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AN AUTOMATIC ANNOUNCER

F. O. J. Crump — Audio Research Laboratory

Devices for making announcements automatically are being used in increasing numbers. The Announcer described in this article was developed for particular application to changed number interception service in an automatic telephone exchange.

THERE are a number of possible applications of an announcing machine as part of an automatic telephone exchange. Changed number interception service can be provided by a machine which instructs the subscriber to refer to the latest directory. The Announcer to be described was designed to provide this fully automatic service for the Kapuskasing automatic telephone exchange in Canada. It is equally applicable to other services such as the announcement of sports scores or weather forecasts, or to cinema programme advertising, etc.

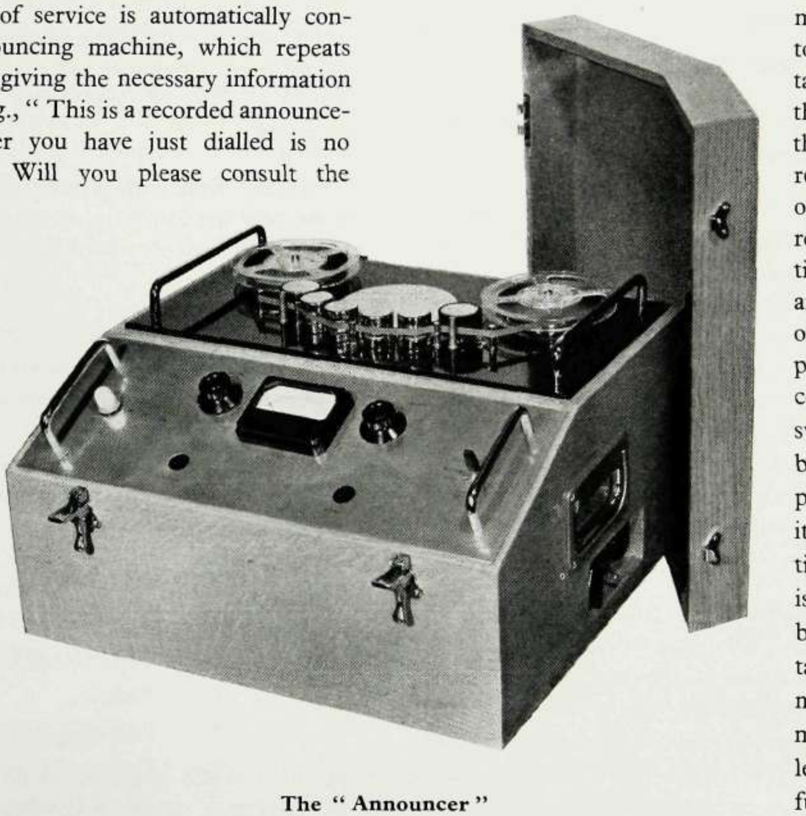
Principle of Operation

A subscriber who dials a number which has been changed or is out of service is automatically connected to the announcing machine, which repeats a recorded message giving the necessary information and instructions ; e.g., " This is a recorded announcement. The number you have just dialled is no longer in service. Will you please consult the latest issue of the Kapuskasing telephone directory. Thank you ! "

The Announcer takes the form of a tape recorder which is started and delivers a pre-recorded message when a subscriber dials any one of a series of numbers connected to it. A number of subscribers can simultaneously receive the message, which is repeated until the last subscriber terminates the call. Messages varying in duration from a few seconds to 30 minutes can be accommodated.

