY SET 9 RESOURCE SET 0 PROJECT DURATION—183
TIME NOW— 0 139 NODES 212 ARROWS

I	J	CODE	DESCRIPTION	Y	EAC	Ts	TC	ST	F	SLACK	RESOURCE SCHEDULE	
1	2			4		0		0	4	0	N	
2	3			4				4	8	0	N	
3	4			24				8	47	15	N	
3	5			1				8	9	0	N	
3	6			18				8	38	12	N	
3	7			7				8	18	3	N	
3	8			4				8	18	6	N	
3	9			6				8	94	80	N	
3	10			26				8	62	28	N	
3	11			15				8	38	15	N	
3	12			4				8	18	6	N	
3	13			0				8	14	6	N	
3	14			10				8	18	0	N	
3	15			22				8	36	6	N	A
3	16			7				8	21	6	N	

FIG. 11—COMPUTER PRINT-OUT

paths) it is convenient to transfer the information from the tabulated print-out to the logic diagram by marking in bold colour those activity arrows with zero slack time. Other paths with relatively small amounts of slack time can be similarly derived and marked on the diagram with different colours. It is worth mentioning here that the computer print-out acts as a check on errors of logic, for if these are present it will produce a critical path quite different from that expected.

Examination of the critical path produced by the first computer run showed that the R.F.S. date would be week 244 and not week 174, as required by the customer, and that the critical path involved provision of block wiring and the design and provision of the main distribution frame (M.D.F.). The logic diagram was amended to provide for information of Post Office requirements on the M.D.F. to be passed to the contractor at an earlier stage than that originally shown. Certain other activities were re-scheduled, and the revised data processed by computer. The second print-out indicated a R.F.S. date of week 194, with two critical paths involving the events "apparatus room ready for equipment" and "battery room ready for equipment." All other paths had a minimum slack time of 20 weeks.

It was not possible to improve the estimated times for activities on the critical paths subsequent to the "apparatus room ready" and "battery room ready" events, and it was clear that these were the holding factors. The activity times which had been used for building operations were based on information that the original building program was in delay, and it was clear that this delay would affect the R.F.S. date for the P.A.B.X. At this stage the B.P. Trading Company were unable to guarantee that delays in the building program would subsequently be made good although they were hopeful of some improvement and would be able some 9 months later to give a definite date for completion of the parts of the building involved. It was decided to proceed with control of the project on the basis of R.F.S. in week 194 (i.e. 20 weeks late) but to regard the 20 weeks slack time on the sub-critical paths as "not available."

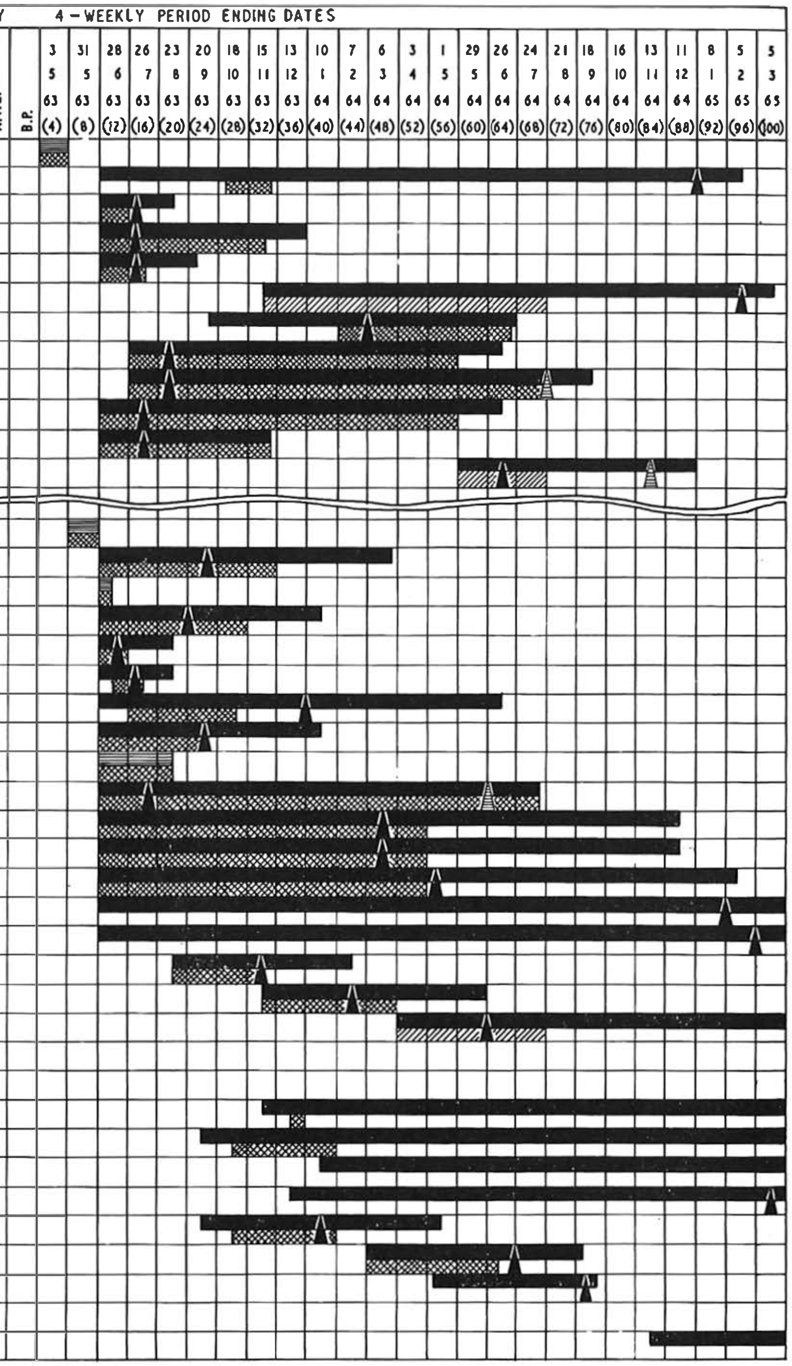
CONTROL CHART

All the information required for control of the project was now available, either on the logic diagram or in tabular form in the print-out from the computer. This information could have been consolidated in a single document by transferring the earliest-start and latest-finish week numbers from the print-out to the logic diagram, but the information would then have been presented in a form which did not lend itself to regular monthly checks or to an immediate appreciation of the position at any time.

To facilitate control on a 4-weekly basis a control chart was produced from the printed-out data, an extract from it being shown in Fig. 12. A horizontal line was provided for each activity, with a description of the activity added for convenience to the pair of event numbers which defined the activity. The week numbers for earliest start and latest finish, together with estimated activity time and total slack on the path, were shown in vertical columns against the activity, and a further column drew attention by means of asterisks to critical-path activities. The party responsible for completion of the activity was indicated, the activities being arranged in groups according to the responsible party. The remainder of the chart was divided into vertical columns indicating 4-week periods, so that each activity could be represented in time sequence across this space by a horizontal bar extending from the earliest-start week to the latest-finish week. Prints of the control chart were circulated to all parties, without the horizontal bars entered. These were entered by hand for all activities on the master control copy, and it was left to the other parties to fill in the activities for which they were responsible. This procedure reduced drawing-office effort and speeded up the circulation of

NETWORK PROGRESS REPORT. PROJECT: B.P. P.A.B.X.

ACTIVITY	DESCRIPTION OF ACTIVITY	LATEST FINISH	EARLIEST START	ACTIVITY TIME	TOTAL SLACK	CRITICAL PATH	RESPONSIBILITY: E.D. S3	OTHER ED BRANCHES, ETC.	DIRECTOR L.T.R.	T.M. CITY	A.T.E.	B.P.
1-2	PREP. OUTLINE PROPOSALS	4	0	4	0	*					✓	
3-9	PREP. PROVISIONAL FLOOR PLANS	94	8	6	80						✓	
3-12	PREP. ELECTRONIC SPECIFICATION	18	8	4	6						✓	
3-15	PROD. PROTOTYPE P.B. SIGNALLING SYSTEM	36	8	22	6						✓	
3-16	PROD. 1ST. PROTOTYPE P.B. TELEPHONE	21	8	7	6						✓	
9-30	FINALIZATION OF FLOOR PLANS TO P.O.	98	30	4	64						✓	
11-32	PRELIM. DESIGN OF PORTABLE TESTERS TO P.O.	64	23	21	20						✓	
12-35	PROG. DESIGN AND MFR. ELECTRONIC EQMT.	62	12	44	6						✓	
12-33	AWAITING 1ST. BATCH ELECTRONIC EQMT.	74	12	56	6						✓	
13-36	PROG. DESIGN AND MFR. SWITCHING EQMT.	62	8	48	6						✓	
13-119	AWAITING CCT. INFORMATION	31	8	17	6						✓	
36-58	CONT. DESIGN AND MFR. SWITCHING EQMT.	88	56	26	6						✓	
2-3	CONSIDERATION OF OUTLINE PROPOSALS	8	4	4	0	*	✓					
3-4	ACCEPTANCE OF MANUAL SWITCHROOM	47	8	24	15					✓		
3-5	ACCEPTANCE OF APPARATUS ROOM	9	8	1	0	*				✓		
3-6	ADVICE TO B.P. ON WELFARE ACCOMMODATION	38	8	18	12					✓		
3-7	ACCEPTANCE OF BATTERY ROOM	18	8	7	3		✓					
3-8	ASSESSMENT OF P/P FOR ACCOMMODATION	18	8	4	6		✓					
3-10	ASSESSMENT OF SECURITY	62	8	26	28		✓	TPM				
3-11	ASSESSMENT OF TESTING REQUIREMENTS	38	8	15	15		✓	TPM				
3-14	PREPARATION OF TRAFFIC DATA	18	8	10	0	*				✓		
3-19	PLANNING OF BLOCK WIRING	67	8	52	7					✓		
3-21	SELECTION OF C.O.W. AWAITING TRAINING	86	8	40	38					✓		
3-22	SELECTION OF TESTING STAFF AND AWAITING TRAINING	86	8	40	38					✓		
3-23	SELECTION OF NTCE. STAFF AND AWAITING TRAINING	93	8	40	45					✓		
3-24	PREP. OF ACCEPTANCE TESTING SPECN'S.	104	8	12	84		✓					
3-50	DETERMINING NTCE. SPARES	111	8	15	88		✓	TPM				
8-29	FINALIZATION OF POWER REQUIREMENTS	42	18	12	12		✓	P	✓			
29-53	PREP. OF POWER PLANT SPECN. AND ORDERING	60	30	18	12			P	✓			
53-71	MFR. OF POWER PLANT AND SHIPMENT	104	48	44	12			P	✓			
71-96	INSTALLATION OF POWER PLANT	118	104	14	0	*			✓			
96-97	TESTING OF POWER PLANT	123	118	5	0	*			✓			
29-111	ADVISING B.P. OF A.C. REQUIREMENTS	114	30	2	82		✓	P				
50-51	DECIDING POLICY FOR PROVISION OF SPARES	126	23	15	88		✓	TPM				
51-52	ORDERING OF SPARES	134	38	8	88		✓	TPM		✓		
30-54	APPROVAL OF FLOOR PLANS	101	34	3	64					✓		
11-31	DECIDING POLICY FOR SUPPLY OF TEST EQUIPMENT	53	23	15	15		✓	TPM				
32-55	APPROVAL IN PRINC. OF TESTER PROPOSALS	73	44	9	20		✓	TPM				
55-72	ORDERING OF PORTABLE TESTERS	75	53	2	20		✓	TPM				
87-85	FITTING OF KEY CALLERS	173	150	4	19					✓		
56-75	APPROVAL OF MODIFIED ELECTRONIC INFORMATION	127	82	7	38		✓					



Latest start — Latest finish to conserve slack — Other activities

Activity in progress — Activity completed — Critical path activities

FIG. 12—EXTRACT FROM CONTROL CHART

documents after amendment, since changes corresponding to a new computer print-out required amendments only in the left-hand columns.

Entries on the master copy were made in contrasting colours for critical-path activities, activities with 20 weeks path slack time, and activities with path slack times greater than 20 weeks. As discussed above, the 20-week slack-time paths could become critical if the delays in the building program were recovered. On each bar the latest-start date, i.e. earliest start plus slack time, was also indicated except for those on the critical path, where by definition the latest and earliest start dates coincide.

CONTROL PROCEDURE

The control chart is used as a wall chart available for instant reference. A vertical cursor indicates the current 4-week period and enables the controller to read off those activities in progress at any time. During the second week of each 4-week control period an enquiry form is sent to the individual responsible for each activity in progress or due to commence within the current or the next 4-week period. This form is phrased to ask the definite question "Will the activity be completed by the scheduled time?", and asks for a reply before a specified date in the last week of the 4-week period. The control chart is kept up to date on the basis of these replies, activities in progress being indicated by hatching and completed activities by cross-hatching. The effect of any reported delay is investigated and action taken accordingly. It should be emphasized here that where slack time exists it is on the path concerned and not on individual activities. Thus, if an activity with path slack time of 32 weeks is reported as completed 2 weeks later than its indicated earliest-finish date, all subsequent activities on that path will have their path slack time reduced to 30 weeks. To assist supervision, the latest date for the completion of an activity to permit the stated slack time to be maintained may be marked on the control chart.

Some 12 months after the PERT procedure for this project was initiated, delays were reported on certain activities on paths with 20 weeks slack time and at the same time an improvement of 13 weeks in the building program brought forward the ready dates for the apparatus and battery rooms. These changes could not be accommodated by increased effort on later activities alone, and it was necessary to amend the logic diagram in addition to re-scheduling certain activity-duration estimates on the paths concerned. The whole program was again processed on the computer, and all activities are currently on schedule to meet a revised R.F.S. date of week 179, which is now acceptable to the customer.

CONCLUSION

The application of PERT to this project has proved of great benefit in the first third of the program in enabling a complex undertaking to be integrated on a realistic time-scale. It has not eliminated delays, but has brought these to attention at a much earlier stage than would otherwise have been the case, and present indications are that the remedial actions to reduce overall delay will be effective. Considerable initial effort was required to produce the logic diagram and to establish the control procedure, but the continuing effort to control the established program is small. The experience gained in this first exercise will greatly reduce the effort required to produce control documentation for subsequent similar projects. The network diagram produced for the B.P. Trading Company installation is based on the general procedure which has been agreed for the supply of all large privately purchased P.A.B.X.s, and is applicable, with relatively minor modifications, to other similar projects.

ACKNOWLEDGEMENTS

The authors wish to thank the B.P. Trading Company, Ltd., and the Automatic Telephone & Electric Co., Ltd., for assistance given during all stages of the exercise.

Book Reviews

"Properties and Applications of Transistors." J. P. Vasseur. Pergamon Press, Ltd. xxvii + 434 pp. 298 ill. 100s.

This book is a comprehensive introduction to the theory and practice of linear transistor circuits, and covers a wide range of topics. However, it completely ignores switching circuits, despite the generality of its title. It contains seven chapters, of which the first is devoted to the fundamentals of semiconductors, including crystal structure, the properties of p–n junctions, the basic properties of the transistor, and some information on transistor technology. The first chapter forms a good introduction to the subject, though it contains no mention of planar technology. Chapter 2 deals with the fundamental properties of linear 2-port networks, giving particular attention to the relationships between the various parameter systems, and between the three possible terminal-grounding configurations of a transistor. Unfortunately in section 2·3 there is confusion between reciprocal and passive networks; the conditions given in equations 2·6 and 2·8 apply to the former, not the latter. The section on Thévenin's theorem could well have been placed much earlier in the chapter. In Chapter 3, transistor parameters are dealt with, first as families of curves and later from the point of view of linear equivalent circuits; some methods of parameter measurement are given. This chapter contains some dubious statements; most workers would not agree with its opening sentence, or with the statement that the equivalent circuits of Fig. 3·34 are of practical use up to the maximum frequency of oscillation. Chapter 4 is devoted to linear amplifiers; it contains a large number of formulae useful to the circuit designer and devotes much space to neutralization, including purely reactive neutralization. It is a pity that 10 pages are devoted to the now obsolete point-contact transistor. Chapter 5 describes d.c. bias circuits in considerable detail; it includes some material on d.c. coupled stages and also on compensation of temperature effects by the use of p–n junctions. Chapter 6, devoted to maximum ratings of transistors and rectifiers, is mainly a detailed treatise on thermal runaway, with a useful section on thermal measurements. The final chapter deals with transistor noise; it covers the basic properties of noise signals, noisy 2-port networks, noise figure and the nature of transistor noise. It includes some information on noise measurements.

H.G.B.

"Basic Matrix Algebra and Transistor Circuits." G. Zelinger, M.Brit.I.R.E., Sen.Mem.I.R.E., Mem.A.I.E.E. Pergamon Press, Ltd. xv + 116 pp. 34 ill. 42s.

The complicated nature of the transistor as a circuit element has led to the use of increasingly powerful methods of circuit analysis, in which matrices play an essential part.

The book is intended as an introduction to this topic, and its first section, occupying about half of the book, deals with the elementary properties of determinants and matrices and their application to 2-port networks. The main emphasis here, and throughout the book, is on the transmission matrix. The remainder of the book deals with the application of these ideas to transistor circuits.

It is a pity that the book contains misleading statements and implications about the basic properties of 2-port networks. The author confuses passive networks with reciprocal networks, as for example on p.18 where it is stated that "for passive networks the determinant of the (transmission) matrix is unity." This condition applies to reciprocal networks, and it is well known that both passive, non-reciprocal, and active reciprocal networks exist. There are some other inconsistencies, and, in addition, the literary style is not always beyond criticism.

H.G.B.

Notes and Comments

Retirement of Mr. R. J. Halsey, C.M.G., B.Sc.(Eng.), F.C.G.I., D.I.C., M.I.E.E.

On 31 December 1964 Mr. R. J. Halsey retired from his position as Director of Research in the Post Office after a long and remarkable career as a telecommunications engineer. Like many others who have climbed high in the Post Office, he received his engineering initiation in one of the Royal Dockyards, where he won a place in the City and Guilds Engineering College in 1923. After graduating with a 1st Class Honours degree

he spent a short time in university teaching and then entered the Post Office as an Assistant Engineer (old style) in 1927.

Soon after joining the Transmission Section of the Research Branch in Marshalsea Road, Mr. Halsey took up the then new subject of electrical filters and rapidly established himself as an authority on their design and construction. His first published paper was concerned with filters, and for this he received the Bronze Medal of the I.P.O.E.E. As a natural consequence of this first interest he moved into the new field of carrier telephony, where he established himself as a leading authority and had a large influence in the build-up of the national carrier trunk network.

Towards the end of the Second World War the practical possibilities of valve-repeatered submarine telephony became apparent, and Mr. Halsey took over the task of developing cables and repeaters—laying the first-ever submarine repeater in the Irish Sea in 1943. The success of this venture led to an upsurge of interest in overseas cable telephony and, after a number of successful repeater-insertion operations in North Sea cables, he went to the United States to join the consultations which led eventually to the inauguration of the first transatlantic telephone cable in 1956. Since then, as Director of Research and a Government-appointed director of Cable and Wireless, Ltd., he has carried a wide measure of technical and planning responsibility for such schemes as CANTAT, SEACOM and COMPAC. These global cables have changed the whole character of Commonwealth telecommunications and have given Mr. Halsey an international reputation as a leading authority on the submarine telephone-cable art. Such achievements were recognized in the New Year's Honours List in 1957 by the award of the C.M.G.

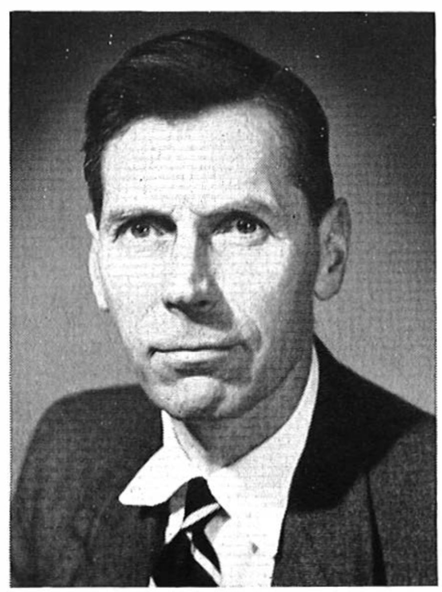
As a professional engineer Mr. Halsey has been active in the affairs of the I.P.O.E.E., contributing some 15 published papers which have been recognized by the award of two Senior Bronze Medals and one Senior Silver Medal. In the I.E.E. he has served as Chairman of the Electronics and Communications Section, and as a Member of Council. His many I.E.E. published papers have gained him the John Hopkinson (twice), Fahie, Ayrton and J. J. Thomson Premiums.

And now a word as to the man himself. High endeavours tend to stand or fall on the character of the man at the top—and the success of the British submarine telephone art is something of a reflection of R. J. Halsey himself. He has the qualities that go to the making of a great engineer: unlimited personal energy, a wide and unusually penetrating professional background, and that elusive "something" which has enabled him to lead an enthusiastic tide of men on a long and exhausting march. All who have worked for him are grateful for the experience. And so his many friends in the United Kingdom, on the Continent, in the United States, and in the Commonwealth countries will wish him and Edna Halsey every happiness and good health in their retirement.

G.H.M.

G. H. Metson, M.C., D.Sc., Ph.D., M.Sc., B.Sc.(Eng.), M.I.E.E.

Dr. G. H. Metson succeeds Mr. R. J. Halsey as Director of Research, becoming the first "scientist" to occupy the post. He was not always so graded, for he joined the Research Station as a Youth-in-Training in 1925 and worked for some years in close association with Sir Gordon (then Dr.) Radley. While still an S.W.I he obtained a B.Sc.(Eng.) external degree and passed the examination for Probationary Assistant Engineer (old style), a rare feat in 1933. He was posted to Northern



Ireland, where he acquired 6 years' experience in the field and carried out research on magnetron oscillators at Queen's University, Belfast; this earned him first an M.Sc. and, later, a Ph.D. degree.

As a Territorial, he went to France with the Royal Corps of Signals in 1939. He took with him the material for his Ph.D. thesis and wrote it up during the "phoney war," only to lose it at Dunkirk during the evacuation. Altogether, 1940 was an eventful year, for he earned both an M.C. for gallantry and his Ph.D.—and, for full measure, was promoted Executive Engineer (old style) *in absentia*. He subsequently served with distinction in North Africa, Italy and India, rising rapidly to the rank of Lieutenant-Colonel, after which he returned to the War Office as a General Staff Officer, Class 1.

On demobilization in 1946 he returned to Dollis Hill. About this time the development of thermionic valves of extreme reliability, for use in submerged repeaters, assumed considerable importance, and soon after his return he took charge of the Thermionics Group, newly formed for this purpose. With the introduction of scientific grades into the Post Office he became a P.Sc.O. and, with his work on submerged-repeater valves growing in magnitude and importance, he became a S.P.Sc.O. in 1951. His personal contributions to the understanding of the behaviour of oxide-coated cathodes have been extensive and have led to many published papers and to world-wide renown. His I.E.E. contributions under the heading of "The Conductivity of Oxide Cathodes" have run (so far) to 16 Parts and have brought him both the Kelvin and Institution Premiums; he has also received three minor premiums from the I.E.E.

It is not only his personal scientific work but his ability as the leader of a team which have been outstanding; production of some 18,000 valves at Dollis Hill for submarine-cable projects has required organizational ability and tact far exceeding those of a research worker.

In 1956 he received "Special Merit" promotion to D.C.Sc.O.—the only Post Office scientist, so far, to achieve this rank or to receive merit promotion at any level. In 1958 he was awarded a D.Sc. by Queen's University for his work on oxide-coated cathodes, and in 1962 he became a Deputy Director of Research in succession to Mr. C. E. Richards.

When the Engineer-in-Chief set up a Working Party in connexion with the proposed move of Research Branch, the choice of Gilbert Metson as its Chairman was both obvious and, in the event, thoroughly justified. A location satisfactory to all parties concerned having been agreed, his term of office should see the first moves to Martlesham Heath effected. He has enormous patience and diligence and is very conscious of the needs of the Station and of its Staff. The future of the Research Branch is in good hands.

R.J.H.