Mechanical Operation

Since it may be necessary to repeat a message continuously for a fairly long period, the standard type of tape recorder is not suitable. A continuous loop of tape is not convenient since many feet of tape are needed for long messages and complex mechanical arrangements are required for the control of a large loop. To obviate such complication twin track recording is used. The message is recorded on one track as the tape moves from left to right ; the tape direction is then reversed and the message is recorded on the other track. The reversal of direction of the tape and the selection of the track to be played back are controlled by limit switches operated by metal foil applied to the tape itself. The duration of the message is thus determined by the length of tape between the metal foils, and may have any length up to the full capacity of the



The " Announcer "

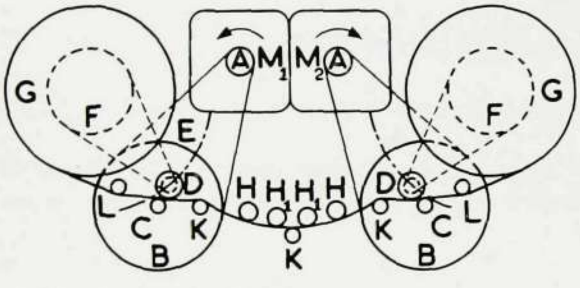


Fig. 1—Mechanical Layout

M_1 M_2	Fractional H.P. Synchronous Motors.
A	Main Driving Pulleys.
B	Capstan Flywheel.
C	Capstan.
D	Rubber-Tyred Pinch Roller.
E	Spool Drive Pulley (Main).
F	Spool Drive Pulley.
G	Tape Spool.
H	Record/Playback Heads.
H_1	Erase Heads.
K	Tape Guides.
L	Limit Switches.

tape reel. Separate erase and record/playback heads are used for each recording track.

Fig. 1 shows that the device is driven by two fractional h.p. synchronous motors M1 and M2 which run in opposite directions. The two capstans C are rotated in opposite directions by spring belts from the main driving pulleys A to the rims of the capstan flywheels B. Two rubber-tyred pinch rollers D can be pulled magnetically into contact with their respective capstans. Thus since the magnetic recording tape is made to pass between the capstans and their pinch rollers it is possible to make it pass backwards or forwards by operation of the appropriate pinch roller.

The take-up spool is driven from the engaged pinch roller, the other spool being free to rotate as its associated pinch roller is not engaged. Since the tape speed is constant, the rate of rotation of the take-up spool must decrease as the amount of tape on it increases. The friction drive shown in Fig. 2 allows the necessary variation to occur.

The driving plate Y is rotated by the pulley F which in turn is driven by a belt from a smaller pulley fastened to the pinch roller spindle. Thus the tape spool is driven by friction between the driving plate and the felt washer X. The diameter of pulleys F and E are such that the plate Y is driven at a higher speed than the tape spool ever requires, so that the tape is taken up at all times. Since the magnetic recording heads are arranged in an arc of a circle, no pressure pads are needed to keep the tape pressed against them, drag from the disengaged spool system being sufficient to keep the tape taut. Special oil-retaining bearings used throughout the equipment ensure smooth running with the minimum of attention.

Amplifier

The amplifier unit (Fig. 3) is used for both recording and playback. Conventional power supplies with provision for mains voltages of 250V or 110V at 50 or 60 cycles per second are incorporated. Miniature double diodes are used for rectification to supply an h.t. of 270 volts.

The main requirements for the tape recorder amplifier are a high gain and the provision of approximately 15 volts of undistorted signal for recording purposes.

In view of the high gain, every precaution is taken to prevent hum pick-up and random noise through-

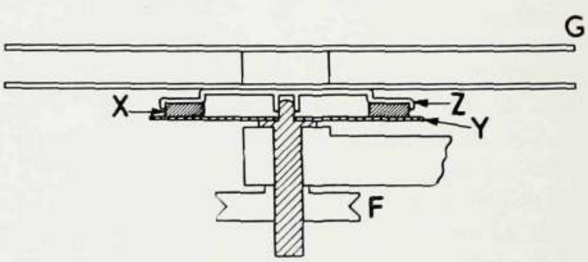


Fig. 2—Friction Drive for Take-Up Spool

G	Tape Spool.
F	Pulley.
X	Felt Ring.
Y	Driving Plate.
Z	Spool Holder.