N. C. C. de Jong, B.Sc.(Eng.), A.M.I.C.E., A.M.I.E.E.

Mr. de Jong, appointed Assistant Engineer-in-Chief in September 1964, joined the Post Office as a Probationary Inspector in 1934 after 2 years post-graduate experience with a Westminster firm of civil-engineering consultants in ferro-concrete design, mainly of bridges. His early years as a Post Office engineer were passed mostly in Wales and the West Country—in the Technical Section, Cardiff, and in the Gloucester and Bournemouth Telephone Areas. He also worked in the Telegraph Branch and at the Research Station, Dollis Hill.

Then, between 1943 and 1946, he was commissioned for Civil Affairs work in North-West Europe and appointed to S.H.A.E.F. Headquarters. His concern there was the restoration of communication services, and he acted as a liaison officer between the P.T.T.s of

Belgium and the Netherlands and the Allied Forces. For his services he was awarded the Bronze Star Medal of the U.S.A. and was appointed an Officer of the Order of Orange Nassau.

Soon after his return to the Bournemouth Area in 1946 Mr. de Jong moved to Swansea as the Area Engineer, and in 1953 he left the Engineering Department to become the Telephone Manager in Preston. One of the occasions there he recalls with pleasure was the installation of ERNIE at Lytham St. Annes, both as regards the technical interest of new electronic devices and as a winner of a small prize in the first draw! He stayed in Preston for 4 years, during which time he visited Cyprus and various islands in the West Indies to advise their Governments on telecommunication matters.

His recall to the engineering fold began in 1957 on his appointment to Northern Ireland as Regional Engineer and Telecommunications Controller, although in this dual capacity he was also responsible for advising the Regional Director on all aspects of telecommunications policy. His wartime experience no doubt stood him in good stead in dealing with some of the difficulties met in both Cyprus and N. Ireland!

In 1961 he came to Headquarters as Staff Engineer to take charge of the newly formed Organization and Complements Branch of the Engineering Department, where he was quickly immersed in a variety of problems ranging from computers to complementing, from recruitment policy to research-expenditure apportionment.

Mr. de Jong has for long had a keen interest in the efficiency and economics of the telephone service, most recently shown by his I.P.O.E.E. paper on engineering productivity. This interest plus his exceptionally wide range of experience, including a first-hand knowledge of the problems of Regional and Area work, should prove of great value in his new appointment. In this, his numerous friends at Headquarters, in the Regions and overseas will join in wishing him all success.

F.J.M.L.

Retirement of Mr. L. F. Salter, B.Sc.(Eng.)

Mr. L. F. Salter retired on the 30 September 1964 at the end of nearly 37 years service in the Post Office. He was one of the many Post Office engineers who commenced their engineering training in one of the Royal Naval dockyards, having been an apprentice in the Portsmouth Dockyard from 1919–23. He was, however, unique among Post Office engineers in that he trained for and became a fully qualified Naval Constructor at the

Royal Naval College, Greenwich, between 1923 and 1926. During this period he also studied for and obtained a London University 1st Class Honours external degree in engineering.

He entered the Engineering Department by open competition as an Assistant Engineer (old style) in January 1927, when there were no standard training courses as now, and, after short periods in various offices, was posted to the Telephone Section of the Engineer-in-Chief's office and employed on subscriber's apparatus design. In June 1929 he was transferred to the London Engineering District, Superintending Engineer's Office, and employed on trunking and junction-cable design duties. Some 3 years later he moved to the London Centre Internal Section, where one of his main tasks was the organization of the opening of the largest automatic exchange in the country in the Mayfair Building. After some $2\frac{1}{2}$ years in the telephonically densest area of the country he moved to the relatively rural Swansea Section and was promoted to Sectional Engineer in May 1936.

Two years later he joined the Telephone Branch of the Engineer-in-Chief's Office, and, apart from dealing with maintenance procedures, was concerned with the design of emergency-exchange equipment and in drawing up plans for the rapid restoration of damaged exchanges. His design and plans were put to the test when Southampton exchange was completely destroyed at the end of 1940, and under his personal on-site direction both design and plans were shown to be completely successful.

Promotion to A.S.E., Telephone Branch, in 1945 placed him in charge of all telephone-exchange circuit, apparatus, routiner and tester design, and also led him to play a major part in the re-organization of the British Technical Telephone Development Committee.

Nine years later Mr. Salter was made Deputy Chief Regional Engineer on Planning and Provision in the London Telecommunications Region, and until July 1958 carried a heavy responsibility with distinction in coping with the provision of external and internal plant to meet the ever increasing demand for telephone service in one of the most congested areas in the world.

When it was decided in 1958 to split Telephone Branch into two Branches it was almost axiomatic that Mr. Salter should be chosen to take charge of the Telephone Exchange Standards and Maintenance Branch. For the last 6 years of his career he has led this Branch through very difficult times, with the high pressure of new development to meet a rapid expansion of the facilities offered to subscribers, many of which involved the application of new techniques, competing with the requirements to improve service and at the same time reduce maintenance costs. Apart from his undoubted technical ability, his success can without doubt be attributed to his ability to "get on" with people. He has always shown a strong personal interest in the well-being of his staff, and has played a leading part in sports and social activities organized within each office in which he has served. For many years he was Chairman of the Engineer-in-Chief's Branch of the Post Office (later Civil Service) Sanatorium Society and worked hard in this deserving cause. Soon after his return to Headquarters as Staff Engineer he initiated the reconstitution of the Engineering Department Billiards and Snooker Club and was its President until he retired.

The esteem in which Mr. Salter was held by all ranks was fully apparent at the very large gathering on the occasion of his farewell presentation of 28 September 1964, and there is no doubt that he leaves the Service with the sincere wishes of many hundreds of the people who knew him for a long and happy retirement.

W.J.E.T.

T. F. A. Urben, B.Sc.(Eng.), A.M.I.E.E.

Mr. T. F. A. Urben, recently promoted to Staff Engineer, Telephone Exchange Standards and Maintenance Branch, takes justifiable pride in the fact that he started at the foot of the ladder as a Youth-in-Training in the Exeter Section in 1936—a fact from which any young entrant of today can take encouragement at the commencement of a career in the Post Office.

Successful in the Limited Competition for Probationary Inspector in 1938, and completing his probationary period shortly after the outbreak of war, Mr. Urben was seconded to the Admiralty Signals Establishment, Portsmouth, early in 1940. For the next 4 years he was employed in the A.S.E. Production Department on the engineering and control of naval radio equipment, transferring to the Development Department in 1944 and engaging in circuit design of control systems for ships' radio.

In spite of several interruptions to his evening studies at technical colleges, caused by wartime moves, he graduated with a 1st Class Honours B.Sc.(Eng.) degree in 1943.

In 1945, by which time he had received two promotions and attained the rank of Admiralty Technical Officer, Mr. Urben returned to the Post Office and, following a brief period in the Subscribers' Apparatus and Miscellaneous Services Branch of the Engineering Department, was

promoted to Assistant Engineer (old style), Telephone Branch. This first period of association with Telephone Branch continued for 12 years during which he covered many aspects of the Branch responsibilities. As an Executive Engineer, Mr. Urben was engaged in automatic routiner development and later in the circuit design and development of a.c. signalling systems.

Promoted to Senior Executive Engineer in 1950 he was put in charge of a Group dealing with the standards for, and specification of, exchange equipment, and took a particular interest in improvements to apparatus design, the introduction of modern plastics in selector-bank construction being a typical example of his work in this field.

An opportunity to apply his specialized knowledge and experience in a broader field of responsibility arose in 1957 when he was selected for the post of Chief Factories Engineer, a capacity in which he contributed much to the further mechanization of factory operations and the change-over to flow-line production. He returned to his present Branch as Assistant Staff Engineer on maintenance in 1963.

Mr. Urben takes over the position of Staff Engineer at a time when the problems associated with giving an improved quality of telephone service and reducing the cost of maintenance are very much to the fore. To these particular problems and the many others facing the Branch he brings proved technical ability, an incisive approach, and considerable experience in the handling of a large staff. This combination, allied to a friendly disposition, augurs well for the success confidently wished him by his friends and colleagues in the Post Office and in the exchange-equipment manufacturers' organizations.

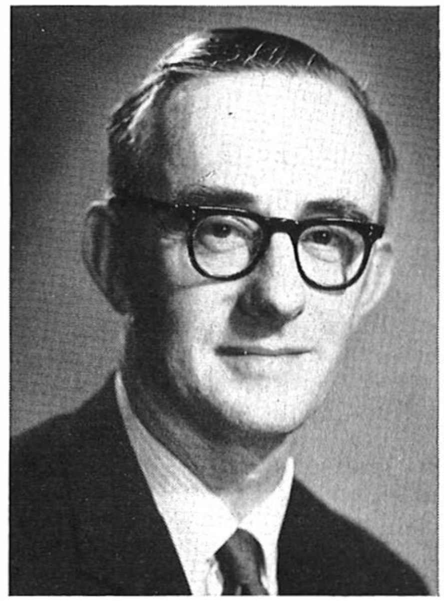
G.E.S.

F. J. M. Laver, B.Sc., M.I.E.E.

The appointment, *in absentia*, of Murray Laver as a Staff Engineer on 23 September 1964 has been widely welcomed by his many colleagues and friends in the Post Office, other Departments, and in industry.

Since April 1963 he has been seconded to H.M. Treasury, for a nominal 3 years, as an Assistant Secretary in the Management Services Division. He is responsible there for the introduction and utilization of computer systems throughout all Government Departments. His originality of mind and other special talents for this work are particularly valuable at this time when progress is beginning to be made into the use of automatic data-processing systems as management tools as distinct from their proven use as clerical aids.

Mr. Laver is an accomplished and entertaining lecturer, and his numerous lectures and talks on computers have



done much to unravel the mysteries of a complex subject to thousands of Civil Servants and others.

His Post Office career has been an interesting one. Born in Plymouth in 1915, he entered the Post Office as a Probationary Inspector in June 1935, and passed the Limited Competition for Probationary Assistant Engineers (old style) in May 1939. In both examinations, he attained first place.

His official life until March 1948 was spent in the Radio Experimental Development (WE) Branch, Dollis Hill, where he worked on frequency and time standards. This work brought him into close contact with the B.B.C., the National Physical Laboratory, and the Royal Observatory.

He became a Senior Executive Engineer in WE Branch in March 1948, responsible for the group which designed, produced and installed the repeater equipment for the 1 in. diameter London–Birmingham coaxial cable which subsequently carried television signals to the B.B.C. Sutton Coldfield transmitter. After this project he was engaged on comparative tests of f.m. and a.m. broadcasting on v.h.f. and began development of an auto-scanning receiver for radio monitoring.

In 1951 he was transferred to the Radio Planning and Provision (WP) Branch to study radio systems, navigational aids and radio frequency allocation questions. He also contributed to the work of the

International Radio Consultative Committee (C.C.I.R.) on radio telegraphy, f.m. for ships, and colour television, and was a delegate to meetings in Brussels (1953) and London (1954).

From September 1955 he was a temporary A.S.E. in WP Branch, planning and providing microwave television and telephone radio-relay systems. In July 1956 he joined the Organization and Efficiency (O) Branch as an A.S.E. to take charge of its newly formed computer group and was intimately concerned with the LEAPS computers and the launching of the highly successful Dollis Hill National-Elliott 803B computer, including programming training for engineers. Whilst in O Branch, he was involved in productivity and manpower-deployment studies and did much to initiate the use of critical path analysis techniques. In connexion with his computer work he has made two tours of the U.S.A. to study automatic data processing in business and Government, and to visit computer manufacturers.

He has been an active supporter of the Institution of Post Office Electrical Engineers and of the Institution of Electrical Engineers and has made numerous contributions to their technical literature.

He is a voracious reader over a wide field, and has special interest and facility in communicating ideas. This has found expression in articles in the engineering volume of the Oxford Junior Encyclopaedia and books for children on "Electric Power," "Electrons at Work," "Waves" and "Energy."

We congratulate him warmly on his promotion and wish him every success in his future career.

J.W.F.

N. V. Knight, B.Sc.(Eng.), M.I.E.E.

Mr. Knight, who was appointed Staff Engineer of the newly formed Organization and Efficiency (Maintenance and Computers) Branch on 5 October 1964, started his business career in the Headquarters Office of the National Union of Railwaymen as office boy to

the late J. H. Thomas, who was Colonial Secretary in the J. R. MacDonald's first Labour Government in 1924. Eye trouble necessitated a change to outdoor duties, and he has subsequently enjoyed an unusually wide range of experience in telecommunications engineering and management since he joined the Post Office, as a Youth-in-Training, in the old South Midland District in 1925.

In 1929 he was one of the group of young men selected by Mr. B. O. Anson for service in the rapidly expanding Circuit Laboratory, and he remained with the Laboratory when, in 1931, he was appointed as a Probationary Inspector. Then, following his success in the limited competition for Probationary Assistant Engineer (old style), he was employed in the Exchange Equipment and Accommodation Branch of the Engineer-in-Chief's Office from 1933 to 1937. Apart from a spell with the Control Commission, as Controller, P. & T., Lower Saxony, between 1946 and 1948, Mr. Knight spent the next 15 years in Telephone Area work—being appointed successively as Assistant Engineer (old style) in the London Telecommunications Region (L.T.R.) South East Area 1937, Area Engineer at Stoke in 1940, Deputy Telephone Manager in the L.T.R. North Area in 1948 and North West Area in 1949, and Telephone Manager in the L.T.R. City Area in 1950.

In 1952 he returned to the Engineering Department as an A.S.E., and rejoined the Equipment Branch of the Engineer-in-Chief's Office. In the following 5 years he was particularly concerned in studies of the planning and recoveries of telecommunication systems. It was during this period that he earned the unique distinction of being awarded senior medals of this Institution in two successive years; the Bronze Medal in 1955 for his paper "Depreciation and Service Life of Telecommunications Plant," and the Silver Medal in 1956 for his paper "Economic Principles of Telecommunications Plant Provision." Also, during this period he undertook short-duration special assignments as Adviser to the Singapore Government on the take-over of the Oriental Telephone Company's assets (1954), and as Adviser to British Honduras and Jamaica (1956).

From 1957 to 1962 Mr. Knight served in "approved employment" as General Manager in the newly formed Singapore Telephone Board, a post which provided him with opportunities to visit other Telecommunications Administrations in Europe, North America, Africa and Australia. He returned to the Post Office for a brief spell in 1962–3 as an A.S.E. in the Joint Post Office and Ministry of Public Building and Works Research Group and then went abroad again, on secondment, to Nigeria, first as Director, P. & T., and later as Adviser to the Nigerian Government. Since returning from Nigeria in June 1964, as an A.S.E. in the Equipment Branch of the Engineer-in-Chief's Office, he has been concerned with economic studies and consultative services, and recently has made a further visit to Singapore, on behalf of the Post Office, as adviser to the Ministry of Defence.

Throughout his career, Mr. Knight has been an enthusiastic student of telecommunications in its widest context. In recent years, he has concentrated more on economic aspects of telephone service, and has been admitted to Fellowship of the Royal Economic Society. He was a prize winner, in his early days, in the I.P.O.E.E. essay competitions and a silver medallist in the City and Guilds of London Telegraphy examination; he lectured at Northampton, Regent Street and S.E. London Polytechnics; and was co-author of the "Telephone Handbook." In spite of the many demands of these professional activities, he has, wisely, cultivated a wide range of other interests and hobbies, notably in music, motoring, including competition driving, and tennis, in which he still takes an active part.

His world-wide circle of friends wish him every success in his new appointment. W.A.H.

Retirement of Mr. R. S. Phillips, M.I.E.E.

After 40 years of Post Office service, Mr. R. S. Phillips retired from the post of Staff Engineer, Power Branch, on 31 December 1964.

His early training was as an engine fitter in H.M. Dockyard, Pembroke, after which he came into the Post Office as an open competition Inspector. Two years later he succeeded in the open competition for Assistant Engineer (old style).

For the first 10 years of service he was at Dollis Hill Research Station, which was the scene of great re-building activity. The old hutments were being replaced by new laboratories in grand style and he was engaged on the wide range of special electricity supplies and engineering services which were needed. Subsequently he transferred, as a power specialist, to the Manchester headquarters of the old South Lancs District until 1936, when the North Eastern Region was constituted. He was a natural choice as Power Engineer, Leeds, and became the first of this new grade ever to be appointed.

In 1942 he came back to London as A.S.E., Power Branch. In 1951 he was promoted C.R.E., London Postal Region, returning to Power Branch as Staff Engineer in 1956.

Although he was concerned with power engineering throughout his career he kept in touch with a wider range of subjects and for several years was an evening lecturer at the London Polytechnics. He also studied telegraphy and was awarded the City and Guilds Silver Medal and the Pewterers Prize in that subject. But he will be remembered, more particularly, for his excellent text book on "Electric Lifts," which was first published in 1939 and has been in regular demand ever since, running to four editions with a fifth in course of preparation. He was also keenly interested in developments in the field of postal mechanization and visited Canada, U.S.A. and European countries to study their techniques. He contributed several Institution papers and articles on this and allied subjects.

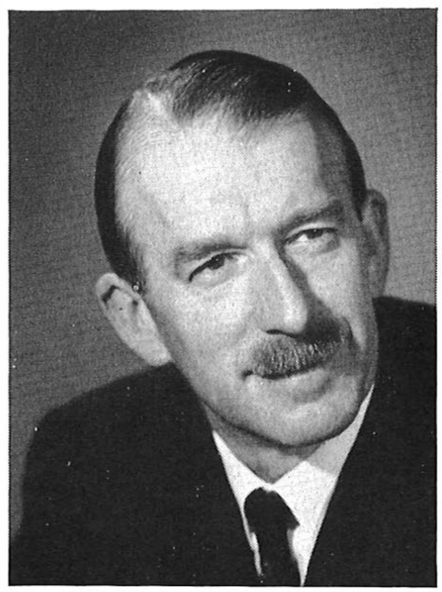
"Phil" was always a keen sportsman, participating in soccer, rugby and cricket. There are probably a number of old-timers who will remember his exploits with the soccer teams at Dollis Hill in the early days. One of his favourite relaxations was gardening, with the emphasis on ornamental shrubs and fruit. He won many R.H.S. prizes for fruit and also carried off several "coups" with the L.P.R. Horticultural Society when he was C.R.E.

He will be remembered for his friendly disposition, his fairness and competence in handling official matters, and his ability to offer adverse comment without giving offence. His many friends and colleagues will miss him and will wish him a happy retirement with the opportunity to spend more time at his holiday bungalow on the Pembrokeshire coast. G.M.M.

J. Piggott, B.Sc.(Eng.), M.I.Mech.E., M.I.E.E.

John Piggott has been promoted Staff Engineer of Power Branch, a post for which his experience and outlook befit him admirably. The appointment will be warmly welcomed by all his many friends in and outside the Post Office.

Leaving Emanuel School in 1930 he commenced his engineering apprenticeship with the B.T.H. Co., at Rugby. He later completed a full-time course at London University and obtained 1st Class Honours in the B.Sc.(Eng.) examination in 1935. Attracted to a Civil



Service career 2 years later he entered the Post Office Engineering Department by Open Competition as Assistant Engineer (old style). He was soon seconded to the Postal Services Department and studied the potential for mechanization of all kinds in the postal services. During the war years he was in the External Plant Group of the Research Branch carrying out overhead line and cable measurements. At that time carrier working was prominent, and the requirements of overhead routes and cables for civilian and service use needed investigation. He also contributed to the design of buried-pipe and cable-pair locators and suggested means for greater consistency in high-voltage protection.

Soon after the war he received promotion to Senior Executive Engineer, Power Branch, and took charge of the Postal Engineering Development Unit at Mount Pleasant. This period was possibly the most challenging in his career in which a 6-operator mechanical letter-sorting machine had to be designed and constructed—the first of its kind. A Goliath of a machine took shape providing 144 selections: it laid the foundation of the British system. A considerable improvement in operating speed was demonstrated by the use of non-synchronous operation. It was also during this period that he worked on numerous cable-ship problems and originated the idea for the handling of rigid repeaters by the use of "Vee" sheaves.

Promotion to Assistant Staff Engineer in 1955 in the Research Branch saw him in charge of the Research Services Section. In this he has controlled, and knows individually, a staff of some 300, comprising over 20 different ranks, who supply a design and production service to the 13 Scientific and Engineering Divisions. The work is immensely varied and ranges from heavy mechanical plant to fine precision scientific apparatus. In this field he has been concerned with many developments already reported in these pages.

His youthful enthusiasm and unfailing courtesy allied to a naturally kind and sympathetic disposition has always brought out the best in others and attracted a loyal staff. His success in his new post is assured, but his colleagues in Research Branch in particular will be sorry to lose him.

J.P.H.

Reprint of Articles from the Special S.T.D. Issue of the Journal (Vol. 51, Part 4, Jan. 1959).

Copies are still available of the reprint of selected articles from the special subscriber trunk dialling issue of the Journal (Vol. 51, Part 4, Jan. 1959). This 32-page reprint, price 2s. 6d. (3s. post paid) per copy, contains some notes drawing attention to developments that have taken place since the original publication of the selected articles and which affect the information contained in these articles. The articles in the reprint are as follows:

The General Plan for Subscriber Trunk Dialling.
Controlling Register-Translators, Part 1—General Principles and Facilities.
Local Register for Director Exchanges.
Periodic Metering.
Local-Call Timers.
Metering over Junctions.
Subscribers' Private Meter Equipment.

Orders and remittances, which should be made payable to *The P.O.E.E. Journal* and crossed "& Co.," should be sent to *The Post Office Electrical Engineers' Journal*, G.P.O., 2–12 Gresham Street, London, E.C.2.

Reprint of Article Entitled "Outline of Transistor Characteristics and Applications."

Copies are available of a reprint of the article entitled "Outline of Transistor Characteristics and Applications" (Vol. 56, pp. 122, 196 and 268, July and Oct. 1963, and Jan. 1964). The 22-page reprint, price 3s. (3s. 6d. post paid) per copy, contains the three parts of the article, which had the following subsidiary titles:

Part 1—Transistor Parameters and Stabilization of Characteristics.
Part 2—Application of Linear Characteristics.
Part 3—Applications of Non-Linear Characteristics.

Orders and remittances, which should be made payable to *The P.O.E.E. Journal* and crossed "& Co.," should be sent to *The Post Office Electrical Engineers' Journal*, G.P.O., 2–12 Gresham Street, London, E.C.2.

Journal Binding.

This issue completes Vol. 57 and readers wishing to have this volume bound should refer to page 296 for details.

Institution of Post Office Electrical Engineers

Annual Awards for Associate Section Papers—Session 1963–64

The Judging Committee having adjudicated on the papers submitted by the Local Centre Committees, prizes and Institution certificates have been awarded to the following in respect of the papers named:

First Prize of £7 7*s*.

L. Vranch, Technical Officer, Bath Centre—"Some Observations on Going S.T.D."

Prize of £4 4*s*.

P. Gorrett, Technical Officer, Hastings Centre—"Taped Sound."

The Council of the Institution is indebted to Messrs. W. L. A. Coleman, F. Summers and G. A. Probert for kindly undertaking the adjudication of the papers, and to Mr. W. L. A. Coleman, Chairman of the Judging Committee, for the following report:

The paper submitted by Mr. Vranch was both interesting and stimulating. The author, who is clearly an enthusiast, produced a paper of interest and value to engineers concerned with S.T.D. and also to a wider audience.

The first part of the paper introduced the principles of S.T.D. working, and the explanation of the equipment functions by relating them in detail to the functions otherwise carried out by operators was very well done. In the second part, the author dealt with maintenance aspects and the subscribers' point of view, and described the role of the maintenance engineer in an S.T.D. network. He underlined the fact that the quality of service and the public reaction to it depends in large measure on the interest and enthusiasm of each individual maintenance engineer and on their co-operation with each other and with their traffic colleagues.

Mr. Gorrett's paper was an interesting résumé of the history and technique of magnetic-tape recording, and touched briefly on the use of tape recorders in the creation of electronic music. The author's treatment of the basic technical problems of recording and playback was adequate without being too detailed. His demonstrations, which were well chosen, undoubtedly contributed effectively in the presentation of the paper.