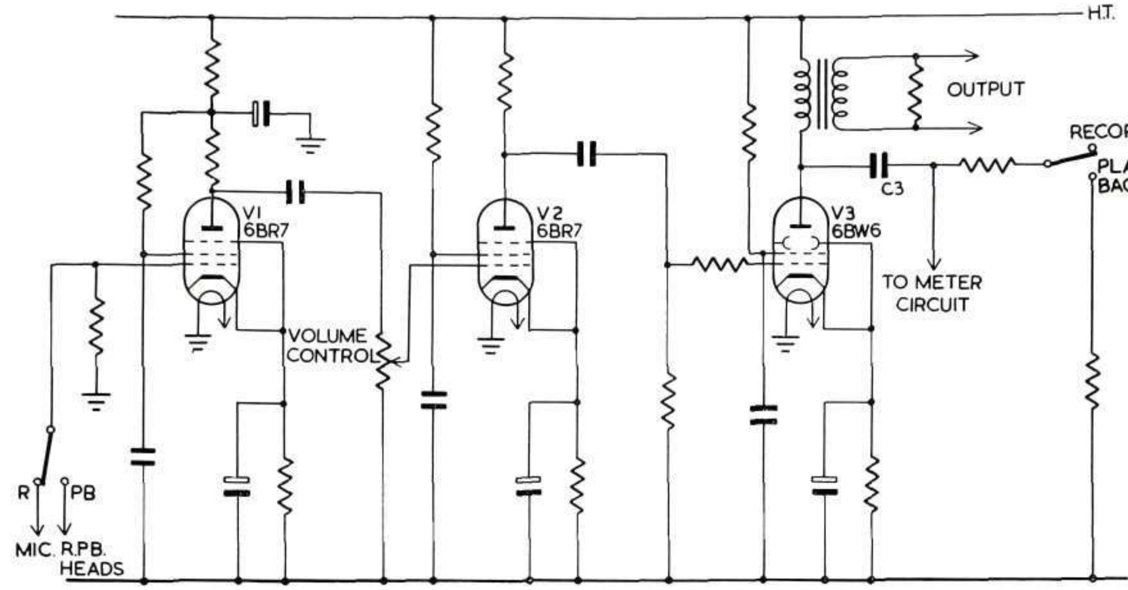


Fig. 3—Simplified Circuit of the Amplifier

out the amplifier. Low microphony miniature valves are used. Screening of the valves in the first two stages has been carried out to minimize hum pick-up, and as an added precaution a single earth is used for the first two stages and the magnetic recording heads.

Fig. 3 shows a simplified circuit diagram of the amplifier. A signal from the microphone or one of the two playback heads is fed directly to the grid of V1 (6BR7). The amplified signal is then fed via the volume control to the second stage V2 and from there to the output stage, which uses a single beam tetrode (6BW6).

When the amplifier is used for recording, the amplified signal is taken from the anode of V3 through an isolating capacitor C to the record heads via a series resistance which ensures constant current recording. On playback the signal is taken from the secondary of the output transformer, which is isolated from earth since it has to feed into the interception circuit equipment. This output is at low impedance and is fed through suitable matching pads to prevent crosstalk between subscribers simultaneously connected to the Announcer.

Recording and Output Levels

An efficient form of metering is essential on all types of tape recorder, since when recording the tape must be magnetized to the highest intensity which will not cause distortion of the reproduced signal. Too low a level will result in more background noise on playback, due to the increased gain required from the amplifier. It is also necessary that the signal sent to the exchange equipment be of