President of the Associate Section

Mr. E. Hoare, Regional Engineer, Home Counties Region, has been appointed President of the Associate Section, succeeding Mr. A. J. Leckenby, M.B.E., whose term of office is complete.

S. Welch,
General Secretary.

Regional Notes

Scotland

CALEDONIAN CANAL CABLE CROSSING AT CORPACH

Scotland West Telephone Manager's Office was informed that, due to urgent reconstruction and repair work, the Caledonian Canal at Corpach would be empty between the end of April 1964 and the end of July 1964.

This provided an ideal opportunity to cross the canal with two steel pipes, and a contract was placed with Messrs. Christie and Co., Banchory. The work was duly commenced on 15 June and finished on 26 June.

The actual work consisted of placing two steel pipes in a trench from the canal bank to the bottom of the canal, across the bed of the canal and up the other side. A reinforced-concrete joint-box was required in the bank at each end of the pipes.

The total distance involved was approximately 56 yd. A preliminary inspection of the empty canal revealed that, although the locks were empty, the canal reach where the pipe was due to cross contained about $2\frac{1}{2}$ ft of water and that the canal bank was inclined at 45° to the bottom.

To completely empty the canal where the trench was to be excavated on the canal bed, it was necessary to place a sand-bag dam on each side of the crossing position. Once the dam was in position the area between was pumped out to allow the work to proceed under reasonably dry conditions.

To facilitate the building of the sand-bag dam and the easier carriage of materials, a wire rope with a pulley was fixed across the canal as the access to one bank of the canal involved a walk of over a mile. In four days from the start of work 27 tons of sand was filled into 900 sand-bags and the dams completed on each side of the crossing position. Three motor pumps were then placed in position and the crossing area between the dams emptied of water. The two steel pipes were placed in position on the canal bed.

As a safety measure three concrete anchors each containing $\frac{3}{4}$ yd^3 of concrete were placed in position at the middle and ends of the steel pipes. The tracks in the canal banks were next excavated and the pipes laid up to the joint-box positions on each bank. The sand-bag dams, apart from their actual purpose, proved to be admirable bridges for crossing the canal during the execution of the work and saved a great deal of time. On completion of the jointing chambers a test-piece was pulled through both steel pipes from jointing chamber to jointing chamber. The test was carried out quite easily with one man pulling the testing rope.

On successful completion of the tests the sand-bag dams were dismantled and the site cleared up, thus concluding a very successful and unusual duct-laying job.

C.H.M.

North Eastern Region

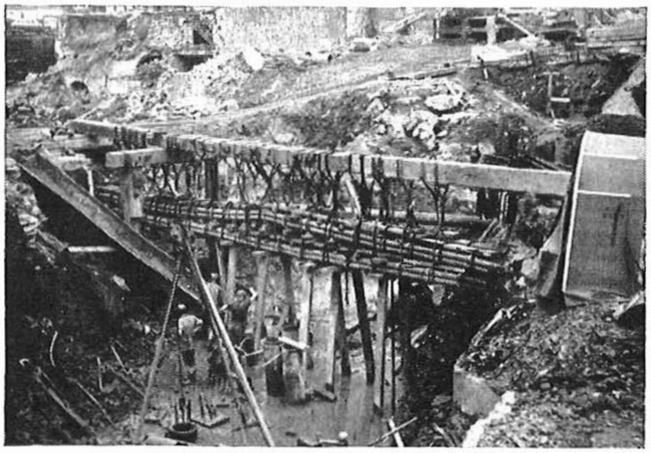
ROAD WORKS ON THE A1 AT NEWCASTLE CITY CENTRE

Major alterations to the road system have been undertaken in the city of Newcastle-upon-Tyne at the point where the A1 leaves the north bank of the Tyne. The new system will incorporate a roundabout to distribute traffic within the city and a low-level road slipping underneath to take north-bound traffic through to what will eventually be a city-centre by-pass road. The works cover an area of about four acres, between Telephone House and the Tyne bridge. All the cables passing north and south through Newcastle go through the reconstruction area.

The diversion of these cables has been a major task and a new routing has been selected which by-passes some of the works and passes underneath others at a level which would be unaffected by later operations. The depth of road reconstruction was such that all undertakers' plant had to be diverted early in the program to allow the new road levels to be excavated.

The new duct line was built up of pitch-fibre pipes set in concrete and incorporates several unusual features. Over one section the line of the duct route runs underneath that of a temporary diversion of one of the railways and has had to be built to withstand the dead weight of a temporary railway bridge. Over two other sections the deviations required were too great to allow pitch-fibre ducts to be used and for these portions p.v.c. ducts had to be specially manufactured. The change-over manholes also presented considerable difficulties because of the number and size of cables being diverted, and at the Telephone House end of the diversion the manhole could not be roofed until after the old cables had been recovered; here a weatherproof temporary roof of polythene sheeting was constructed and proved very satisfactory.

As is common in work of this magnitude there were times when the staff had to work under considerable discomfort, and interference was caused by other services, notably gas and sewage. There was also a period of about a month when, as shown in the photograph, the entire north and south communication cables were suspended on a beam over the excavations for about 25 yd.



CABLES SUSPENDED OVER ROAD WORKS AT NEWCASTLE

During the whole of the works there was no disruption of service and the only sheath fault which occurred did not affect any of the conductors.

J.E.W.

North Western Region

BLOCK-RELEASE COURSE RESULTS—LANCASTER AREA

Important changes in the system of technical education for Youths-in-Training in the Lancaster Area were introduced in September 1963. Details are as follows:

Following the Government White Paper, "Better Opportunities in Technical Education," published in 1961, the three-year Ordinary National Certificate (O.N.C.) course has now been replaced by a two-year course, O1 and O2, requiring higher entry qualifications, e.g. G.C.E. "O" level certificates including mathematics and a suitable science subject. To permit the inclusion of liberal and general studies, an increase of study time was recommended, and was one of the major factors which led to experimental block-release courses as an alternative to the normal one-day per week arrangement.

With the co-operation of Lancaster and Carlisle Technical Colleges, it was arranged that the first-year block-release course should cover, by the inclusion of a specialist telecommunications subject, the City and Guilds of London Institute Intermediate Telecommunications Technicians Course (T.T.C.) syllabus as well as O.N.C. (O1). (The second-year block-release course will cover O.N.C. (O2) and the T.T.C. "B" year). The idea of combining the O.N.C. and T.T.C. courses may not be unique, but it is not thought to have been widely adopted and is, therefore, considered to be worthy of special report.

The results for the O.N.C. (O1) course showed that at Lancaster nine out of ten Youths-in-Training passed, with seven out of seven passing at Carlisle. The following table gives the results subdivided into subjects.

Subject	Distinction	Credit	Pass	Fail
Mathematics	10	7	—	—
Electrical Engineering Science	4	10	3	—
Mechanical Engineering Science	1	12	3	1
Physics	1	14	2	—
Totals	16	43	8	1

The City and Guilds results for the Lancaster Youths were that seven out of the ten gained the intermediate T.T.C. achieving the following results in individual subjects.

Subject	Passes		Fail
Mathematics A	10		—
Telecommunication Principles A	4 (1st Class)	5 (2nd Class)	1
Selected Subject	4 (1st Class)	3 (2nd Class)	3

Whilst due credit must be given to the students, there is no doubt that the new system is a big improvement on the day-release system. In addition to the advantage of more effective technical education, the block-release courses seem to be developing group friendship and co-operative spirit amongst the youths concerned. Without exception they have been most enthusiastic towards this form of training.

The success of this new pattern of training must depend on having the right student material, and this is partly ensured by the required entry qualifications for the O.N.C. (O1) course. The technical education scheme now being offered is becoming more widely known and is undoubtedly helping to attract suitable youths, mainly those who just miss going on at school to G.C.E. "A" level science studies.

G.C.S.

London Telecommunications Region

DAMAGE TO THE HIGH WYCOMBE–LONDON No. 2 CABLE

Prior to the construction of the M4 motorway in the area where it was due to cut Sipson Road, West Drayton, Middlesex, some diversions and improvements of the existing trunk routes were necessary.

A 36-way pitch-fibre duct route was, therefore, constructed for some 320 yd, with a formation of 6 × 6 ducts in a position and depth thought to be immune from subsequent disturbance when not only the motorway was constructed but also when a pedestrian subway and a new County road were built.

Ten trunk and junction cables were changed over and it was with some surprise that, a year later on 14 April 1964, faults were reported on the 122 pr 40 lb/mile High Wycombe–London No. 2 cable and were located to a point within the pitch-fibre block. A visual inspection of the ground, however, showed no signs of recent disturbance.

Interruption cable was pulled in and the circuits were changed over during the night. Attempts were then made to recover the faulty cable, which was located in a top outside bore. This was achieved with some difficulty and the cable was found to be flattened and partially cut at one point. Subsequent measurements pin-pointed the damaged area to be under the newly laid and bitumen-proofed concrete of the entrance to the new County road.

The road contractors could throw no light on the situation, but it was noticed that the estimated point of damage was directly in line with two drainage gully pots on opposite sides of the road.

Fortunately, the road was of dry lean concrete construction and breaking out was not difficult. The final excavation revealed that the cover concrete of the block and the top row of six pitch-fibre ducts had been completely cut out to lay a 4 in. earthenware drain, the cable, as shown at the bottom of the accompanying photograph, being flattened out in the process.

DAMAGE TO DUCT ROUTE CONTAINING HIGH WYCOMBE–LONDON No. 2 CABLE

Repairs to the duct block were effected by carefully cutting out the remains of each of the six pitch-fibre ducts as far back as a spigot-and-socket joint, the other ends being carefully levelled off. The semi-circular bed of concrete in which each had rested was not disturbed.

Six new lengths of duct were then accurately cut to a length just slightly shorter than the broken out lengths, and these were fitted over the joints and the other ends dropped into line with the cut ends. The joints were then wrapped with Denso tape to prevent ingress of cement and the whole then concreted over to the original thickness above the ducts; after this, tests with mandrel and brushes were satisfactorily carried out.

The cable being located in a top bore at least served as an early warning system for the duct block as a whole. Had no faults been reported, the damaged ducts would not have been discovered until some time in the future when attempts were made to use them.

B.S.T.

Midland Region

BIRMINGHAM NEW TELEVISION NETWORK SWITCHING CENTRE

Since 1949 the equipment associated with television links in Birmingham has been accommodated in an area of

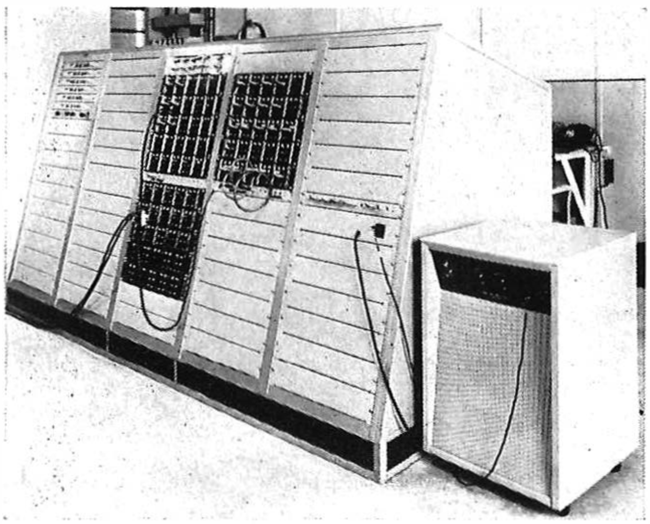
1,100 ft² at the end of the main repeater station in Telephone House, Birmingham. This space became overcrowded, and further development was restricted by the telephone transmission equipment already installed.

A new television network switching centre has therefore been provided in another wing of Telephone House, and has now been brought into service. An area of 4,100 ft² has been allocated and this is expected to cater for 20 years development. This area accommodates the apparatus room of 3,000 ft² and the control room of 1,100 ft².

The control room accommodates the following equipment.

(*a*) The video distribution frame—the main flexibility point where cabling to apparatus room, video distribution rack and switching equipment is terminated.

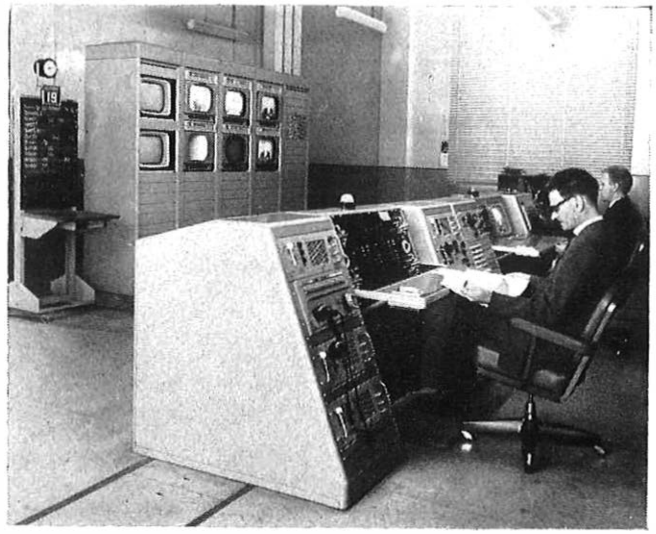
(*b*) The video distribution rack (V.D.R.), on which test points for all links are provided. Facilities have been provided for the connexion to any link of the standard pulse-and-bar test signal and for the monitoring of waveform or



(*a*) VIDEO DISTRIBUTION RACK AT BIRMINGHAM TELEVISION NETWORK SWITCHING CENTRE

picture. It is at this point that links are interconnected by standard coaxial "U" links. Three units have been provided and each unit will accommodate 50 incoming and 50 outgoing circuits. The video distribution rack is shown in photograph (*a*).

(*c*) The network-switching console, comprising switching panels, 23 db gain video amplifiers and waveform correctors. This equipment will switch any of 10 sources to any of 10 destinations for both sound and vision. It employs a 10-way splitting network on each of the 10 sources. Associated with each destination is a 10-way push-button Yaxley-type switch with a locking bar which permits only one button to be operated at one time. From the splitting networks each source is connected to each destination switch, the video output of which is fed to the high-impedance input of a video amplifier. Each video circuit is provided with a waveform corrector so that when a source is connected to any destination the distortion is less than ½ per cent.



(*b*) SWITCHING AND TEST CONSOLES TOGETHER WITH THE MONITOR SUITE

(*d*) The monitor suite, comprising six video monitors and two monitors for monitoring local transmitters. The monitors are mounted in cubicle-type racks (Racks, Apparatus, No. 52) and can be seen in photograph (*b*).

(*e*) The test console, comprising waveform generators, oscilloscope, picture monitor, noise and linearity measuring equipment, speaker switchboard, and monitor-selection unit. The test console is provided with special low-loss trunks to the V.D.R. The appropriate test equipment is connected to these trunks by low-capacitance relays controlled by push-buttons on the desk of the console.

The monitor selection unit consists of six sets of illuminated push-button switches, one set for each monitor. These switches remotely control the monitor-switching relays fitted on the monitor-selection equipment installed in the apparatus room. To give additional flexibility all monitor points and the inputs to the monitor-selection equipment are cabled to the video monitor distribution frame. The monitor points are jumpered to the inputs of the monitor-selection equipment so that each of the six monitors can be switched to one of nine monitor points. Associated with each monitor is an indicator panel showing the designation of the link being monitored.

The layout of the apparatus room has been arranged on a functional basis, i.e. two suites are devoted to coaxial line terminal equipment, another two suites to frequency-translating equipment, etc. Coaxial cables carrying power for feeding to dependent intermediate stations terminate on the line equipment concerned. All other external cables terminate on a cable terminating-rack (C.T.R.) at the end of the apparatus room remote from the control room.

The installation has been planned by the Midland Region transmission group and the Engineering Department. The whole of the installation work has been carried out by the staff of the Telephone Manager, Birmingham.

The setting up and correcting of links was performed by the Engineering Department.

R.C.M., L.T. and F.C.S

E

Associate Section Notes

London Centre

The final of the quiz competition between the Associate Section Centres within the ambit of the London Centre took place in the Pavilion, Brighton, on 16 October.

A large gathering, including a contingent from London who had generously provided tea, taken earlier, together with a number of distinguished visitors from both the Home Counties Region and the London Telecommunications Region, saw a keenly fought "20 questions" program which Brighton finally won by a narrow margin. However, London (represented by a team from the South West Area) had no reason to hang their heads as the President of the Associate Section, Mr. E. Hoare, who also acted as Question Master, made clear when he presented the trophy to the winning team.

This trophy, a handsome silver-plate-on-copper model of the Post Office Tower in Howland Street constructed by the well-known model maker Mr. F. A. A. Pariser of the Midland Region, was recently presented by the London Centre Committee to be contested annually by all the Associate Centres covered by the Committee. The preliminary rounds of the competition were fought out in London and in the South Eastern Group. It is hoped that the formal recognition now given to the competition will encourage more Associate Centres to take part.

R.V.S.

Cornwall Centre

In April a further visit to the Rosewarne Experimental Horticulture Station at Camborne to see the numerous species of daffodils was marred by rather adverse weather conditions. Nevertheless, those members who attended appreciated the formidable sight of approximately 1,200 beds of daffodils, each bed containing a different variety.

Messrs. B. J. Woollett and L. B. Handley gave their paper entitled "Local Line Networks in Sweden" in late April. As both Mr. Woollett and Mr. Handley had visited Sweden on an interchange of staff, their information and comparisons were first hand and the paper proved to be very interesting indeed.

The annual general meeting held in May revealed that membership of the Centre had now reached 213; the meeting was followed by a visit to the premises of the West Briton Newspaper Co., at Truro. Here an extremely enjoyable evening was spent, ending by each member being handed a copy of the latest edition as it came off the press.

D.J.G.C.

Barnstaple Centre

The elected officers for the 1964–65 session are as follows: *Chairman:* Mr. R. H. Palmer; *Secretary:* Mr. H. J. Hutchings; *Treasurer:* Mr. F. D. Colwill; *Committee:* Messrs. W. W. Holbourn, C. H. Langdon, C. L. Wright, F. Gaskin, A. G. Somerville and R. G. Lawrence.

The winter program includes the following papers.

"The Training of Youths," by Mr. E. H. Piper, Bournemouth.

"Modern Maintenance—Serving the Subscriber," by Mr. T. F. A. Urben, Telephone Exchange Standards and Maintenance Branch, Engineering Department.

"The Traffic Division," by Mr. Young, Telephone Manager's Office, Taunton.

"The Royal Observer Corps."

"Illustrating Lectures and Technical Articles," by Mr. W. R. Paul, F.I.B.P., F.R.P.S., Post Office Research Station, Dollis Hill.

"Subscribers' Telephone Instruments—Some Possible Future Developments," by Mr. Harding, Subscribers' Apparatus and Miscellaneous Services Branch, Engineering Department.

Although the membership of the Centre is now 62, attendances have not been good lately and better support for future papers, which promise to be as excellent as past talks, is hoped for from our members.

H.J.H.

Exeter Centre

The annual general meeting was held on Thursday, 8 October. It was especially well attended by members from out-stations.

The following officers were elected: *President:* Mr. R. Clinnick (Telephone Manager); *Chairman:* Mr. R. Powlesland; *Vice-Chairman:* Mr. B. Byrne; *Secretary:* Mr. T. F. Kinnaird; *Treasurer:* Mr. C. Chandler; *Librarians:* Messrs. M. Saunders, Exeter, and N. H. B. West, Torquay; *Committee Members:* Messrs. P. C. James, J. Curwood, B. J. Rolston, G. A. B. Sealey and J. L. Petherick; *Auditors:* Messrs. W. R. Coles and L. J. Squires.

The meeting unanimously carried a proposition that the retiring Chairman, Mr. W. J. Foster, be made an Honorary Life Member in recognition of his services to the centre since its re-formation.

The meeting also saw films on the development and progress of helicopters, hovercraft, long-length cabling and paint.

During the summer session members visited the Atomic Energy Establishment at Winfrith and enjoyed a very interesting tour.

T.F.K.

Aberdeen Centre

The opening meeting for the 1964–65 session, on Thursday 17 September, was a broadcast joint meeting with the newly formed Inverness Associate Centre, and took the form of a quiz, Aberdeen *v.* Inverness. The questions covered recent developments in most aspects of the Department's work, including underground cabling, subscribers' apparatus, automatic exchange equipment, power plant, transmission and electronic apparatus. Competition was very keen and there was much discussion of the plan numbers introduced and made obsolescent in recent years. There were many frowns during the discussion on the methods of working register-translators. Everyone seemed to learn something. The broadcast was received by out-stationed members at Lerwick, Kirkwall, Wick, Gairloch, Stornoway and Huntly. After a break for tea, our President, Mr. J. B. Duff, Area Engineer, gave a talk on "Developments in External Construction" in which he mentioned the rodding machine, pole-erection unit, directly-laid cable, fibre-glass poles, and the use of drop-wire to eliminate open wire.

On Thursday, 24 September, 19 of our members enjoyed a visit to the Aberdeen Journal. We were shown through the wire room, photography department and typesetting machines, and followed the news all the way to the presses. As with our own service, the morning paper is very much taken for granted, and one tends to forget the organization required to find the news, write it down, gather it together, edit and print it. Our visit was recorded with a picture in the "Press & Journal."

D.W. and G.D.A.

Inverness Centre

The session opened with a broadcast quiz against the Aberdeen Centre. The broadcast was received by a large number of out-stations. The contest was close, Aberdeen winning by 35 to 27½ points. The questions were compiled in the Regional Training School, Edinburgh.

An interesting program of talks and visits has been arranged, and it is hoped that program cards will be circulated to members before these notes are printed.

The Centre's first Chairman and one of the Founders, Mr. J. C. Hines, has been promoted to Welfare Officer, Edinburgh. We extend our congratulations and good wishes to him in his new sphere.

W.C.

Darlington Centre

Darlington Centre members were guests of the Royal Air Force at Topcliffe on 28 September when they attended a lecture and demonstration entitled "Air Electronics."

On 16 November Dr. Torday of Messrs. Torday, Ltd., North Shields, presented a paper describing precious-metal electro-plating. We visited Messrs. Westool, Ltd., at St. Helens, Auckland, on 11 December to see, among other things, the manufacture of windings and coils. This firm transferred its premises from London to South Shields in 1964 and now provides employment for nearly 1,000 people. Among its products have been the Warner electromagnetic clutch and the Sovac ultrasonic sensing and switching system.

A further attractive item in our program is a lecture and demonstration concerning Burgot automatic burglar alarms.

Middlesbrough Centre

At the annual general meeting the following officers were elected: *Chairman:* Mr. L. E. Sparkes; *Secretary:* Mr. D. Campbell; *Treasurer:* Mr. K. J. Ashworth; *Librarian:* Mr. J. Whittington; *Assistant Secretary:* Mr. R. D. Purvis; *Committee:* Messrs. H. Daggett, J. O'Conner, J. C. Meek and D. A. Pratt.

The Centre anticipates an interesting and successful session in 1964–65 since the program includes some seven lectures, two visits and two film shows, and we are favoured by contributions from the Area Engineer, other senior-section members and also our own members.

Visiting lecturers include Mr. C. E. Hitchens, of the Local Authority Parks Committee, and Mr. H. Leslie, a Probation Officer.

D.C.

Huddersfield Centre

At the annual general meeting on 22 July the following officers and committee were elected: *Chairman:* Mr. P. Williamson; *Secretary:* Mr. I. R. Gunson; *Assistant Secretary:* Mr. I. A. Roberts; *Librarian:* Mr. A. Longstaff; *Treasurer:* Mr. B. B. Howell; *Committee:* Messrs. D. Haigh, P. Firth, D. Boulton, J. Nelson, R. Beaumont, L. W. Parkinson and S. Sunderland (Halifax representative).

Dinner at a local hotel brought the meeting to an enjoyable conclusion.

The program for 1964–65 was arranged to meet the prior demands of the recent conversion of Huddersfield exchange to automatic working, but it has been possible, nevertheless, to plan the following program:

September: Afternoon visit to Belling & Co., Ltd., Burnley.
October: Regional Lecture.
November: A talk on "Building Societies," by Mr. J. S. Kaye, manager of the Brighouse branch of the Halifax Building Society.
December: Afternoon visit to H. J. Heinz, Wigan.
January: "Some Aspects of External Maintenance," by Mr. T. A. Slater, A.M.I.E.E.
February: Talk on "Athletics," by Mr. D. Ibbottson.
March: Full-day visit to Boots, Ltd., Nottingham, and Whiteley Radio, Ltd., Mansfield.
April: Evening visit to J. Tetley, Ltd., Leeds.
June: Annual general meeting.

Sheffield Centre

On 9 January 1964, the Telephone Manager, Mr. J. D. H. Martin, gave a very interesting lecture on the future development of the telephone service and the effect of these developments in the Area, and nationally.

Also in January 1964, we held our annual Christmas social. About 70 members, families, and friends enjoyed a short film-show, followed by supper and games, the latter being organized by Mr. A. Knowles.

In February members of the centre visited Skelton Grange power station. The comparison between this new type of station and an older type, which we visited last year, was of considerable interest.

On Thursday 19 March Mr. N. A. Elkins, Engineering Department, presented a very interesting lecture entitled, "Microwave Techniques." The lecture was illustrated with slides and various pieces of complicated waveguide.

A full-day visit was made on 1 April by 30 of our members to the new Ford assembly plant at Halewood near Liverpool. The plant is new and fully mechanized. Members saw some of the new Post Office vehicles being finished.

On 23 April we had another excellent lecture from Mr. C. N. Kington, of Messrs. Husband & Co., of Sheffield, entitled "The Goonhilly Project" and it was an account of the design of the now famous satellite tracking station. Mr. Kingston's lecture was most entertaining and prompted many questions.

The annual general meeting of the centre was held in May. Officers and committee members elected were: *Chairman:* Mr. A. Knowles; *Vice-Chairman:* Mr. F. S. Brasher; *Secretary:* Mr. D. Ashton; *Assistant Secretary:* Mr. B. A. Sargent; *Financial Secretary:* Mr. C. S. Shepherd; *Committee Members:* Messrs. H. S. Beddus, F. Bough, J. G. Buckley, S. Cottage, C. B. Gray, R. B. Lines, J. E. Poulton, G. T. Risdale, J. K. Tomlinson, P. T. Weston and G. Woodhouse.

At this meeting we said farewell to our Liaison Officer of many years past, Mr. T. C. R. Harrison, who has now retired.

On Thursday 9 July, 25 members visited the forensic science laboratories at Harrogate. A conducted tour of the biological, chemistry and physics laboratories was made, and among other things the techniques of scientific aids in crime detection were demonstrated. Members saw many examples of such things as counterfeit coins, various drugs, poisons and the methods of stain detection. This was a most interesting and entertaining visit.

In August the Jodrell Bank radio telescope was open to the public, and a coach party of members and friends visited the station. This outing was of particular interest after hearing Mr. Kingston's lecture in April.

B.A.S.

Bedford Centre

Bedford Centre has now embarked upon its second year of activities. The annual general meeting (its first) was held on 30 September and there are quite a few changes in officers and committee, largely due to promotions. The present officers are: *Chairman:* Mr. D. A. Crampton; *Secretary:* Mr. E. W. H. Philcox; *Assistant Secretary:* Mr. G. A. Coles; *Treasurer:* Mr. L. W. Dodd; and a committee of seven.

We have a varied program of lectures planned for the 1964–65 winter session which is as follows:

15 September: Motoring Films.
26 October: "Engineering Training in the Post Office," by Mr. R. O. Boocock, Training Branch, Engineering Department.
2 December: "Space Communication," by Mr. H. E. Pearson, Space Communication Systems Branch, Engineering Department.
14 January: "P.O. Mechanical Aids," by Mr. J. O. Colyer, External Plant and Protection Branch, Engineering Department.
22 February: "Coal Mining," by Mr. S. L. Pepper, National Coal Board.
6 April: "Television Switching," by Mr. W. L. Newman, Museum Television Switching Centre.

The average attendance at our last year's lectures was 34·2. If this support is maintained—or improved upon—we shall feel that we are at least succeeding in providing material of interest to a fair cross-section of our membership, which now stands at 130.

E.W.H.P.

Staff Changes

Promotions

Name	Region, etc.	Date
Deputy Director of Research to Director of Research		
Metson, G. H.	E.-in-C.O.	1.1.65
Staff Engineer to Assistant Engineer-in-Chief		
de Jong, N. C. C.	E.-in-C.O.	14.9.64
Assistant Staff Engineer to Staff Engineer		
Laver, F. J. M. (*In absentia*)	E.-in-C.O.	23.9.64
Urben, T. F. A.	E.-in-C.O.	1.10.64
Knight, N. V.	E.-in-C.O.	5.10.64
Piggott, J.	E.-in-C.O.	1.1.65
Executive Engineer to Area Engineer		
Gilpin, F. A.	Mid. Reg.	4.8.64
Marsh, R. V. R.	N.W. Reg. to N.E. Reg.	24.8.64
Brick, P. E.	H.C. Reg.	16.9.64
Executive Engineer to Senior Executive Engineer		
Mooney, B. K.	E.-in-C.O.	1.7.64
Hall, W. F. J.	H.C. Reg. to E.-in-C.O.	20.7.64
Chapman, E. W.	L.T. Reg. to H.C. Reg.	6.7.64
Winterburn, G. E.	N.E. Reg.	21.9.64
Skinner, A. H.	L.T. Reg.	8.9.64
Stollard, A. F.	Mid. Reg.	16.9.64
Oatey, L. W.	L.P. Reg.	28.9.64
Fuller, W.	L.T. Reg.	18.9.64
Executive Engineer (Open Competition)		
Rowbotham, T. R.	E.-in-C.O.	24.7.64
Fitton, D.	E.-in-C.O.	24.8.64
Deadman, D. J.	E.-in-C.O.	30.7.64
Griffin, St. J. I.	E.-in-C.O.	1.9.64
Simmonds, T. G.	E.-in-C.O.	7.9.64
Wright, A.	E.-in-C.O.	1.9.64
Smith, T. F.	E.-in-C.O.	1.9.64
Beattie, J. A.	E.-in-C.O.	1.9.64
McVeigh, N.	E.-in-C.O.	7.9.64
Johns, P. B.	E.-in-C.O.	7.9.64
Rolph, P.	E.-in-C.O.	14.9.64
Bailey, K. E.	E.-in-C.O.	2.9.64
Reynolds, N. J. E.	E.-in-C.O.	2.9.64
Crabtree, M.	E.-in-C.O.	1.9.64
Clarke, K. E.	E.-in-C.O.	2.9.64
Assistant Executive Engineer to Executive Engineer		
Stevens, H. J.	L.T. Reg.	19.3.64
Unwin, J. H.	H.C. Reg. to S.W. Reg.	1.7.64
Downie, R. I.	E.-in-C.O.	6.7.64
Patrick, N. C.	Scot. to N.E. Reg.	20.7.64
Birch, C. B.	E.-in-C.O.	31.7.64
Wright, R. H.	H.C. Reg. to E.T.E.	2.6.64
Garnett, J. A.	L.T. Reg.	17.6.64
Heath, K.	L.T. Reg.	17.6.64
Warner, H. G.	L.T. Reg.	17.6.64
McBretney, P.	E.T.E.	17.6.64
Banner, G. H.	E.T.E.	6.8.64
Roberts, E.	H.C. Reg. to E.-in-C.O.	6.8.64
Eveling, J. E.	E.-in-C.O.	6.8.64
Colby, W. H.	N.E. Reg.	10.8.64
Alexander, A.	L.T. Reg.	10.8.64
Hannah, R. A.	N.W. Reg.	10.8.64
Blundell, R. C.	W.B.C.	6.8.64
Hall, R.	L.T. Reg. to E.-in-C.O.	4.8.64
West, G. E.	E.-in-C.O. to E.T.E.	14.9.64
Walker, A. R.	S.W. Reg.	7.9.64
Clark, R. M.	Scot. to Mid. Reg.	7.9.64
Clough, H. R. H.	W.B.C. to N.W. Reg.	14.9.64
Hardman, F. E.	Scot. to Mid. Reg.	21.9.64
Clayton, C. E.	Scot. to N.W. Reg.	21.9.64
Bamford, A.	Mid. Reg.	11.9.64
Assistant Executive Engineer to Executive Engineer—continued		
Willmot, J. W. (*In absentia*)	N.E. Reg. to H.C. Reg.	8.9.64
Paynter, W. J. W.	L.T. Reg.	11.9.64
Whitaker, T. H.	N.E. Reg.	7.9.64
Ford, A. E.	W.B.C.	30.9.64
Atkinson, W. R.	N.W. Reg.	14.9.64
Assistant Executive Engineer (Limited Competition)		
Lewis, R. E.	N.W. Reg. to Mid. Reg.	19.5.64
Preston, G. C.	Mid. Reg.	19.5.64
Smith, T.	N.E. Reg.	19.5.64
Edwards, P. J.	W.B.C. to Mid. Reg.	19.5.64
Haynes, D. A.	N.W. Reg.	19.5.64
Poulson, R. G. W.	W.B.C. to Mid. Reg.	19.5.64
Fox, H. D.	N.W. Reg. to N.E. Reg.	19.5.64
Whiteley, G.	N.E. Reg. to Mid. Reg.	19.5.64
Milford, C.	S.W. Reg. to E.-in-C.O.	1.6.64
Markley, K.	H.C. Reg.	19.5.64
Stephenson, R. A.	N.E. Reg. to E.-in-C.O.	19.5.64
Goldie, W. L.	Scot. to E.-in-C.O.	19.5.64
Nicholls, M. C.	E.-in-C.O.	19.5.64
Barton, D. F.	H.C. Reg. to E.-in-C.O.	1.6.64
Bathgate, J. M.	S.W. Reg.	1.6.64
Domoney, R. P.	S.W. Reg. to Mid. Reg.	15.6.64
Clouter, R. D.	H.C. Reg.	1.6.64
Botherway, G.	L.T. Reg. to E.-in-C.O.	29.6.64
Roach, D. G. C.	S.W. Reg. to E.-in-C.O.	1.6.64
Bland, T. A.	L.T. Reg.	1.6.64
Dix, D. C.	E.-in-C.O.	15.6.64
Daniels, J. D.	E.-in-C.O.	1.6.64
Wiffon, R. E.	H.C. Reg.	1.6.64
Allen, H. M.	Scot. to E.-in-C.O.	1.6.64
Jannece, D. M. F.	E.-in-C.O.	1.6.64
Martin, D. G.	E.-in-C.O.	15.6.64
Pizzey, R. E.	H.C. Reg. to E.-in-C.O.	29.6.64
Cooper, W.	W.B.C. to E.-in-C.O.	15.6.64
Castle, B. P.	H.C. Reg. to E.-in-C.O.	15.6.64
Lawrence, R. D.	L.T. Reg.	15.6.64
Amey, J. F.	H.C. Reg.	15.6.64
McLeod, P.	Scot. to E.-in-C.O.	15.6.64
Gleaves, D. J.	L.T. Reg.	15.6.64
Austin, G. P.	E.-in-C.O. to Mid. Reg.	15.6.64
White, B. L.	H.C. Reg.	1.6.64
Stoddart, A. G.	E.-in-C.O.	15.6.64
Pearson, F.	Mid. Reg.	15.6.64
Harry, R. J.	E.-in-C.O.	29.6.64
Smith, P. T.	E.-in-C.O.	15.6.64
Holmes, D. C.	H.C. Reg. to E.-in-C.O.	15.6.64
Hallam, R.	Mid. Reg.	15.6.64
McLeod, N. A. C.	Scot. to E.-in-C.O.	29.6.64
Barber, K. F.	H.C. Reg. to E.-in-C.O.	29.6.64
Bedson, R. A.	E.-in-C.O.	29.6.64
Clarke, J.	Mid. Reg. to E.-in-C.O.	29.6.64
Carter, M. J.	S. W. Reg. to E.-in-C.O.	29.6.64
Rhodes, D.	N.E. Reg. to E.-in-C.O.	29.6.64
Hollands, D. W.	H.C. Reg. to E.-in-C.O.	29.6.64
Willis, J. M.	L.T. Reg. to E.-in-C.O.	29.6.64
Bateson, F.	Mid. Reg.	29.6.64
Whall, A. J.	L.T. Reg. to E.-in-C.O.	29.6.64
Dove, B. A.	H.C. Reg. to E.-in-C.O.	29.6.64
Green, K. L.	L.T. Reg. to E.-in-C.O.	29.6.64
Dickinson, D. C.	N.E. Reg. to E.-in-C.O.	29.6.64
Assistant Executive Engineer (Special Selection)		
Hunt, A. G.	E.-in-C.O.	2.3.64
Palfrey, A.	E.-in-C.O.	2.3.64
Rump, M. R. G.	L.T. Reg. to E.-in-C.O.	31.3.64
Warry, A.	E.-in-C.O.	2.3.64
Lovegrove, C. J.	Factories Department to E.-in-C.O.	2.3.64
Sewell, F. H.	E.-in-C.O.	2.3.64
Banks, W. A.	L.T. Reg. to E.-in-C.O.	2.3.64

Name	Region, etc.	Date
Assistant Executive Engineer (Special Selection)—continued		
Praed, J. F. H.	L.T. Reg. to E.-in-C.O.	31.3.64
Simmonds, D. W.	L.T. Reg. to E.-in-C.O.	2.3.64
Monk, A. E.	E.-in-C.O.	9.3.64
Stroud, R. W.	L.T. Reg. to E.-in-C.O.	31.3.64
Hughes, D.	L.T. Reg. to E.-in-C.O.	9.3.64
Clark, D. J. A.	Scot. to E.-in-C.O.	16.3.64
Sear, B. L.	L.T. Reg. to E.-in-C.O.	9.3.64
Watts, D.	L.T. Reg. in E.-in-C.O.	9.3.64
Collins, B. J.	E.-in-C.O.	2.3.64
Martin, J. R.	E.-in-C.O.	16.3.64
Hiett, A. E.	L.T. Reg. to E.-in-C.O.	2.3.64
Hawes, B. A.	E.-in-C.O.	31.3.64
Whelan, D. L.	E.-in-C.O.	2.3.64
Archer, C.	L.P. Reg. to E.-in-C.O.	18.3.64
Squelch, B. M.	H.C. Reg. to E.-in-C.O.	16.3.64
Gurr, J. W.	H.C. Reg. to E.-in-C.O.	13.4.64
Williamson, C.	N.E. Reg. to E.-in-C.O.	1.5.64
Wilson, R. S.	L.T. Reg. to E.-in-C.O.	15.6.64
Harvey, G. W.	E.-in-C.O.	31.8.64
Sheekey, B.	E.-in-C.O.	24.8.64
Smith, J. R.	H.C. Reg. to E.-in-C.O.	31.8.64
Sloan, T.	E.-in-C.O.	28.9.64
Wilkinson, R.	H.C. Reg. to E.-in-C.O.	'14.9.64
Kingett, W. A.	E.-in-C.O.	7.9.64
Pullin, A. E.	E.-in-C.O.	7.9.64
Filmer, A. J.	L.T. Reg. to E.-in-C.O.	16.9.64
Gilmour, G.	Scot. to E.-in-C.O.	14.9.64
Inspector to Assistant Executive Engineer		
Selway, G. E.	Scot.	19.3.64
Pannell, R. R.	H.C. Reg.	4.3.64
McCarty, J. W.	S.W. Reg.	9.3.64
Jackson, K. D.	S.W. Reg.	11.3.64
Vincent, R. S.	S.W. Reg.	7.7.64
Delaney, H. T.	N.E. Reg.	30.6.64
Stitt, J. A. G.	Scot.	20.7.64
MacDonald, W. F.	Scot.	6.7.64
Parry, T. R.	Mid. Reg.	22.7.64
Machin, H. E.	Mid. Reg.	22.7.64
Barrows, P. R. A.	Mid. Reg.	22.7.64
Smith, J. T.	Mid. Reg.	14.8.64
Moody, T. A.	N.W. Reg.	25.8.64
Bowden, M. A. H.	S.W. Reg.	31.7.64
Harding, R. W.	Mid. Reg.	9.9.64
Lammas, F. H.	Mid. Reg.	9.9.64
Wolvey, A. F.	H.C. Reg.	7.9.64
Winder, W.	Mid. Reg.	9.9.64
Munn, H. T.	Mid. Reg.	9.9.64
Evans, B. H. W.	L.T. Reg.	7.9.64
Technical Officer to Assistant Executive Engineer		
Strong, F. J.	H.C. Reg.	9.3.64
Stalker, A. S.	Scot.	20.2.64
Miller, R. A. H.	Scot.	2.3.64
English, K. J. G.	H.C. Reg.	5.3.64
Holkham, K. W. E.	H.C. Reg.	19.2.64
King, D. A.	E.T.E.	27.2.64
Bishop, T. A.	E.T.E.	27.2.64
Moss, T.	H.C. Reg.	25.2.64
Willis, R. C.	S.W. Reg.	31.3.64
Rushton, J. T.	Mid. Reg.	3.3.64
Hill, D. A.	Mid. Reg.	3.3.64
Bracher, H.	Mid. Reg.	3.3.64
Rogers, V. S.	Mid. Reg.	3.3.64
Piercy, A. M.	H.C. Reg.	13.3.64
Freer, B. R.	L.T. Reg.	6.3.64
McCallum, T. C.	Scot.	18.3.64
Hallifax, W. J.	S.W. Reg.	11.1.64
Sutton, P. J.	L.T. Reg. to E.-in-C.O.	16.3.64
Butler, S. E.	L.T. Reg. to E.-in-C.O.	16.3.64
Shepherd, G.	H.C. Reg.	1.7.64
Armstrong, S. S.	Scot.	27.5.64
Clark, J. B.	Scot.	1.6.64
Yule, D. N.	L.P. Reg.	20.7.64
Booth, P. G.	N.E. Reg.	30.6.64
Harding, R. H.	N.E. Reg.	30.6.64

Name	Region, etc.	Date
Technical Officer to Assistant Executive Engineer—continued		
Bound, I.	L.P. Reg.	20.7.76
Crotch, J. F.	Scot.	22.6.64
Cowan, C. A.	Scot.	22.6.64
Gaskell, G.	N.W. Reg.	7.7.64
Woodhouse, R. O.	Mid. Reg.	22.7.64
Palin, E.	Mid. Reg.	22.7.64
Pope, R. R.	Mid. Reg.	22.7.64
Belson, A. R.	Mid. Reg.	22.7.64
Wait, D. W.	Mid. Reg.	22.7.64
Daffon, T. J.	Mid. Reg.	22.7.64
Higgins, F. J.	Mid. Reg.	22.7.64
Everton, L. E.	Mid. Reg.	22.7.64
Martin, R. D.	Mid. Reg.	22.7.64
Nichols, G. W.	Mid. Reg.	22.7.64
Bramwell, G. G. H.	Mid. Reg.	22.7.64
Clark, J. B.	Mid. Reg.	22.7.64
McKenzie, D.	Mid. Reg.	22.7.64
Battle, J. M.	Mid. Reg.	22.7.64
Welling, G. F.	L.T. Reg.	22.7.64
Harlow, N. A.	L.T. Reg.	22.7.64
Burrell, L. A.	L.T. Reg.	22.7.64
Priest, F. A. G.	L.T. Reg.	22.7.64
Lapwood, E. H.	L.T. Reg.	22.7.64
Vassar, C. R. T.	L.T. Reg.	22.7.64
Jones, R.	L.T. Reg.	22.7.64
Flannery, F. E.	L.T. Reg.	22.7.64
Richards, C. A.	L.T. Reg.	22.7.64
Holness, W. R.	L.T. Reg.	22.7.64
Hart, B. F.	L.T. Reg.	22.7.64
Lane, D. H.	L.T. Reg.	22.7.64
Phillips, A.	L.T. Reg.	22.7.64
Lang, V. T.	L.T. Reg.	22.7.64
Crawford, A. S. J.	L.T. Reg.	22.7.64
Payne, J. A.	L.T. Reg.	22.7.64
Leney, R. W.	L.T. Reg.	22.7.64
Whitehouse, M. E.	L.T. Reg.	22.7.64
Sutton, L. F.	L.T. Reg.	22.7.64
Doe, C. F.	L.T. Reg.	22.7.64
Wisdom, B. G. W.	L.T. Reg.	22.7.64
Hodson, D. A. S.	L.T. Reg.	22.7.64
Wyatt, J. R.	L.T. Reg.	22.7.64
Wright, A. F.	L.T. Reg.	22.7.64
Archer, W. D.	L.T. Reg.	22.7.64
Myers, F. D.	L.T. Reg.	22.7.64
Mercer, A. F.	L.T. Reg.	22.7.64
Catt, B. C.	L.T. Reg.	22.7.64
Sutch, E. W. F.	L.T. Reg.	22.7.64
Williams, J. A. K.	L.T. Reg.	22.7.64
Jones, W. H.	L.T. Reg.	22.7.64
Poole, J. C.	L.T. Reg.	22.7.64
Cass, A. C.	L.T. Reg.	22.7.64
Long, R. W.	L.T. Reg.	22.7.64
Smith, R. V.	Mid. Reg.	22.7.64
Foden, A. E.	Mid. Reg.	22.7.64
Hunter, E. R.	L.T. Reg.	22.7.64
Piper, R. S.	L.T. Reg.	22.7.64
Weeden, C. S. V.	L.T. Reg.	22.7.64
Phillips, W. T.	L.T. Reg.	22.7.64
Dean, J. A. C.	L.T. Reg.	22.7.64
Mealing, A. W.	L.T. Reg.	7.7.63
Davies, W.	L.T. Reg.	18.12.63
Clayton, R. A.	L.T. Reg.	18.12.63
Taylor, C.	N.E. Reg.	28.5.64
Williams, R. K. G.	Mid. Reg.	14.8.64
Tooke, C. T. J.	H.C. Reg.	4.8.64
March, J. E. G.	H.C. Reg.	4.8.64
Willis, D. J.	Mid. Reg.	14.8.64
Jackson, R. J.	Mid. Reg.	14.8.64
Morgan, J. B.	W.B.C.	17.8.64
Mellor, F. L.	N.W. Reg.	25.8.64
Patrick, F. W.	N.W. Reg.	25.8.64
Jones, W. E.	N.W. Reg.	25.8.64
Slater, J. A.	N.W. Reg.	25.8.64
Vranch, L. W. F.	S.W. Reg.	20.7.64
Goostray, J.	N.E. Reg.	1.7.64
Brady, D.	N.E. Reg.	1.7.64
Pearce, H. H.	S.W. Reg.	11.8.64