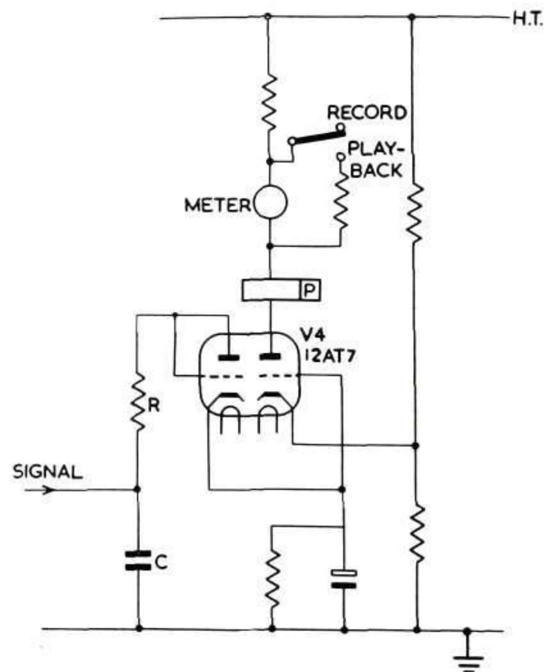


Fig. 4—Metering Circuit and Alarm Relay

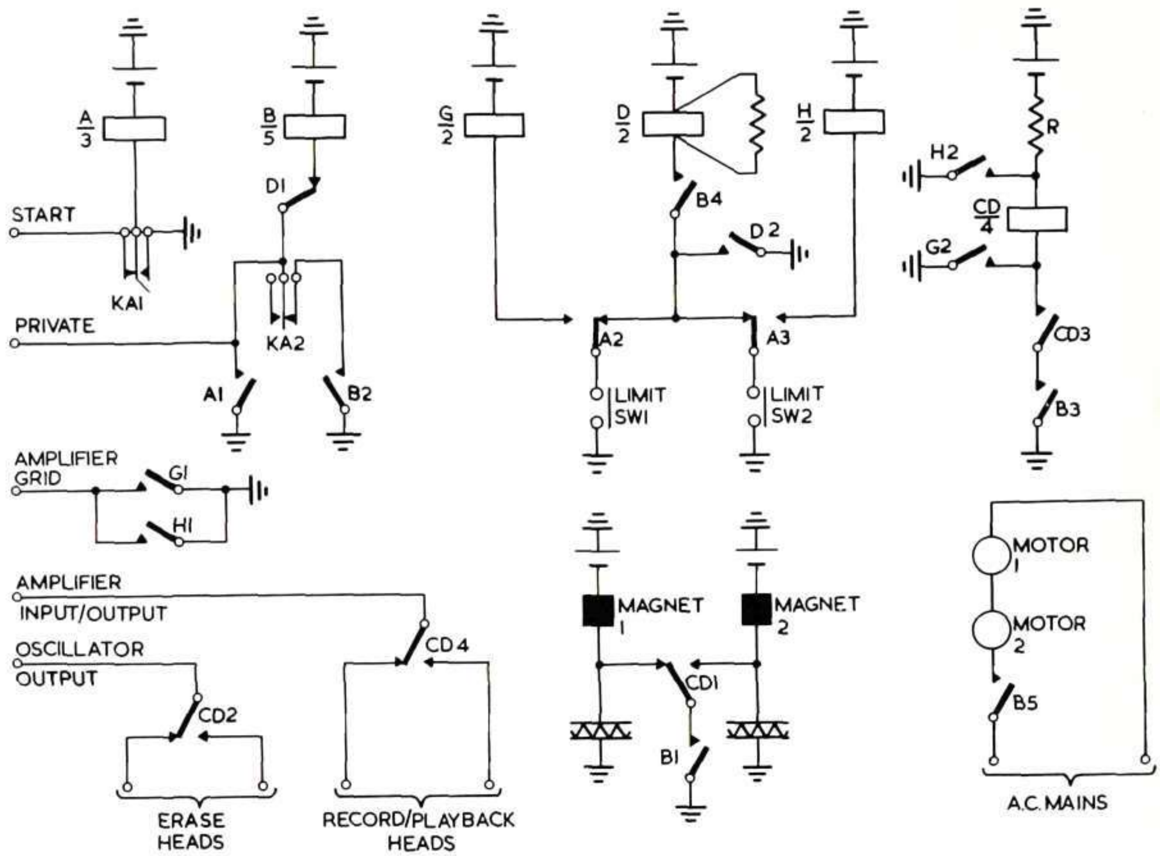


Fig. 5—Control Equipment Circuit

sufficient amplitude to produce adequate output to the subscriber. Fig. 4 shows a simple valve voltmeter which is incorporated in the Announcer. Part of the signal from the anode of V3 (Fig. 3) is fed to the strapped anode and grid of the first half of the double triode V4. The capacitor C, which has a value of .001 μF, prevents bias voltage break-through into the meter circuit during recording. The resistance R prevents diode clipping during playback, when a high voltage may appear across the cathode resistance.