Name	Region, etc.	Date
Technical Officer to Assistant Executive Engineer—continued		
Hobson, G. M.	N.E. Reg.	9.9.64
Smart, P.	N.E. Reg.	9.9.64
Walsh, E. M.	W.B.C.	22.9.64
Bree, A. E.	Mid. Reg.	9.9.64
Bell, C.	Mid. Reg.	9.9.64
Burns, R. J.	Mid. Reg.	9.9.64
Wood, J. G.	Mid. Reg.	9.9.64
Kerry, F. B.	H.C. Reg.	7.9.64
Cotton, H.	Mid. Reg.	9.9.64
Shirley, N.	Mid. Reg.	9.9.64
Orme, H.	N.W. Reg.	7.9.64
Cakebread, J.	E.-in-C.O.	17.9.64
Crome, A. J.	E.-in-C.O.	17.9.64
Salathiel, T. A.	W.B.C.	18.9.64
Whiteley, A. E.	W.B.C.	22.9.64
Jones, R. E.	W.B.C.	18.9.64
Otley, B. H.	W.B.C.	18.9.64
Tarr, H. W.	W.B.C.	18.9.64
Griffiths, W. R.	W.B.C.	18.9.64
Wheeler, F. W.	W.B.C.	18.9.64
Burrows, S.	W.B.C.	21.9.64
Law, E. A. R.	L.T. Reg.	2.9.64
Solomons, J.	L.T. Reg.	2.9.64
Carson, P. D.	L.T. Reg.	2.9.64
Baker, V. H. J.	L.T. Reg.	2.9.64
Graham, J. A.	L.T. Reg.	2.9.64
Welch, W. E.	L.T. Reg.	2.9.64
Lake, S. J.	L.T. Reg.	2.9.64
King, S. H.	L.T. Reg.	2.9.64
Lewis, R. G.	L.T. Reg.	2.9.64
Hawley, R. J.	L.T. Reg.	2.9.64
Evans, J. D.	L.T. Reg.	2.9.64
Cooke, J.	L.T. Reg.	2.9.64
Taylor, L. G.	L.T. Reg.	2.9.64
Tuck, A. S.	L.T. Reg.	2.9.64
Dalton, A. H.	L.T. Reg.	2.9.64
Jack, A. J.	L.T. Reg.	2.9.64
Jessop, P. G.	L.T. Reg.	2.9.64
Hurdle, P. J.	L.T. Reg.	2.9.64
Ricketts, F. G.	L.T. Reg.	2.9.64
Richards, R. A.	L.T. Reg.	2.9.64
Boon, D. R.	L.T. Reg.	2.9.64
Humphries, A. H.	L.T. Reg.	2.9.64
Seeds, J. H.	L.T. Reg.	2.9.64
Stimpson, A. F.	L.T. Reg.	2.9.64
Pearce, K. M.	L.T. Reg.	2.9.64
Golding, F. G. W.	L.T. Reg.	28.9.64
Stevens, T. J. S.	L.T. Reg.	14.9.64
Hearsey, R. S.	E.T.E.	1.9.64
Clark, I. M.	E.T.E.	1.9.64
Wilshire, N. F.	E.T.E.	1.9.64
Allen, R.	E.T.E.	1.9.64
Iggleden, H. W.	E.T.E.	1.9.64
Driscoll, J. R. E.	E.T.E.	1.9.64
Farn, R. C.	E.T.E.	7.9.64
Ralfs, L. E. V.	N.W. Reg.	25.9.64
Lyon, P. M. J.	N.W. Reg.	25.9.64
Hobster, B. D.	N.W. Reg.	25.9.64
Haslam, W. H.	N.W. Reg.	25.9.64
Draughtsman to Assistant Executive Engineer		
Rowell, G.	N.E. Reg.	2.3.64
Varley, W. F.	E.-in-C.O.	6.3.64
Technical Officer to Inspector		
Wigley, E. R.	L.T. Reg.	22.7.64
Dicker, E. S.	L.T. Reg.	22.7.64
Fowler, J. T.	L.T. Reg.	22.7.64
Maidment, W. J.	L.T. Reg.	22.7.64
Palmer, J. L.	L.T. Reg.	22.7.64
Norris, C. E.	L.T. Reg.	22.7.64
Technician I to Inspector		
James, F.	Mid. Reg.	3.3.64
Williams, A. M.	Scot.	16.3.64
Ellender, F. E.	H.C. Reg.	4.3.64
Technician I to Inspector—continued		
Tanner, H. J.	S.W. Reg.	10.3.64
Moor, G.	N.E. Reg.	2.3.64
Greenwood, K.	Mid. Reg.	3.3.64
Evans, J. C.	W.B.C.	2.3.64
Mann, C. W.	H.C. Reg.	4.3.64
Stillwell, R. V. G.	H.C. Reg.	4.3.64
Price, I. T.	S.W. Reg.	9.3.64
Cubitt, D.	N.I.	16.3.64
Edwards, A. J.	S.W. Reg.	16.3.64
Collins, E. P.	N.E. Reg.	30.6.64
Edge, W.	Mid. Reg.	22.7.64
Hurn, R.	L.T. Reg.	22.7.64
Twigg, C. E.	L.T. Reg.	22.7.64
Ward, J. C.	L.T. Reg.	22.7.64
Connolly, P.	N.W. Reg.	23.7.64
Atherton, J.	N.W. Reg.	23.7.64
Jackson, J. W.	N.W. Reg.	23.7.64
Allonby, J. D.	N.W. Reg.	28.9.64
Thompson, R. J.	N.E. Reg.	9.9.64
Powell, R. A.	Mid. Reg.	9.9.64
Clews, E. R. A.	Mid. Reg.	9.9.64
Parker, C. E.	N.W. Reg.	1.9.64
White, E. F.	L.T. Reg.	2.9.64
Downton, W. J. L.	S.W. Reg.	28.9.64
Anderson, T.	L.T. Reg.	2.9.64
Grose, H.	S.W. Reg.	29.9.64
Chiswell, R. E.	S.W. Reg.	29.9.64
Rawlinson, W. A.	N.W. Reg.	25.9.64
Principal Scientific Officer to Senior Principal Scientific Officer		
Ayers, E. W.	E.-in-C.O.	1.9.64
Experimental Officer to Senior Experimental Officer		
Kelly, L. C.	E.-in-C.O.	1.7.64
Senior Scientific Officer (Open Competition)		
Stanley, I. W.	E.-in-C.O.	19.8.64
Dunkerley, B. D.	E.-in-C.O.	21.9.64
Experimental Officer (Open Competition)		
Moore, P.	E.-in-C.O.	26.5.64
Scientific Officer (Open Competition)		
Hopkins, M. G.	E.-in-C.O.	19.8.64
Newman, D. H.	E.-in-C.O.	21.8.64
Ray, B.	E.-in-C.O.	25.9.64
Assistant (Scientific) (Open Competition)		
Espeut, K. W.	E.-in-C.O.	6.7.64
Dunn, P. L.	E.-in-C.O.	6.7.64
Workshop Supervisor II to Technical Assistant		
Isitt, R. A. C.	E.-in-C.O.	2.7.64
Mechanic-in-Charge to Technical Assistant		
Waller, A. B.	N.E. Reg.	2.7.64
Brown, J.	Scot.	2.7.64
Senior Mechanic to Technical Assistant		
Smith, E. D.	S.W. Reg. to E.-in-C.O.	2.7.64
Mechanic A to Technical Assistant		
Charles, A. W.	S.W. Reg. to London Reg.	19.8.64
Senior Draughtsman to Chief Draughtsman		
Nichols, D. J.	L.T. Reg.	27.7.64
Taylor, E. W. E.	E.-in-C.O.	27.7.64
Rawlings, L. J. J.	L.T. Reg. to H.C. Reg.	27.7.64
Firth, D. I.	N.E. Reg.	27.7.64
Edwards, H. G.	W.B.C.	27.7.64
Wharmby, L. C.	Scot. to Mid. Reg.	27.7.64
Dodds, A. T.	N.W. Reg.	27.7.64
Williams, E. V.	Mid. Reg. to S.W. Reg.	27.7.64
Craig, G.	L.T. Reg. to Scot.	27.7.64

Promotions—*continued*

Name	Region, etc.	Date	Name	Region, etc.	Date
Leading Draughtsman to Senior Draughtsman			*Leading Draughtsman to Senior Draughtsman—continued*		
Eyre, J. L.	S.W. Reg.	11.8.64	Burgess, R. R.	L.P. Reg. to E.-in-C.O.	11.8.64
Howell, K. G.	H.C. Reg.	11.8.64	Nutt, S. R.	Mid. Reg.	11.8.64
Pearce, C. G.	L.T. Reg.	11.8.64	Carter, N. T. G.	W.B.C.	11.8.64
Macklow, C. D.	H.C. Reg.	11.8.64	Hemming, T. E.	Mid. Reg.	11.8.64
Privett, A. J.	L.T. Reg.	11.8.64	Lewis, G. W. F.	H.C. Reg.	11.8.64
Woods, H. E.	N.W. Reg.	11.8.64	Fulcher, A. S.	H.C. Reg.	11.8.64
Weston, H. E.	H.C. Reg.	11.8.64	Luckham, A. R.	N.W. Reg.	11.8.64
Greening, R.	H.C. Reg.	11.8.64	Lyon, J. C.	Scot.	11.8.64
Turner, G.	N.E. Reg.	11.8.64	Edwards, R. D.	L.P. Reg. to L.T. Reg.	11.8.64
James, L. G.	H.C. Reg.	11.8.64	Rickard, S. P. W.	Scot.	11.8.64
Thomas, F. H. J.	H.C. Reg.	11.8.64	Wilkes, H. C.	H.C. Reg.	11.8.64
Wilkins, J. W.	Mid. Reg.	11.8.64			
Court, G. H.	S.W. Reg.	11.8.64	*Draughtsman (Open Competition)*		
Thurben, H. J.	H.C. Reg.	11.8.64	Wright, E. J.	E.-in-C.O.	26.8.64
Dolman, C. T. N.	W.B.C.	11.8.64			
Murphy, W. T.	N.W. Reg. to H.C. Reg.	11.8.64	*Executive Officer (Open Competition)*		
Gallop, E. A. T.	H.C. Reg.	11.8.64	McMurdo, M.	E.-in-C.O.	29.7.64
Bloor, F.	Mid. Reg.	11.8.64			

Retirements and Resignations

Name	Region, etc.	Date	Name	Region, etc.	Date
Director of Research			*Assistant Executive Engineer—continued*		
Halsey, R. J.	E.-in-C.O.	31.12.64	Brock, A. E.	E.T.E.	31.8.64
			Constable, F. A.	L.T. Reg.	31.8.64
Staff Engineer			Dickson, J. M. (*Resigned*)	E.-in-C.O.	21.8.64
Salter, L. F.	E.-in-C.O.	30.9.64	Headley, M. C. (*Resigned*)	E.-in-C.O.	21.8.64
Phillips, R. S.	E.-in-C.O.	31.12.64	Hannaford, D. (*Resigned*)	E.-in-C.O.	21.8.64
Regional Engineer			Hamel, D. P. M. (*Resigned*)	N.E. Reg.	31.8.64
Bryden, J. E. Z.	L.T. Reg.	17.7.64	Walker, A. (*Resigned*)	E.-in-C.O.	31.8.64
Executive Engineer			Martin, J. R. (*Resigned*)	E.-in-C.O.	31.8.64
Mann, H. F.	E.T.E.	22.7.64	Hallett, C. A.	E.-in-C.O.	6.9.64
Cawood, R. J.	N.E. Reg.	7.7.64	Braine, F. A.	E.-in-C.O.	25.9.64
Hill, B. E. ((*Resigned*)	E.-in-C.O.	3.7.64	Wright, S. C.	L.T. Reg.	28.9.64
Weatherburn, R. (*Resigned*)	E.-in-C.O.	31.7.64	Gardener, S. A.	L.T. Reg.	30.9.64
Hobbs, J. G.	E.-in-C.O.	5.8.64	Hicks, G. W.	E.-in-C.O.	30.9.64
Copley, F. A.	N.E. Reg.	29.9.64	Squire, W. J. S.	E.T.E.	30.9.64
Rivis, J. W.	S.W. Reg.	26.9.64	Bates, W.	L.T. Reg.	30.9.64
Bentley, A.	N.W. Reg.	15.9.64	Callcutt, K. L. (*Resigned*)	E.-in-C.O.	4.9.64
Feltham, W. R.	E.-in-C.O.	4.9.64	Godwin, B. M. (*Resigned*)	E.-in-C.O.	7.9.64
Assistant Executive Engineer			Messent, W. A. P. (*Resigned*)	L.T. Reg.	14.9.64
Easton, R. A.	E.T.E.	1.2.64	Simmons, D. W. (*Resigned*)	E.-in-C.O.	17.9.64
Roberts, F. K.	N.E. Reg.	1.3.64	Probert, P. E. (*Resigned*)	E.-in-C.O.	18.9.64
Martin, J.	Mid. Reg.	7.3.64	Lack, W. T. (*Resigned*)	H.C. Reg.	30.9.64
Sherwin, E.	L.T. Reg.	19.3.64	Mercer, R. M.	E.-in-C.O.	30.9.64
Cawte, H. M.	L.T. Reg.	30.3.64			
Appleton, W. A.	L.T. Reg.	31.3.64	*Inspector*		
Walker, S. E.	N.W. Reg.	6.7.64	Coleman, G. A.	L.T. Reg.	4.3.64
Proctor, F. A.	W.B.C.	11.7.64	Taylor, J.	Scot.	6.3.64
Brown, M. W. V.	H.C. Reg.	11.7.64	MacFarlane, J.	Scot.	28.3.64
Plummer, W. H.	S.W. Reg.	15.7.64	Chilton, G. L.	L.T. Reg.	31.3.64
Jones, J.	N.W. Reg.	27.7.64	Pentlow, H. F.	L.T. Reg.	4.7.64
Wright, J.	Scot.	31.7.64	Harrison, A. A. F.	L.T. Reg.	13.7.64
Taylor, A. A.	L.T. Reg.	31.7.64	Martin, A. J.	Mid. Reg.	16.7.64
Bloomer, B. H.	Mid. Reg.	31.7.64	Disley, H.	N.W. Reg.	25.7.64
Cowie, W. J. (*Resigned*)	Scot.	24.7.64	Scales, W. F.	L.T. Reg.	29.7.64
Clark, D. (*Resigned*)	E.-in-C.O.	31.7.64	Press, J. E. B.	L.T. Reg.	31.7.64
Arnold, W. S.	L.T. Reg.	3.8.64	Barham, H. W. E.	E.T.E.	31.7.64
Huby, T. A.	E.-in-C.O.	7.8.64	Burley, A.	N.W. Reg.	31.7.64
Roper, E. K.	H.C. Reg.	9.8.64	Ramsay, E.	N.E. Reg.	14.8.64
Moyler, H.	E.-in-C.O.	14.8.64	Kirby, F. W.	L.T. Reg.	20.8.64
White, E. M.	E.-in-C.O.	21.8.64	Munday, F. G.	L.T. Reg.	28.8.64
Kissane, T. C.	E.T.E.	29.8.64			
Thornton, F. R.	E.-in-C.O.	31.8.64			
Hopkins, H.	H.C. Reg.	31.8.64			
Hogben, W. A.	L.T. Reg.	31.8.64			
Price, A.	N.W. Reg.	31.8.64			

Retirements and Resignations—*continued*

Name	Region, etc.	Date
Inspector—continued		
Willcocks, F. A.	S.W. Reg.	11.8.64
Skinner, H.	N.W. Reg.	17.9.64
Mitchell, R. W.	L.T. Reg.	18.9.64
Caley, W. H.	N.W. Reg.	25.9.64
Savage, B. A.	L.T. Reg.	25.9.64
Bradley, B. R.	W.B.C.	29.9.64
Hulbert, G. E.	L.T. Reg.	30.9.64
Experimental Officer		
Bolton, B. G. (*Resigned*)	E.-in-C.O.	31.7.64
Assistant Experimental Officer		
Birkby, J. W.	E.-in-C.O.	31.8.64
Perry, R. (*Resigned*)	E.-in-C.O.	4.9.64
Assistant (Scientific)		
Hanscombe, J. L. (*Resigned*)	E.-in-C.O.	21.8.64
Tate, D. J. (*Resigned*)	E.-in-C.O.	14.8.64
Regional Motor Transport Officer		
Dormon, A. E.	H.C. Reg.	6.6.64
Assistant Regional Motor Transport Officer		
Wilson, H. R.	Mid. Reg.	20.8.64
Technical Assistant		
Jenkins, A. A.	N.W. Reg.	3.8.64
Reynolds, W. B.	London Reg.	18.8.64
Palmer, S.	E.-in-C.O.	31.8.64
Maley, A. T.	Scot.	31.8.64
Cooper, G. V.	E.-in-C.O.	3.9.64
Smithson, J. K.	S.W. Reg.	28.9.64
Tait, G. W.	E.-in-C.O.	30.9.64
Royer, E. V.	E.-in-C.O.	30.9.64
Chief Draughtsman		
Benstead, E. C.	E.-in-C.O.	6.7.64
Leading Draughtsman		
Penhallow, E. W.	E.-in-C.O.	28.7.64
Draughtsman		
Ings, D. W. (*Resigned*)	E.-in-C.O.	31.8.64
Higher Executive Officer		
Tucker, F. Y. (Miss)	E.-in-C.O.	19.8.64
Executive Officer		
Clay, J. B. C. (*Resigned*)	E.-in-C.O.	14.8.64
Webb, H. W.	E.-in-C.O.	30.9.64

Transfers

Name	Region, etc.	Date
Senior Executive Engineer		
Bellew, T. K. (*In absentia*)	Approved Employment to E.-in-C.O.	27.7.64
Burton, A. J. H. (*In absentia*)	Approved Employment to E.-in-C.O.	21.9.64
Executive Engineer		
Stoole, J. D.	E.-in-C.O. to Jamaica	17.7.64
Thurlow, E. W.	E.-in-C.O. to Ministry of Aviation	4.8.64
Bartlett, C. A.	Admiralty to E.-in-C.O.	3.9.64
MacMahon, P. J.	E.-in-C.O. to L.T. Reg.	7.9.64
Scott, J.	E.-in-C.O. to L.T. Reg.	10.9.64
Knight, N.	E.-in-C.O. to S.W. Reg.	28.9.64
Marsham, C. H.	E.-in-C.O. to L.T. Reg.	28.9.64
Assistant Executive Engineer		
Rosbotham, F. C.	E.-in-C.O. to East Africa	1.3.64
Flynn, A. W.	E.-in-C.O. to N.W. Reg.	2.3.64
Everett, D. T.	Jamaica to E.-in-C.O.	9.3.64
Quarmby, J.	E.-in-C.O. to N.W. Reg.	16.3.64
Scott, E.	E.-in-C.O. to East Africa	31.3.64
Linney, P. J.	Nigeria to E.-in-C.O.	6.7.64
Parrott, R.	E.-in-C.O. to H.C. Reg.	4.8.64
Wheeler, C. H.	E.-in-C.O. to S.W. Reg.	4.8.64
Assistant Executive Engineer—continued		
Peake, W.	E.-in-C.O. to Mid. Reg.	10.8.64
Hornsby, G. H.	E.-in-C.O. to Zambia	25.8.64
Simmons, H.	L.T. Reg. to H.C. Reg.	1.9.64
Henniker, D. G.	E.-in-C.O. to H.C. Reg.	9.9.64
Calkin, S. W.	E.-in-C.O. to Home Office	14.9.64
Lawson, J. I.	N.E. Reg. to Home Office	14.9.64
Farrell, F. C.	E.-in-C.O. to H.C. Reg.	14.9.64
Green, D. C.	E.-in-C.O. to Ministry of Aviation	14.9.64
Jones, D. H.	E.-in-C.O. to L.T. Reg.	14.9.64
Baker, F. H.	E.-in-C.O. to Ministry of Health	21.9.64
Senior Principal Scientific Officer		
Speight, E. A.	E.-in-C.O. to Civil Service Commission	5.6.64
Technical Assistant		
Norris, V. W.	E.-in-C.O. to S.W. Reg.	2.3.64
Lomax, H.	H.C. Reg. to N.W. Reg.	4.8.64
Goodrum, W. J.	E.-in-C.O. to H.C. Reg.	4.8.64
Draughtsman		
Bliss, F. H.	E.-in-C.O. to Ministry of Defence	31.8.64
Jeffs, P.	E.-in-C.O. to H.C. Reg.	21.9.64

Deaths

Name	Region, etc.	Date
Assistant Executive Engineer		
Govan, J. G.	L.T. Reg.	5.3.64
Thomas, J. L.	W.B.C.	27.3.64
Leigh, R. B.	L.T. Reg.	31.3.64
Abel, G. P.	W.B.C.	20.7.64
Malpas, H. R.	H.C. Reg.	20.7.64
Fox, S. C. P.	N.E. Reg.	2.9.64
Inspector		
Lowe, C. H.	N.E. Reg.	19.8.64
Dwyer, C. W.	L.T. Reg.	8.9.64
Mulliney, H. J.	W.B.C.	14.8.64
Executive Officer		
Ryan, K. M. (Miss)	E.-in-C.O.	8.7.64

The Post Office Electrical Engineers' Journal

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Books Received

"Introduction to Electron Beam Technology." Edited by Robert Bakish. John Wiley and Sons, Ltd. xi + 452 pp. 263 ill. £5 5s.

This volume presents for the first time a review of a new technology. Starting with the physics of electron beams and surveying their many and different configurations as a point of departure the volume then reviews, in necessarily brief but systematic fashion, all areas of science where electron beams can be and are used.

It is a book which will introduce the newcomer to the subject, will serve the knowledgeable reader as a reference source and should satisfy the immediate and intermediate needs of any person working actively in the technology or on its periphery.

"Elements of Feedback and Control." A. M. Hardie. Oxford University Press. xi + 344 pp. 170 ill. 55s.

The author's aim with this book has been an endeavour to fill "the need of a book, intermediate in treatment between the very elementary and the over-advanced, containing many numerical applications within the text in order to drive home the theory and as a guide to the student working on his own."

The result has been a book covering the response of mechanical systems, simple control systems, negative-feedback amplifiers, improvement of control-system performance, the stability of feedback systems, transfer functions, logarithmic gain and phase characteristics, and some electrical and mechanical components of control systems. The standard of the book may be gauged by the fact that a reader is expected to have a knowledge of elementary dynamics, an acquaintance with linear differential equations and their solution by the D operator, an acquaintance with the elements of electric-circuit analysis, and some familiarity with triode and pentode valves and their associated circuits. The book should be suitable for students working for the Higher National Certificate (Endorsement) or Part III of the Institution of Electrical Engineers' examination.

As well as containing worked examples throughout the text there are 58 exercises for students, with numerical answers provided at the end of the book, where appropriate.

"Technical Dictionary of Radio and Telecommunication Installations." Hans Flöhn, Wilhelm Priekshaft and Marian Schwertner. Pergamon Press, Ltd. 1,001 pp. £10.

This dictionary is a useful aid for translators who have not already invested in bilingual dictionaries. Those who already have electronics dictionaries will note the omission of such terms as "radome," "vocoder," "non-director exchange," "Adcock aerial" and "transpander." They will not learn a great deal from this book.

However, those who do not already have Callaham or Patterson will be helped by this collection of 12,000 terms in four languages (English, German, French, Russian). The terms in each language are shown in four parallel columns on each page, and the book is divided into four sections. In the first section, the English terms occupy the first column, and in the other sections the first column is occupied by the other languages in turn. This means that the same information is given four times, but it makes cross-reference much easier. The translations are concise.

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Model Answer Books

Books of model answers to certain of the City and Guilds of London Institute examinations in telecommunications are published by the Board of Editors. Details of the books available are given at the end of the Supplement to the Journal.

Book Review

"Handbook of Microwave Measurements." Third edition, edited by Max Sucher and Jerome Fox. Polytechnic Press, Brooklyn, U.S.A. 3 Volumes. 1,145 pp. 373 ill. £15.

These three volumes would be a boon to any microwave engineer. They are designed to help the experimenter to understand various aspects of microwave measurement techniques in which he may not be well-experienced: but, in fact, these books are more useful than that would imply for each type of measurement is preceded by a thorough account of supporting theory, and followed by a bibliography giving the outstanding references on the technique. They can therefore be regarded as microwave text books with a strong experimental bias.

The first volume deals with the more fundamental types of microwave measurements such as those concerned with frequency, power standing-wave ratio, attenuation and phase, and waveguide modes. The second volume opens with a long chapter on Q measurement which also includes some thorough and useful theory on the subject. Dielectric constant determinations follow naturally after this. The measurement of the shielding efficiency of screened rooms and of microwave interference is also described. The second half of the second volume is devoted to measurements on waveguide components such as directional couplers and hybrid devices, and it closes with an account of measurements on ferrite materials. Volume three is chiefly devoted to measurements on parts of microwave transmission systems, for example microwave receivers, their characteristics and noise factor, microwave amplifiers, oscillators, tunnel diodes, aerials and feeder devices.

The books are written by some 25 separate authors, mostly American, each contributing a chapter on his own specialist field of microwaves. These writers seem to have been allowed freedom to shape their own chapters, because styles and format differ greatly. Some use extensive mathematical treatments, others very little—probably not sufficient to satisfy many readers. One good result of this freedom is that each chapter is self-contained to a high degree and there is no need for a reader to keep referring to other chapters to elucidate points in the one he is reading. The fact that basic matter is sometimes repeated is immaterial: the points of view will differ in different chapters because they are those of separate writers and may therefore be independently valuable. For example, the chapter on antenna measurements gives, within itself, a sufficient account of electromagnetic field phenomena, of polarization and voltage standing-wave ratio, to make reference back to the chapters specifically devoted to these subjects unnecessary. This particular chapter could be criticized, however, as being too short to give a fair presentation of the wealth of techniques now available in microwave aerial measurements.

In some chapters, sets of experimental results are given and worked out in detail; this can be of special help to students. Mathematical formulae are quoted where required, and a reference to a suitable source of detailed analysis is usually given.

The books are large with 8 in. × 11 in. pages. The text is well spaced with clear diagrams printed in their logical positions. Paper and binding are of a good hard-wearing quality that accords well with a first class work of reference. At five pounds per volume all this is expected: at half the price, these books could be more within the reach of advanced engineering students and might then become as well known as, say, Terman's "Radio Engineering" is to the h.f. radio engineer.

C.F.F.

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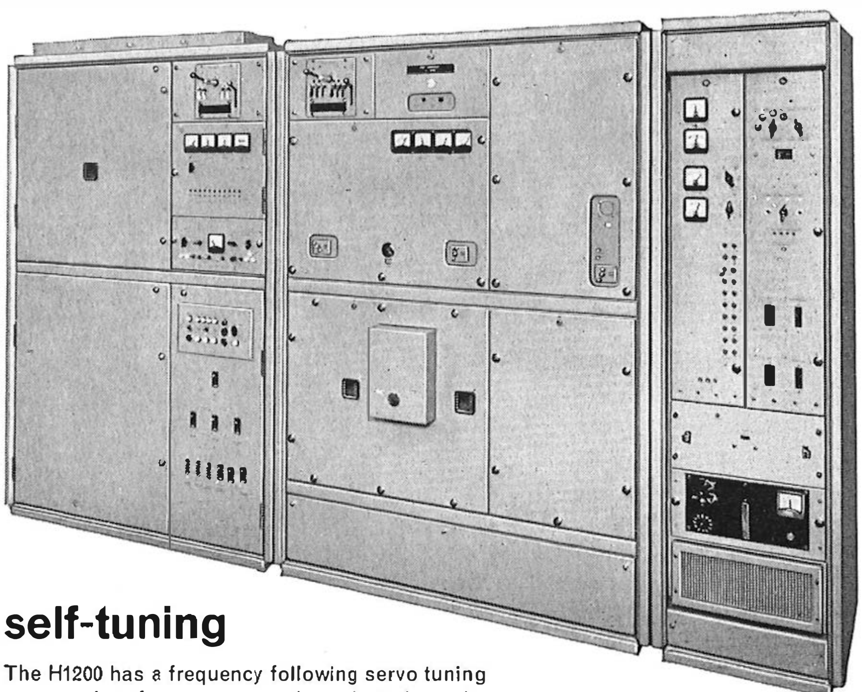

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R.F circuits have been simplified and the number of mechanical parts reduced to a minimum. Highest engineering standards are applied to the design of these parts: stainless steel shafts in ball-bearings in heavy, rigid, machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure. Specified performance is maintained with ample margins.

simplicity

MST reliability allows continuous unattended operation with extended or remote control, saving maintenance and operating staff. Any fault in the servo control circuits can quickly be located with simple test routines. Transistors and printed wiring give these circuits maximum reliability.

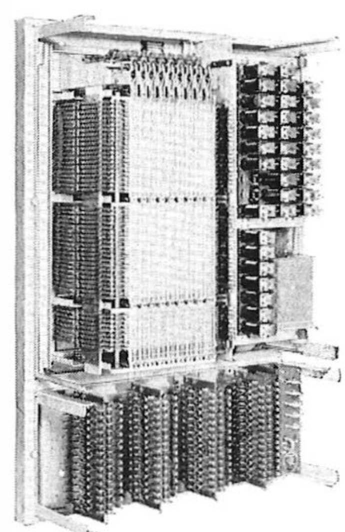
self-tuning

The H1200 has a frequency following servo tuning system. Any frequency may be selected on the synthesizer decade dials in the associated MST drive equipment; the unattended transmitter automatically tunes itself in an average time of twenty seconds. Final stage tuning and loading servos continuously ensure automatic compensation for changes in aerial feeder impedance caused by weather conditions. Self-tuning gives *one-man* control of an entire transmitting station.

Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England.

LTD/HSI



Most people with a 'pluge' in mind would look no further than the Gresham PL4.

Like a great many Gresham instruments, the PL4 is based on recommendations of the British Broadcasting Corporation. It has earned the confidence of engineers, in maintaining consistent levels of brightness and contrast throughout the station or network.

The PL4 generates a composite video test signal for video picture monitors. Quick and accurate setting up of the monitors is achieved by means of two simple, yet highly sensitive controls, Using semi-conductors throughout, this 'super pluge' is light, compact and trouble free. And, with its own power supply, is completely self-contained. The waveform includes an overall pedestal, to facilitate adjustment of monitors in reasonable ambient light conditions.

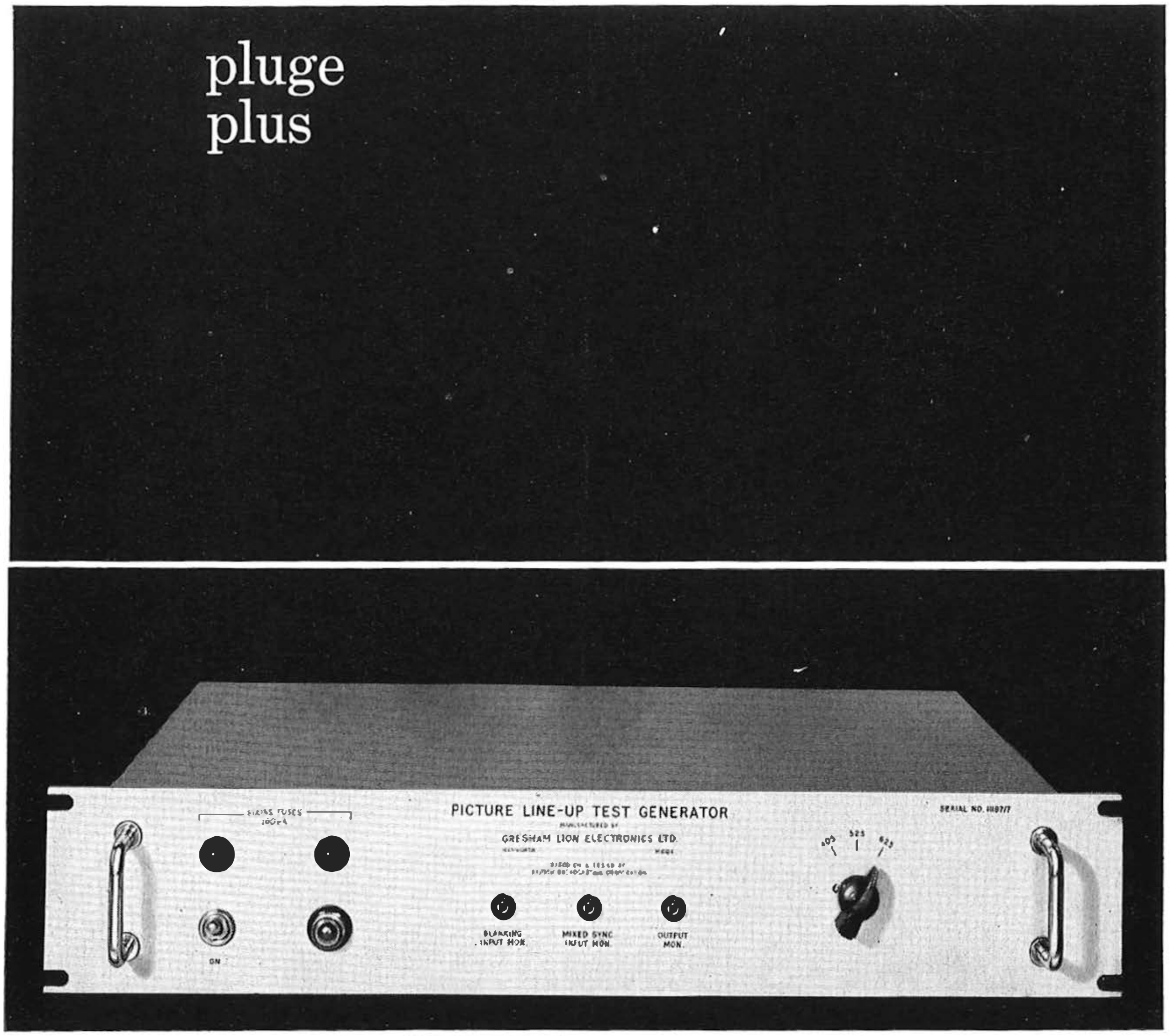
The waveform produces a display consisting of two narrow pulses (black and white) and a wide bar split horizontally—peak white at the top, and grey at the bottom. The combination permits extreme accuracy in setting up, embracing all aspects of picture line-up. Multi standard, for 405, 525 or 625 line operation.

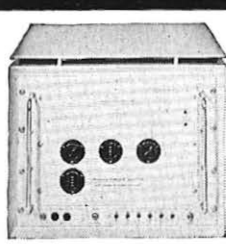
GRESHAM LION ELECTRONICS LIMITED

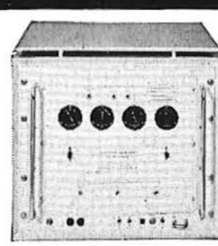
Twickenham Road, Hanworth, Middlesex, England

TWIckenham Green 5511. Cables: Gresham, Feltham, Middlesex

GRESHAM



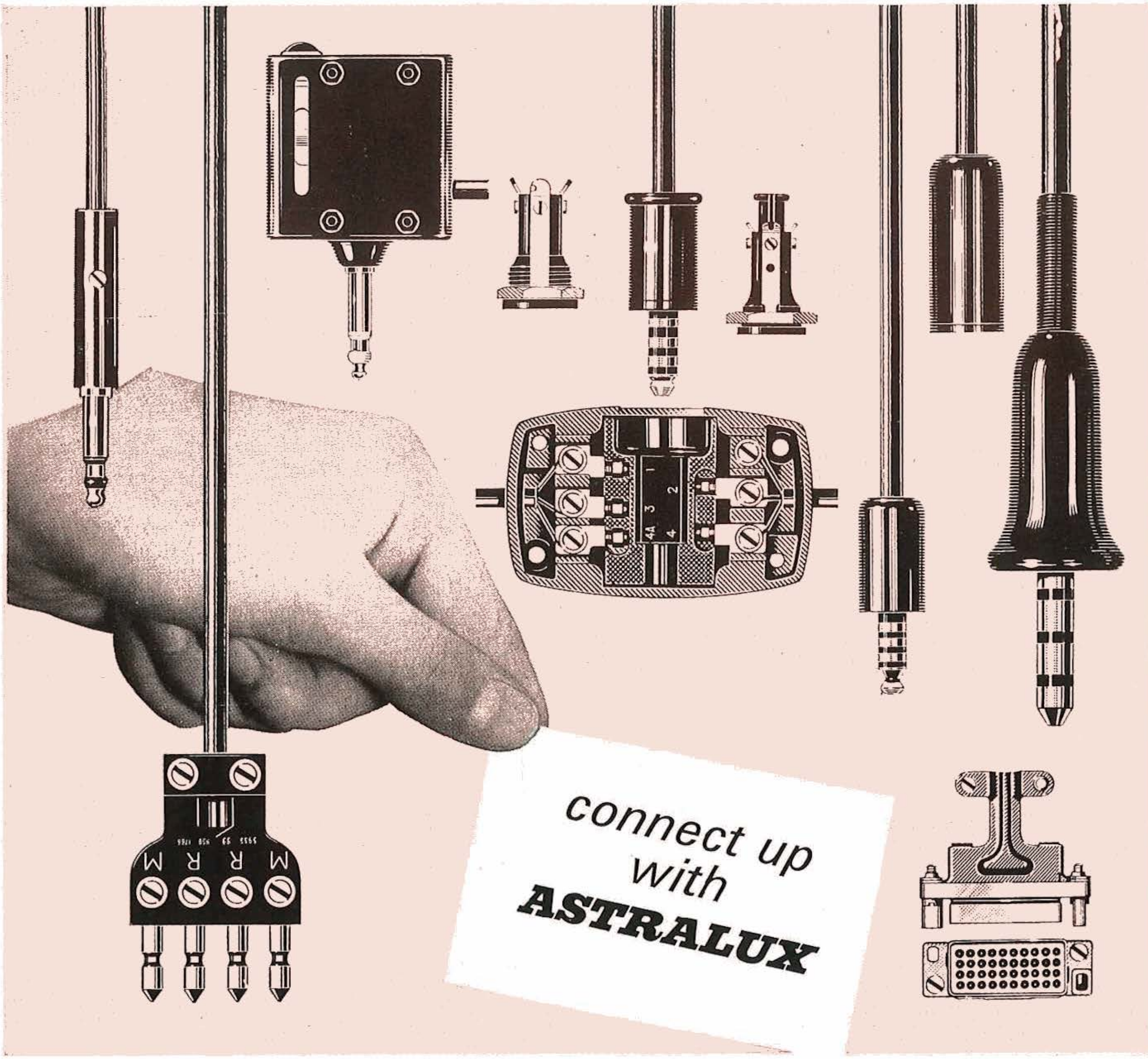




ABOVE: Gresham Type PL4 picture line-up generator.

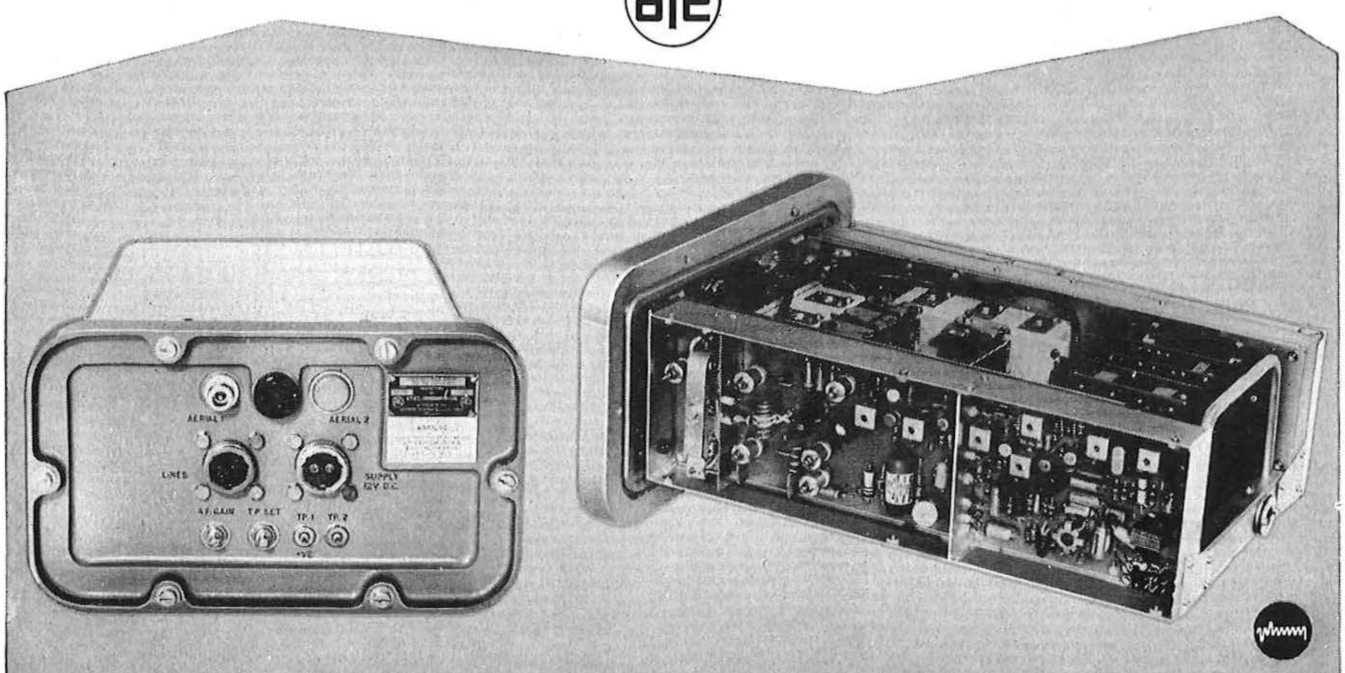
LEFT: CPB2 sine-squared pulse and bar composite waveform generator.

RIGHT: SL3 "Staircase" linearity waveform generator.


M R R M
connect up with
ASTRALUX

NEW AT&E "700" ALL-TRANSISTOR RADIO-TELEPHONE DOES EVERYTHING A NORMAL TELEPHONE DOES —WITHOUT WIRES

Whether used in telephone-to-telephone, telephone-to-exchange, or exchange-to-exchange applications, AT&E's Type 700 is the newest and the best rural set. Best because of its low power consumption—it will run on one set of dry batteries for over a year without attention. Best because it provides by radio all the telephone facilities, including various party-line services, available over a normal line transmission system. And best because it contains no valves—it is completely transistorised for exceptional reliability and the longest possible life. Simple installation, complete weatherproofing, operation in both the high (150-184 Mc/s) and low (54-88 Mc/s) bands, output power level (a supplementary 5-watt amplifier is also available), and broad operating-ambient range (-20°C to +55°C) are five more reasons why you should investigate this major advance in telephone equipment for remote areas. For complete details, write to AT&E (Bridgnorth) Ltd., Bridgnorth, Shropshire, England. *A member of the Plessey Group.*



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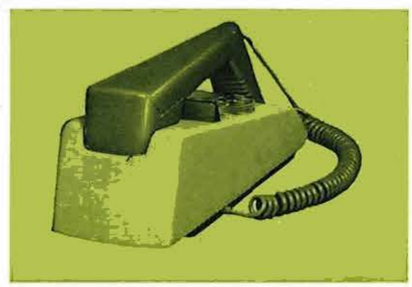


Increased protection cuts maintenance costs

The latest A E I Protector–No. 16 provides an exceptionally high degree of protection for communication and instrument circuits.

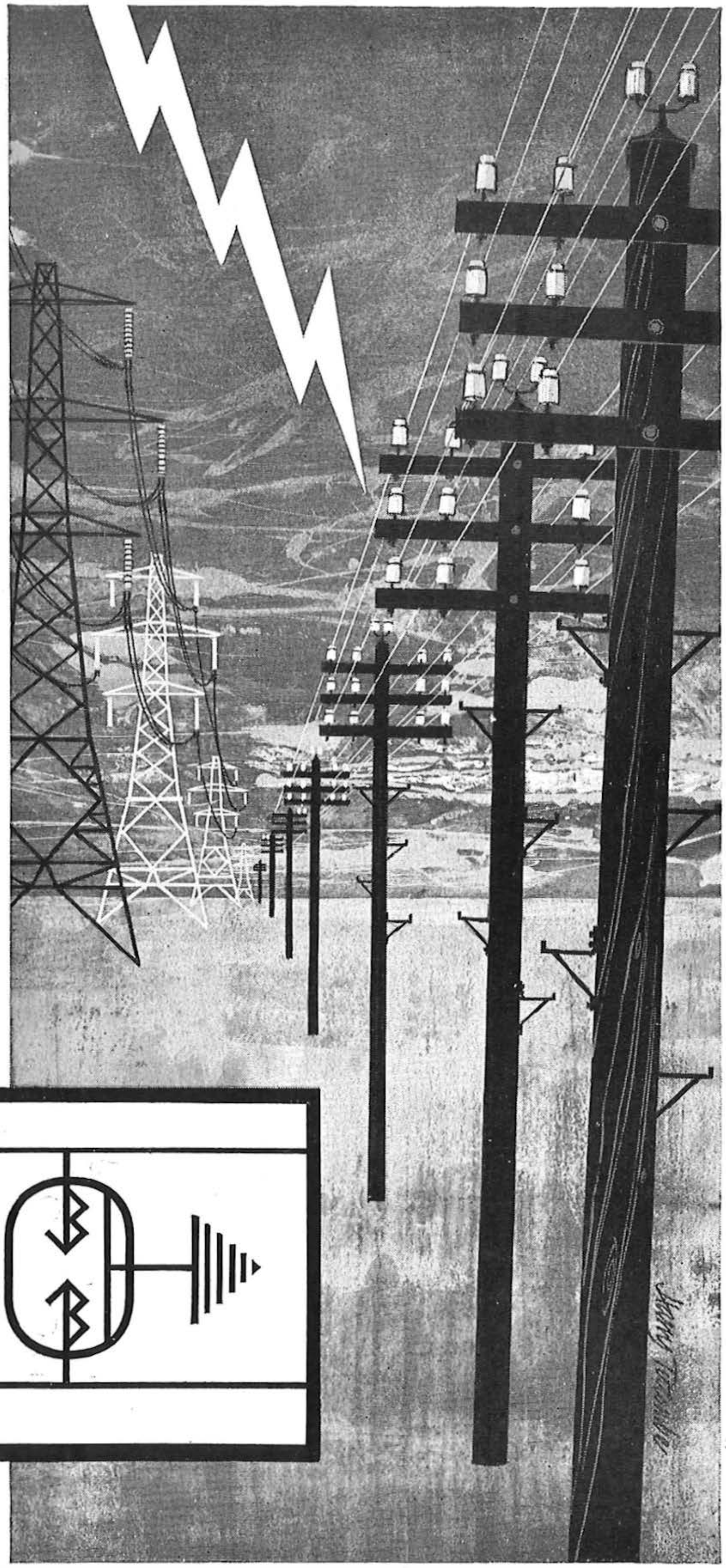
It operates many times without attention and thus considerably reduces maintenance costs. The three-electrode construction enables it to replace two conventional protectors and, due to the tendency of both gaps to break down simultaneously, it minimises the excess voltages to which the apparatus is subjected.

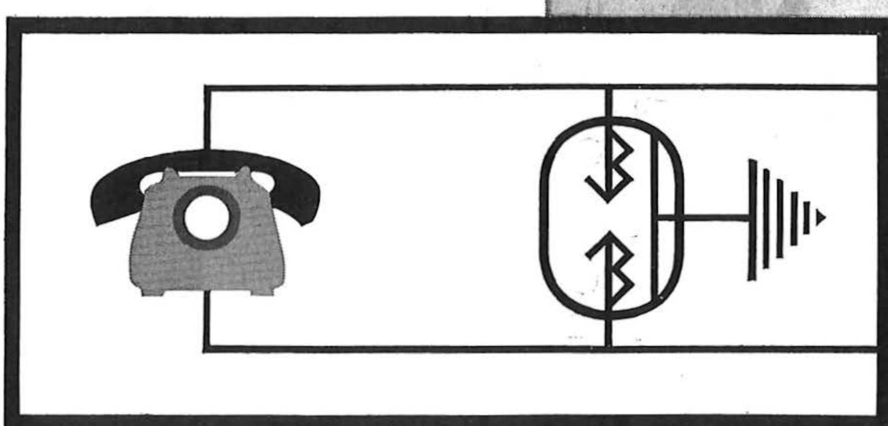
The protector will withstand momentary peak currents of about 20,000 amps and many hundreds of 100 Joule discharges.

Prompt delivery can be offered, because demand from many parts of the world has proved so high that production capacity has been greatly expanded.

The protector is available in three breakdown voltage ranges:—

150—350 d.c.
300—500 d.c.
500—900 d.c.