A shunt resistance is switched across the meter during playback so that similar meter readings can be obtained for record and playback levels.

Breakdown Alarm

In any automatic system operating in a telephone exchange it is necessary to have an alarm which will operate if the equipment ceases to function correctly. In the Announcer the alarm circuit takes the form of a resistance-capacitor delay network working in conjunction with a polarized relay P in the meter circuit of the amplifier (see Fig. 4). If for any reason such as a valve failure or tape breakage there is no output from the amplifier, the alarm circuit operates after a delay of 10 seconds and in turn operates a delayed alarm. This arrangement causes an alarm to be given if insufficient output is fed to the interception equipment.

Erase Oscillator

A conventional Hartley oscillator followed by an amplifying section is used to give some 300 volts of erase signal at 50 Kc/s. Part of this voltage is fed through a resistance and capacitor to the record/playback head to give the necessary recording bias.

Relay Control Equipment

Starting, reversal and stopping of the tape are normally carried out by a relay set built into the Announcer. When recording, these processes are controlled manually by use of a three-position key on the control panel.

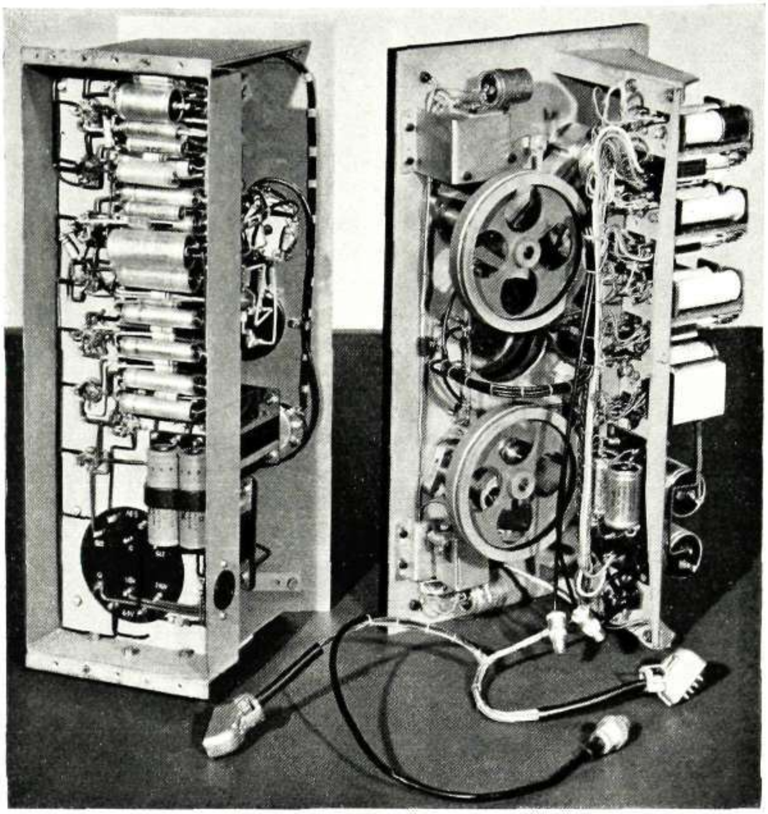


Fig. 6—Interior view showing layout of Amplifier and Tape Deck

Fig. 5 shows the circuit of the control equipment, which is seized on receipt of an earth on the start wire and returns an earth on the private wire. The operation of A relay, and hence of B, starts the motors and prepares circuits for the operation of the appropriate pinch roller and the CD relay. The CD relay is operated or released by the limit switches through G and H relays. By selecting the appropriate pinch roller magnet at CD1, the CD relay controls the direction of traverse of the tape ; it also selects the erase and playback heads at CD2 and CD4.

While the start condition persists, the apparatus will continue to repeat the message automatically, the tape changing direction each time one of the metal foils actuates a limit switch. When the start signal is removed, the A relay is released and at A2 and A3 prepares relay D for operation by the next limit switch to be actuated. Relay D releases relay B, and the Announcer reverts to the stand-by condition.