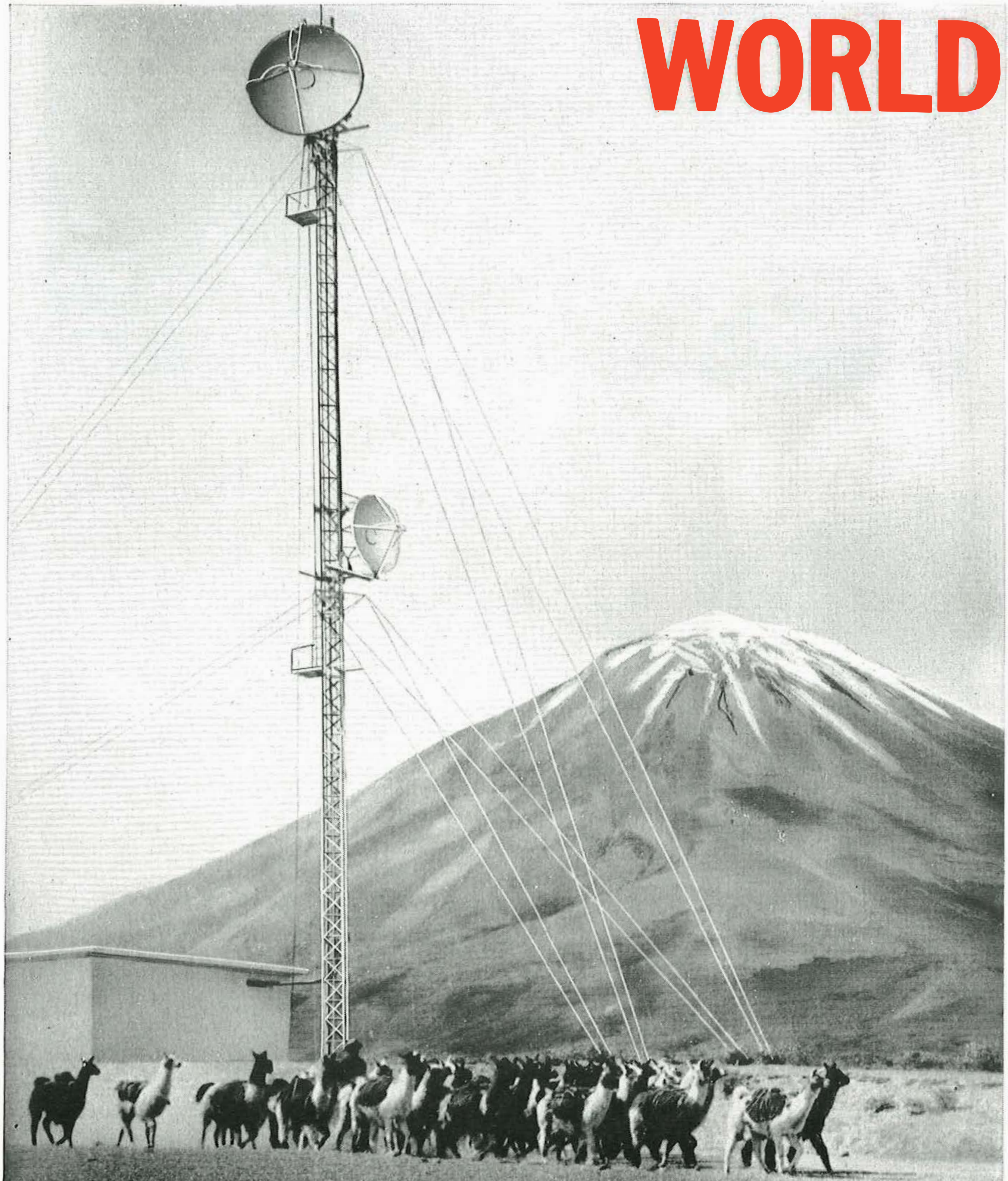


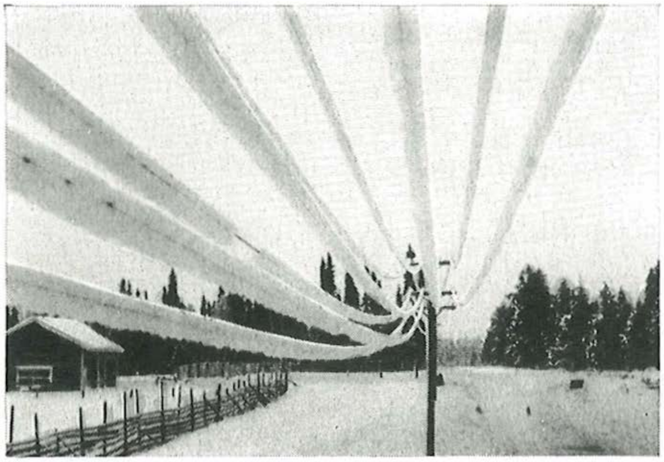
AEI COMMUNICATIONS

Associated Electrical Industries Limited
TELEPHONE APPARATUS DEPARTMENT
Telecommunications Division Woolwich London SE18

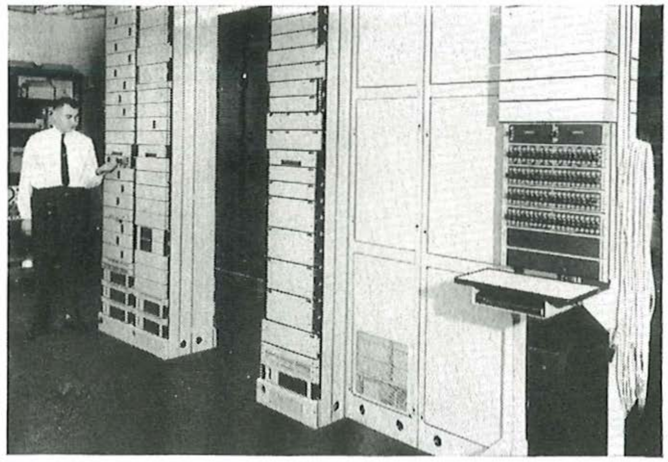
A 9261

TRANSMISSION SYSTEMS FOR THE WORLD





Open-wire line route in Finland.



Carrier Multiplex Equipment at Toronto Terminal, Canada.

G.E.C. OFFERS A COMPLETE TELECOMMUNICATION SERVICE BY LINE AND RADIO

The wide range of transmission equipment manufactured by G.E.C. enables integrated national and international networks to be built up, catering for all traffic requirements. Ease of future expansion is an inherent feature of the equipment.

Backed by more than 40 years of experience, Transmission Division can offer a complete service including surveying, system planning, engineering, manufacturing, installation and commissioning. Where necessary, customers' engineers are trained by the Company locally or at the G.E.C. Telephone Works, Coventry.

G.E.C. transmission equipment is in operation throughout the world, in climatic conditions which range from arctic to equatorial. Throughout the range of equipment, semiconductors are used wherever possible.

Left: UHF Radio Repeater Station at Caima, Peru.

HIGH CAPACITY SYSTEMS

The Company manufactures a comprehensive range of completely transistored carrier multiplex equipment with capacities of up to 2700 channels, for use over coaxial cable or microwave radio routes. Six types of broadband radio equipment are available; four in the SHF 6000 Mc/s and 7000 Mc/s frequency bands and two in the UHF 2000 Mc/s band. These equipments have maximum capacities varying between 300 and 1800 speech circuits per radio channel according to type. Alternatively, monochrome or colour television signals may be transmitted.

A small-bore coaxial cable system with a maximum capacity of 960 speech circuits is also available.

All these equipments conform to the recommendations of the C.C.I.T.T. and C.C.I.R.

SMALL CAPACITY SYSTEMS

Small capacity systems available include completely transistored 3 and 12-circuit open-wire and 12+12-circuit carrier-on-cable equipments. A transistored rural carrier system is also manufactured which provides up to ten stackable subscriber circuits in rural areas or up to ten junction circuits. This equipment can be operated over the same pole route as a 3 or 12-circuit system.

Junction radio equipments, operating in the VHF and UHF bands with capacities of 5 or 9 speech circuits, are supplied.

Below: Maxwell's Hill Repeater Station, part of the 6000 Mc/s system in Malaya.

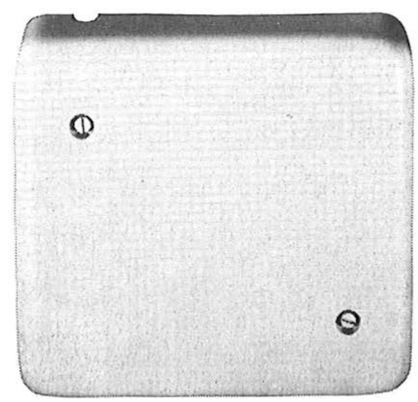
G.E.C. **everything for telecommunications**

Transmission Division G.E.C. (Telecommunications) Ltd.
Telephone Works · Coventry · England

SP8A

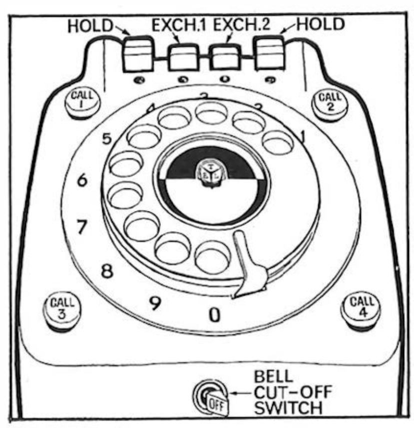
take five of these...

and one of these...



and you have a complete 2+5 Keymaster system

In the modern, compact business, the surrender of space to a switchboard, and the allocation of staff duties for its surveillance, are equally unacceptable.
The 2+5 'Keymaster' system provides a basis of communication free from these disadvantages.
The development of the 2+5 'Keymaster' has resulted in a notably compact system, simpler to operate than its predecessors and of unusually low installed cost.
The facilities offered include all those likely to be required by an intermediate-sized business and are comparable with those hitherto associated with appreciably larger desk units and much more complex central apparatus.
An important feature of the system is the low operating voltage.
Six-volt power requirements may be derived from dry batteries or a mains operated power unit.
Normally, provision is made for 5 stations, but 7 stations and other variations are available.
For further information please contact Sales Dept. Ericsson Telephones Ltd., Beeston, Nottingham.

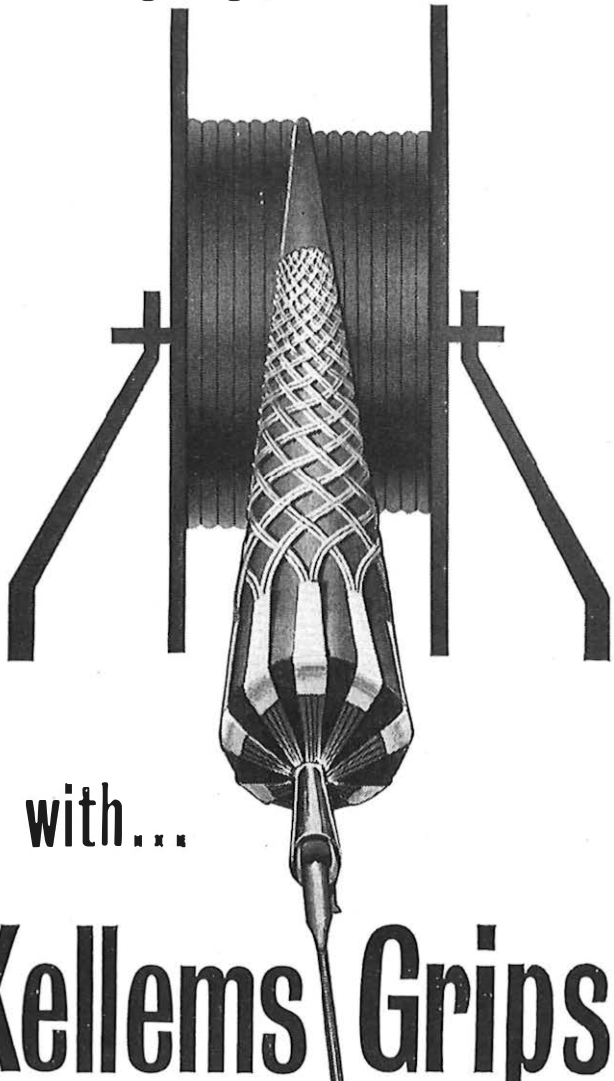


ERICSSON TELEPHONES LTD • ETELCO LTD

A Principal Operating Company of the Plessey Group. Head Office and Main Works: Beeston, Notts. Telephone: 254831. Telex: 37666
Registered Office: 22 Lincoln's Inn Fields, W.C.2. Telephone: HOLborn 6936

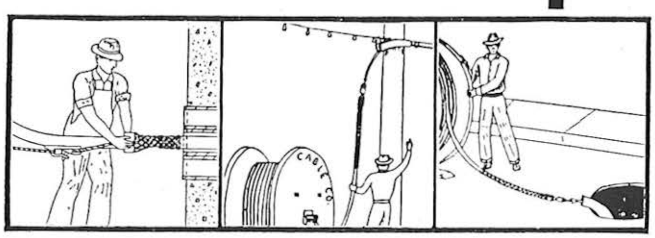
ER 102

Take the strain on any type of cable



with...

Kellems Grips



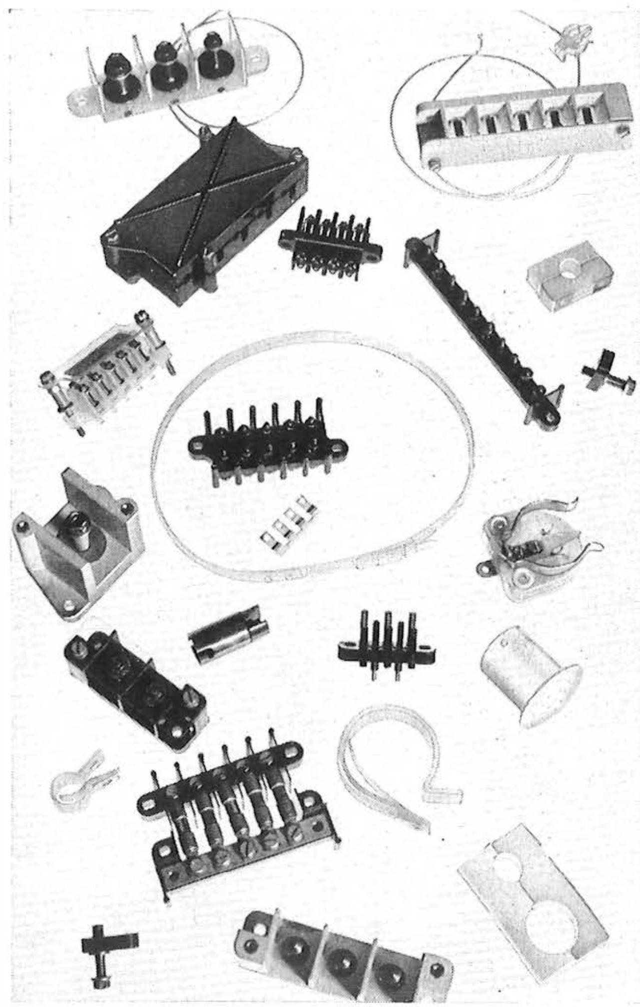
Kellems grips for pulling support or strain relief are quickly installed, adjusted or removed. They are neat in appearance, safe to handle and fully salvable. In stainless steel or bronze, they are of simple construction and light weight. Available in sizes and shapes for most cable applications.

IT PAYS TO HAVE GOOD CONNECTIONS

IT PAYS TO HAVE GOOD CONNECTIONS — HUBBELL

HARVEY **HUBBELL** LIMITED
MINEHEAD · SOMERSET
Telephone: MINEHEAD 740

COMPONENTS WITH A PLUS!



For example, terminal blocks up to 20 way, single or double row — plus non-corrodable studs and unbreakable plastic mouldings — plus acceptance of up to 8 ring terminated conductors per stud, all proof against rotational shorting — plus inter-terminal linking strips and optional covers — plus a choice of BA or unified threads with an extra choice of panel mounting, through and shrouded patterns. Not to mention six colours and numbered terminals! All this adds up to a Ward Brooke part!

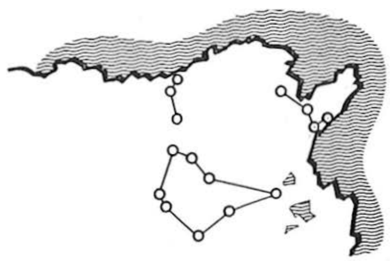
Send for fuller details to Sales Department

WARD BROOKE** WB **& CO LTD

Westbourne St., High Wycombe, Bucks. High Wycombe 4531

G.E.C. small-capacity transmission systems for all climates

G.E.C. telecommunications equipment is installed in many countries with widely differing climates — from tropical to sub-arctic. To ensure that all systems work perfectly under such varying conditions, all equipments are subject to environmental tests at the design stage. Recent orders emphasise the reliability placed upon G.E.C. small capacity systems by countries all over the world.

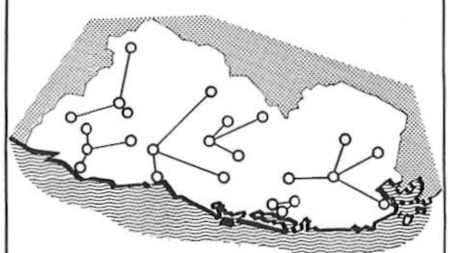


TUNISIA

Orders have been placed with the Company by the Tunisian P.T.T. for three routes in the north of the country. The installations will comprise rural carrier equipment, providing up to ten stackable subscriber circuits or ten junction circuits, which afford an inexpensive, but reliable and efficient communications system.

ICELAND

The Icelandic P.T.T. has ordered 5-circuit junction radio equipment for use on the Reykjavik-Keflavik route. A further order has been received for 6 terminals of rural carrier equipment.



EL SALVADOR

The Central American Republic of El Salvador is currently engaged on the first stage of a new nation-wide telecommunications network.
The contract involves the supply of 3-circuit and 12-circuit open-wire carrier telephone systems and telegraph equipments.

All over the World G.E.C. small-capacity transmission systems are proving themselves in widely differing temperature and humidity conditions

G.E.C. everything for telecommunications

Transmission Division, G.E.C. (Telecommunications) Ltd. Telephone Works · Coventry · England

SP17

STEPMASTER P.A.B.X.'s 20, 50 OR 100 LINE UNITS

GOOD COMMUNICATION facilities in an industrial organization are now recognized as a necessity at all administrative levels. Time saved by obtaining immediate contact with other members of the staff is of inestimable value to all, from the Managing Director to the junior clerk, and the capital cost of providing a properly planned system is small compared with the incalculable losses sustained by having inefficient communications. For many years STC has designed, manufactured and installed Private Automatic Branch Exchanges of various types. As a result of this experience, a large fund of expert knowledge is available, and any technical advice that may be required will be furnished gladly on request.

New light-weight high performance handset ☐ B.P.O. type "long life" components ☐ Transistorized ringing and tone circuits ☐ All "plug-in" type equipment ☐ Quick and easy expansion to full capacity ☐ Simple installation and maintenance ☐ Full tropical finish.

Details from Standard Telephones and Cables Limited, Telephone Switching Division, Oakleigh Road, New Southgate, N.11. Telephone ENTerprise 1234. Telex 21612.

world-wide telecommunications and electronics **STC**

type 174

small diameter coaxial cable specially designed for use with transistor amplifiers

Small diameter coaxial cables have now become an established medium for the provision of long distance high grade telephone circuits. Coupled with underground transistorised amplifiers, this type of cable is rapidly finding increased use amongst telephone administrations throughout the world as the most economical method of providing groups of trunk telephone circuits.

Telephone Cables Limited have developed their own design of small diameter .174 Coaxial Tube to meet the recommendations of the C.C.I.T.T. and the requirements of the British Post Office. The cable has been fully tested and approved by the British Post Office and cables of this design, manufactured and installed by T.C.L., are now in hand for supply and installation in the United Kingdom and overseas.

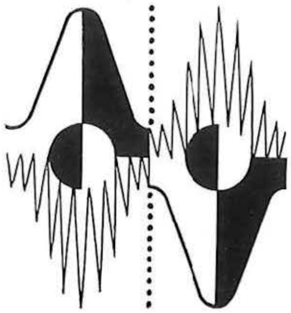
Fullest technical details of Type 174 Coaxial Cable gladly supplied by return.

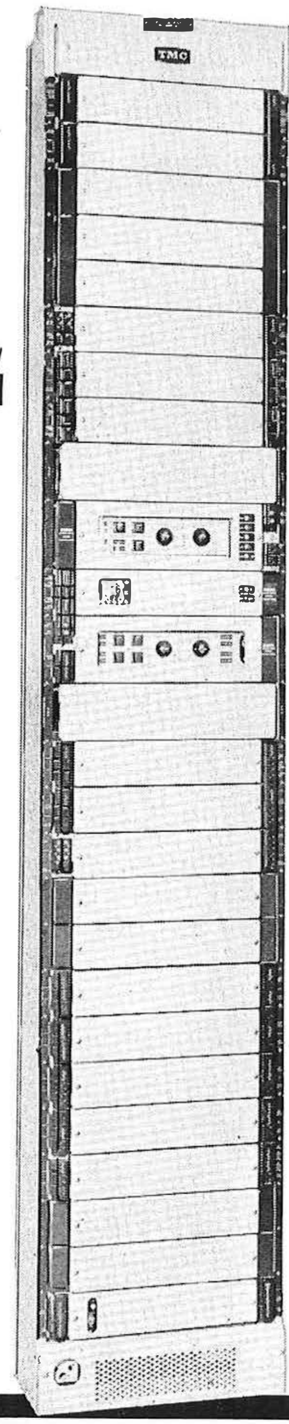
TCL

TELEPHONE CABLES LIMITED

Dagenham, England Tel: Dominion 6611 Cables: Drycore Dagenham

THE ORGANISATION WITH 125 YEARS' EXPERIENCE





TMC

PROGRAM EQUIPMENT

Designed for use with carrier telephone systems, the TMC Type B5811N Equipment provides for the transmission of an audio program channel at the high frequency band of 72.50—83.45 kc/s, or 84.50—95.45 kc/s, in the CCITT Basic Group B.

Its FEATURES include:—

- Compliance with CCITT performance recommendations.
- Operation with either:
  (i) 4 kc/s spaced channel translating equipment
  or (ii) TMC 3 kc/s spaced band economy channelling.
- Choice of 3 program channel bandwidths—5,8 or 11 kc/s—by switching.
- Low basic noise, low carrier leak.
- High stability.
- High level of sideband suppression by virtual carrier displacement.
- Full transistorisation, minimum power requirements.
- In-built special carrier generation equipment.
- Modular construction to provide flexibility of application.
- Alarm circuits.
- a.c. mains or battery power supplies.
- Minimum space requirements. All equipment for a two-way terminal is mounted on a single sided 9-ft. rack,

with as OPTIONS

- Group delay equaliser.
- Compandors.
- Its use as a bearer for high speed data transmission.

The equipment is constructed so that a terminal can be provided equipped for both directions of transmission, and for each of the three bandwidths, or sub-equipped for one direction of transmission for one or more of the bandwidths. For further information please request leaflets No. F3737 and F3777.

TMC

TELEPHONE MANUFACTURING COMPANY LIMITED
Transmission Division,
Sevenoaks Way · St. Mary Cray · Orpington · Kent · England · Tel: Orpington 27020 · Telex 28115

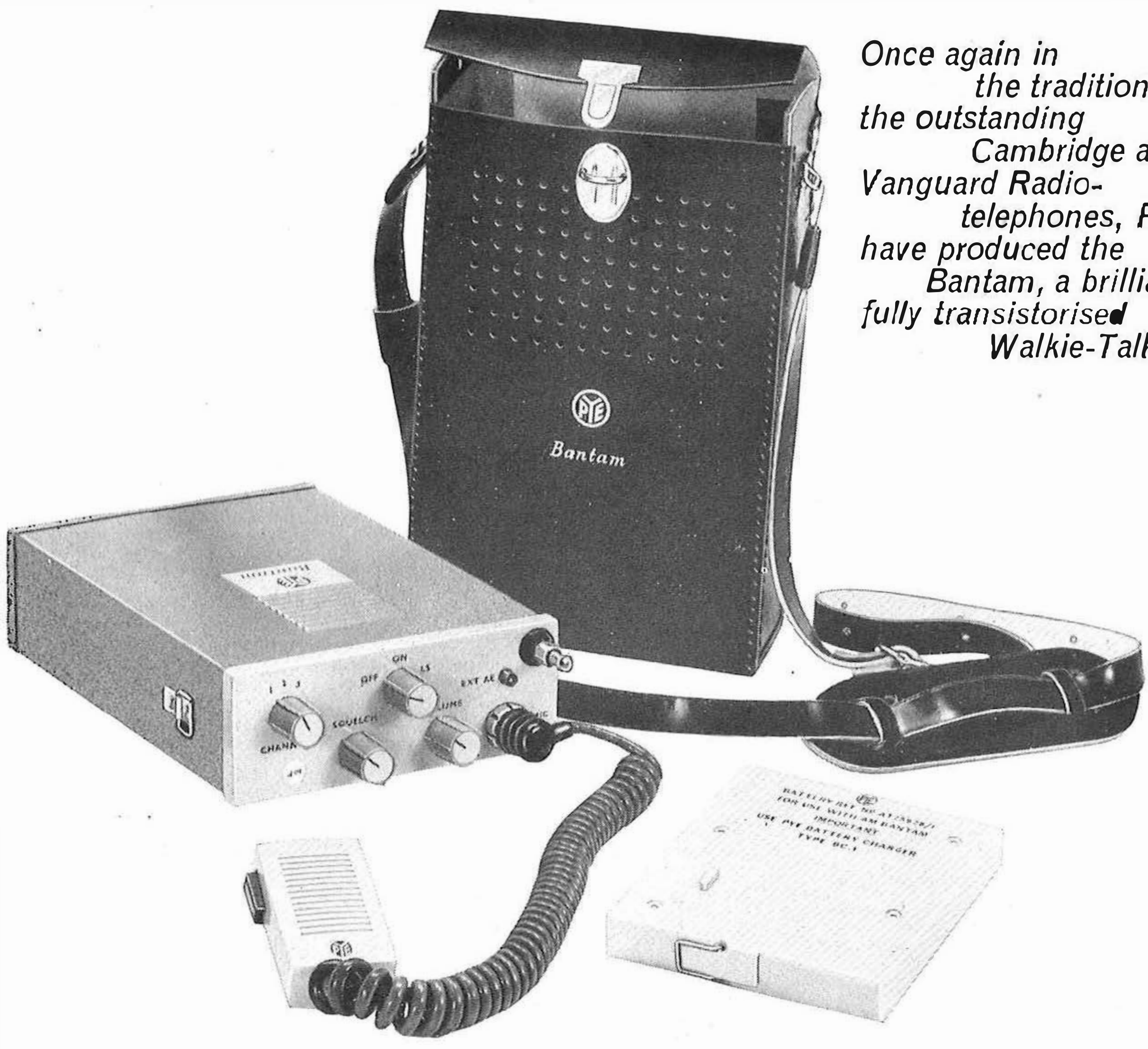
TMC is a Registered Trade Mark   A MEMBER OF THE PYE GROUP OF COMPANIES

and Now-

a Fully Transistorised Walkie-Talkie!

the PYE Bantam

TWO-WAY RADIOTELEPHONE

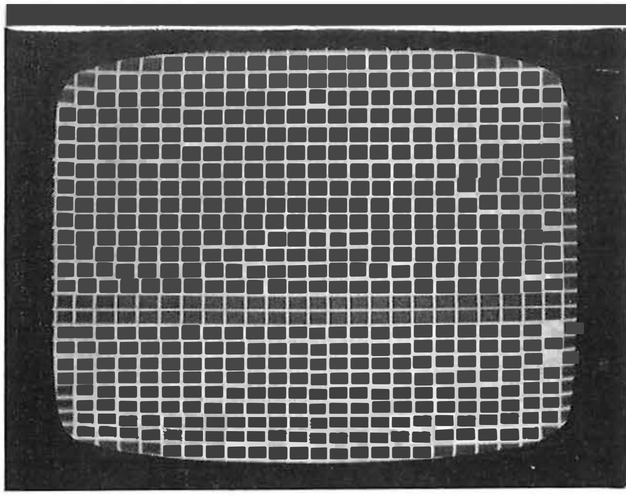


Once again in the tradition of the outstanding Cambridge and Vanguard Radio-telephones, Pye have produced the Bantam, a brilliant fully transistorised Walkie-Talkie.

- Fully transistorised Transmitter and Receiver
- Long endurance with Rechargeable or Dry Batteries
- Crystal Filter selectivity
- Reliability and accessibility of components
- Very high performance Receiver
- Lightweight 4 lbs. (1.82 kg.)
- Frequency Band 25-174 Mc/s.
- Weatherproof

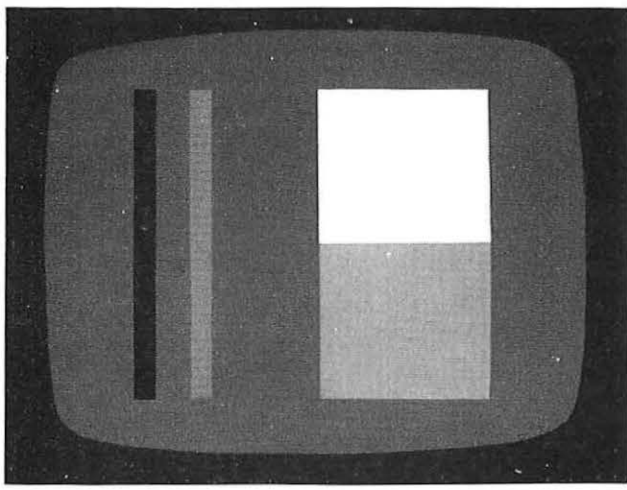
PYE TELECOMMUNICATIONS LTD. CAMBRIDGE, ENGLAND · *Telex No.* ***81166***

THORN TV PATTERN SOURCES



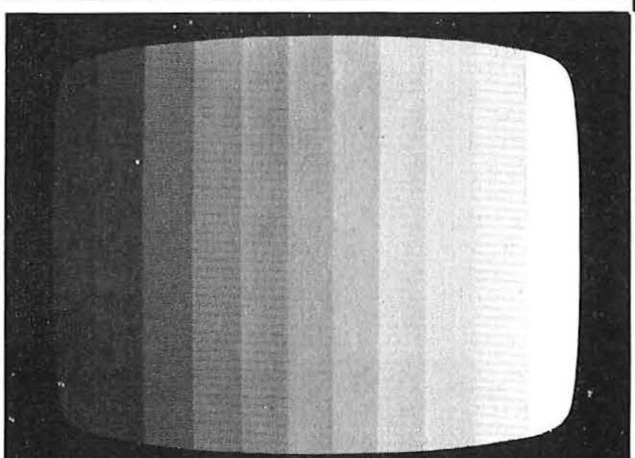
GRATICULE AND DOT GENERATOR–TYPE WH.11

The Thorn Graticule and Dot Generator provides a means of accurately assessing the linearity of television scan systems of both cameras and picture monitors. This fully transistorised, mains powered equipment will operate on 405, 525 or 625 line standards when driven by the appropriate Mixed Blanking and Synchronising waveforms and will provide a composite signal of variable Amplitude and Sync/Output ratio.
The generator produces alternative white on black or black on white graticule or dot patterns selected by means of a front panel switch.
The number of lines or dots along each axis may be adjusted as required, and independent shift controls enable the display to be aligned with an optical graticule when performing linearity tests.
The video signal rise time is less than 0.1 μSec, ensuring a sharp and versatile display.



PICTURE LINE-UP TEST GENERATOR TYPE WK.21 405/625 lines (switchable)

This fully transistorised unit generates, from input signals of mixed synchronising and mixed blanking pulses, a video test signal for use in setting up picture monitors.
The output signal gives a display consisting of two narrow bars on the left and a broad bar, divided horizontally into peak white and grey halves, on the right. The narrow bars have respectively an amplitude of minus and plus 3% peak white relative to the background level.
The signal is used for correctly setting up brightness and contrast in picture monitors and to check for spurious limiting.
Single standard 405, 525 or 625 line versions are also available.



PRESET LAW STEP TEST GENERATOR –TYPE WL.11

This unit which is also fully transistorised, is used for setting up various non-linear amplifiers, having a prescribed law used in telerecording. It can also be used for setting up the gamma units on colour scanners as well as providing a grey wedge for setting up picture monitors.
The signal produced consists of a blanked step wedge having ten steps, together with synchronising pulses. The law of the step wedge can easily be changed and can be altered over the range $y = x^{0.3}$ to $y = x^{2.5}$.
Internal preset adjustments enable this instrument to be operated on 405, 525 or 625 line standards.

Thorn Electronics Limited

THORN ELECTRONICS LIMITED
Wellington Crescent, New Malden, Surrey. (MALden 8701)
A MEMBER OF THE THORN ELECTRICAL INDUSTRIES GROUP OF COMPANIES

TE69

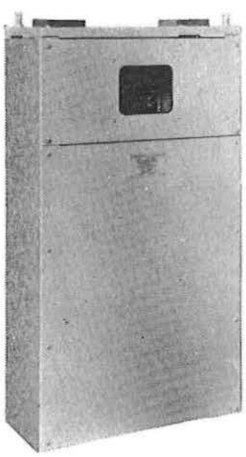
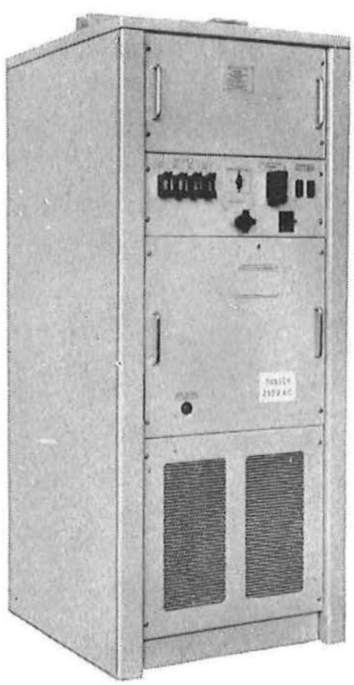
WESTINGHOUSE

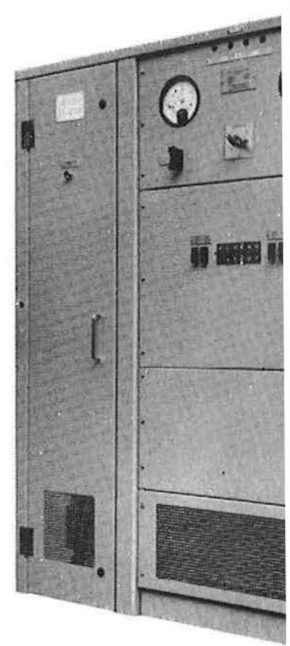
Semicon(


Silicon Diodes
200mA—300A
100—1800V P.I.V.

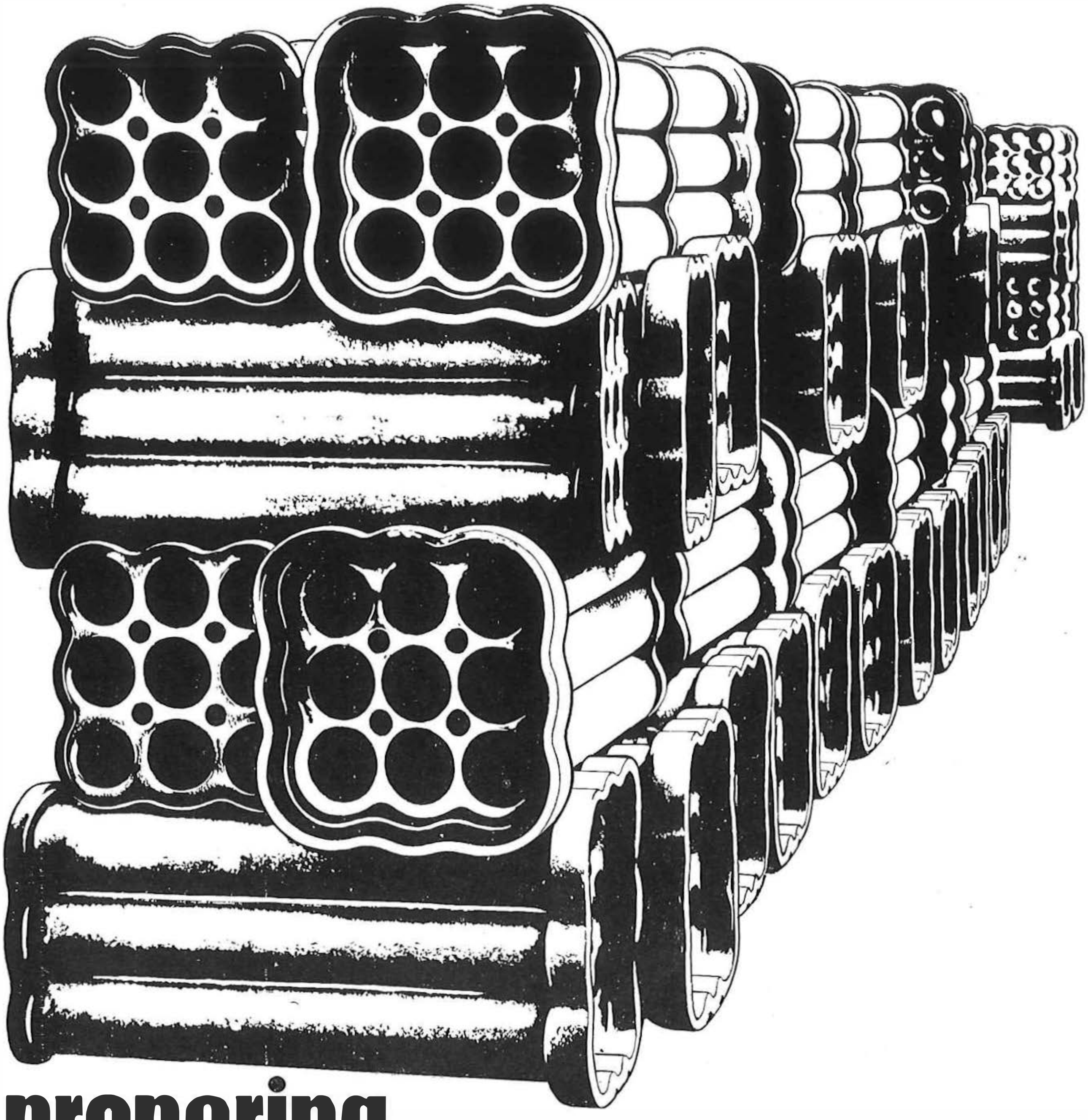
Thyristors
500mA—250A
100—1200V


Constant voltage rectifier equipments for teleph



Dept. PO.1/65 · **WESTINGHOUSE BRAKE AND SIGNAL COMPANY LIMITED** · 82 YORK



QUAD TRUNK CABLE

This cable, manufactured to a British Post Office specification is produced in large quantities for audio frequency junction circuits. In common with other types of cable, they can be made to comply with any national or private specification.

CABLES

2419

INDEX TO ADVERTISERS

Published by *The Post Office Electrical Engineers' Journal*, G.P.O., 2–12 Gresham Street, London, E.C.2,
and printed in Great Britain at The Baynard Press by Sanders Phillips and Co., Ltd., Chryssell Road, London, S.W.9

ERICSSON

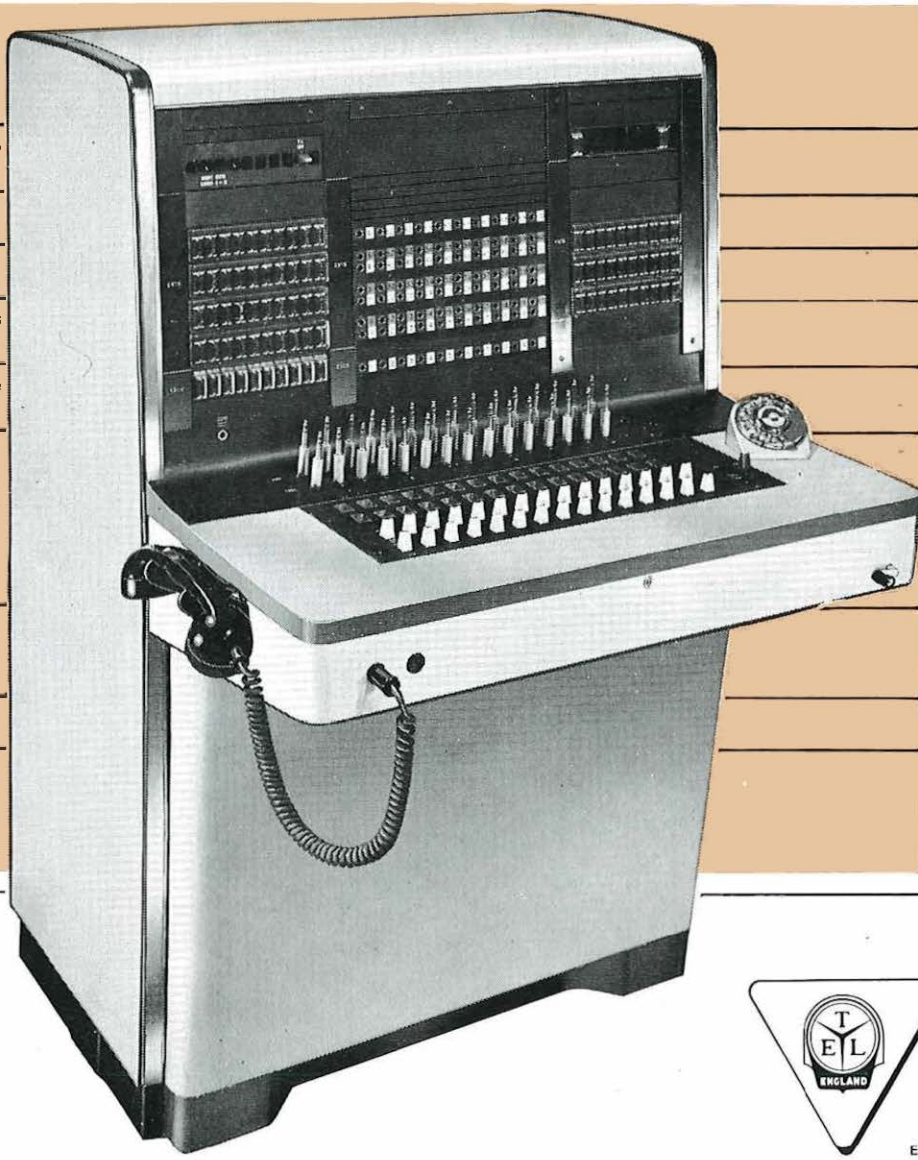
FLOOR PATTERN P.M.B.X. CORD-TYPE SWITCHBOARD

Introduced to meet the need for a switchboard in contemporary idiom, this new design incorporates many exceptional features made possible by forward thinking, new materials and modern manufacturing techniques. Already serving with distinction in many offices, reception areas and similar locations, these switchboards set new standards in functional efficiency and visual appeal and will give completely trouble-free service for many years ☐ Available as Magneto and C.B. types, they are designed for use as single or multiple units. The standard colour scheme is light buff with a faint pattern for the main surfaces, pale mushroom for the top of the keyshelf and black for the plug-shelf and face equipment ☐ The main panels which are removeable for easy access to equipment, are held in position by aluminium trimmer strips in anodized bronze, thus making alternative colour schemes readily available ☐ For further information write to Head Office, Beeston, Nottingham.

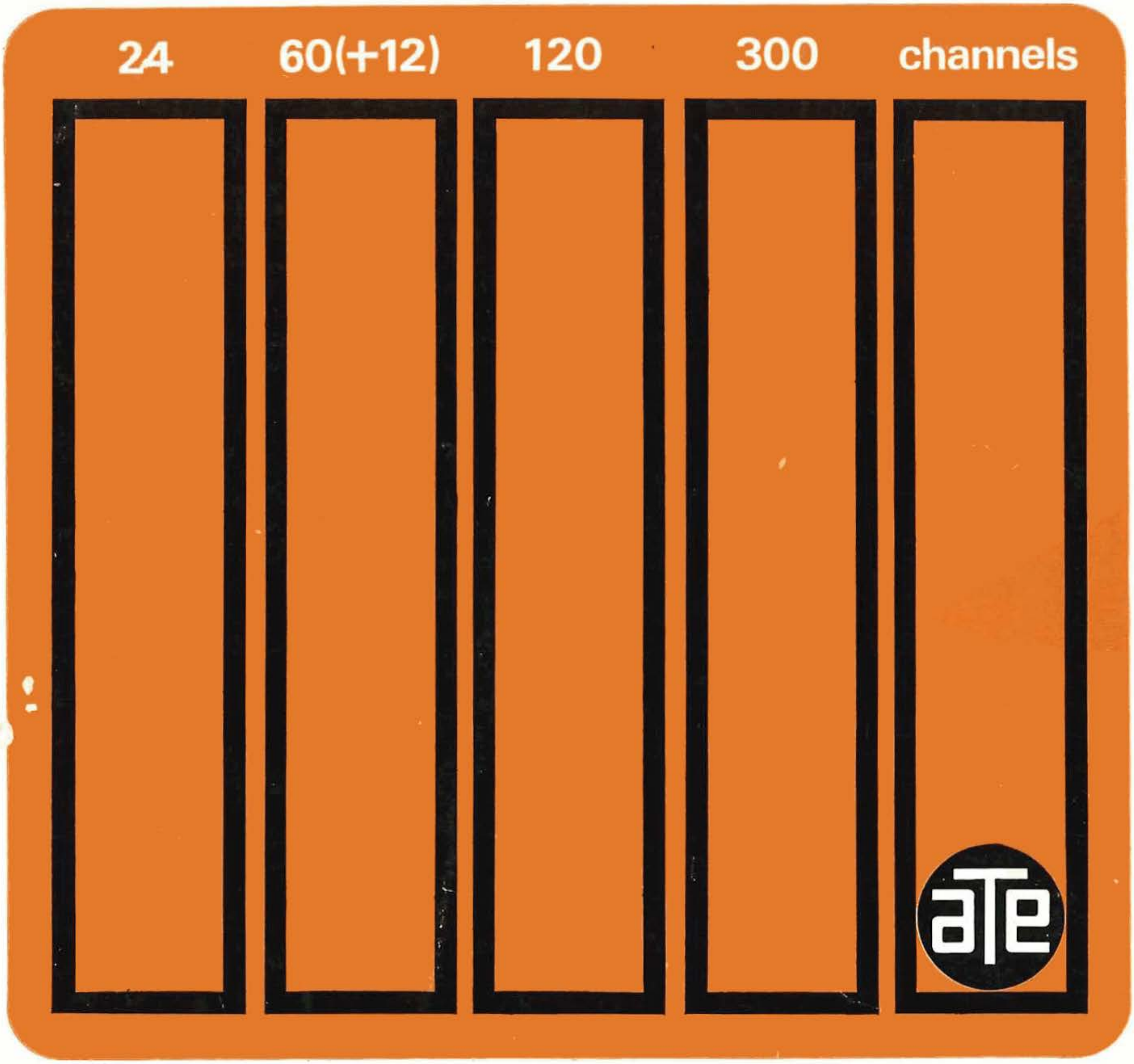
ERICSSON TELEPHONES LTD • ETELCO LTD

A Principal Operating Company of the Plessey Group. Head Office and Main Works: Beeston, Notts. Phone: 254831. Telex: 37666
Registered Office: 22 Lincoln's Inn Fields, W.C.2. Phone: HOLborn 6936

- Up to 20 Magneto, C.B. or Auto exchange lines can be accommodated.
- Easy identification of "thrown" keys.
- Latest lightweight "plug-in" handset.
- Cord test and night service facilities on C.B. switchboards.
- Magneto switchboards have single positive supervision.
- C.B. switchboards have through dialling and clearing, double positive or double negative supervision, operator re-call, follow-on call signal, exchange prohibition. A lamp signalling version is also available.
- Welded pressed steel frame covered by replaceable laminate plastic panels.
- Fully tropicalized



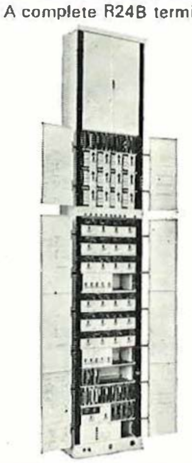
ER91



Performance-proven multiplexing
for radio links – with AT&E/CM equipment

For multi-channel speech transmission over medium capacity microwave links, the AT&E Type CM transistorised series of Multiplex Equipment offers you proven reliability, space saving, and minimum power consumption. Type CM has been demonstrating its superiority in installations around the world for more than 3 years. For full information about how these and the other versatile multiplex systems in the CM range can serve your specific needs, write to:
Automatic Telephone & Electric Co. Ltd., 8 Arundel St., London, W.C.2, England.
Telephone: Temple Bar 9262. *A Principal Operating Company of the Plessey Group.*

A complete R24B terminal



Specifications.

Equipment designation:	R24B	R60B	R120C	R300A
Transmission type:	4-wire on radio link			
Speech channels:	24	60(+12)	120	300
Baseband frequency (kc/s):	6-108	12-252 or 60-300	60-552	60-1300
Channel bandwidth (c/s):	300-3400			
Input power (watts):	50	70	200	500

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