Preparation of an Announcement

When it is necessary to record a fresh announcement, a piece of flexible metal foil is spliced into the tape in such a position as to be in contact with a limit switch. A crystal microphone and a pair of monitoring headphones are plugged into the appropriate jacks on the panel. The amplifier is switched to " record," and the recording level is adjusted by means of the volume control.

The lever of the three-position key is moved to " start ", and the message is recorded. The lever is moved to " stop ", then a further piece of foil is spliced into the tape at the other limit switch. The key lever is returned to the " start " position and the message again recorded. During this second recording the key lever is moved to the " release " position and the tape will automatically stop when the first foil reaches the limit switch. The amplifier is then switched to playback and the Announcer is ready for automatic operation.

UDC.621.395.722.

ROUYN—NORANDA AUTOMATIC TELEPHONE EXCHANGE, CANADA.

E. Tuck, Circuit Development Department

Since 1950 the Company has supplied automatic telephone equipment for some 30,000 lines in the Canadian provinces, the most recent installation being at Rouyn in the province of Quebec. This article describes special features of the otherwise conventional " step-by-step " exchange system.

THE latest of the automatic exchanges which the Company has supplied to Canada was brought into operation in October 1956. It serves the contiguous towns of Rouyn and Noranda, situated at the centre of a mining area about 350 miles north-east of Toronto, mid-way between Lake Ontario and Hudson Bay. Rouyn has 18,000 inhabitants and Noranda 12,000 ; including nearby settlements, of which Farmborough, Arntfield and Evain are the largest, the total population of the district is about 35,000. Telephone communications are operated and maintained by the Ontario Northland Railway Company and the Northern Telephone Company, the former handling toll and the latter local traffic. The new exchange was supplied and installed at Rouyn for the Northern Telephone Company. It serves both Rouyn and Noranda subscribers and brings the number of exchanges operated by the Northern Telephone Company to thirty-four.

The initial number of lines is 6,800, accommodating single, two-party, P.B.X. and rural multi-party subscribers as well as pay-stations. There are terminations for 8,100 multiple numbers and provision is made for growth up to a planned ultimate of 9,000 lines and 10,700 terminations. The exchange operates on the Strowger step-by-step system ; Fig. 1 shows the trunking scheme. A flat-rate tariff is imposed but meters are provided for a few special P.B.X. lines. Toll lines are cabled to terminating equipment provided and installed by us in Noranda for cross-connection by the Ontario Northland Railway Company to their Northern Electric type 3C sleeve control toll switchboard.

Although the general principles of Strowger switching are well known, the Rouyn exchange has several unusual features arising from the incorporation of the latest developments. The automatic switching plant includes double-homing subscribers uniselectors, 20/10 digit-absorbing first selectors, 10/10 second selectors and mixed 100- and 200-line connectors. With the double-homing uniselectors, a call which fails at the first attempt owing to seizure of a faulty selector will almost certainly be connected at the second attempt. The earlier single-homing arrangement made it possible for calls to be blocked by repeated connection to one particular defective switch, and such blocking might have serious consequences in the case of an emergency call.

A national toll dialling scheme is projected for North America and provision for long distance dialling at a later date is made at Rouyn by having, in effect, a 7-digit numbering scheme. The seven digits comprise a two-letter prefix and one numeral which together make up the exchange code, e.g. RO(uyn)2, and the four numerals of the particular subscriber's number. An incoming call from another exchange in the same area can be completed only by dialling all seven digits, but a local caller can dial either the full number of digits or only the last five. In the former case the two prefix digits must be discarded ; this is achieved by providing digit-absorbing incoming and first selectors which are designed to :—

(*a*) absorb a specified digit or digits once only,

(*b*) absorb a specified digit or digits repeatedly, unless the preceding digit discriminates for single-digit absorption,

(*c*) return " all paths busy " tone on specified levels unless the preceding digit discriminates for single-digit absorption,

(*d*) search for a free outlet to the succeeding equipment on specified levels without digit absorption,

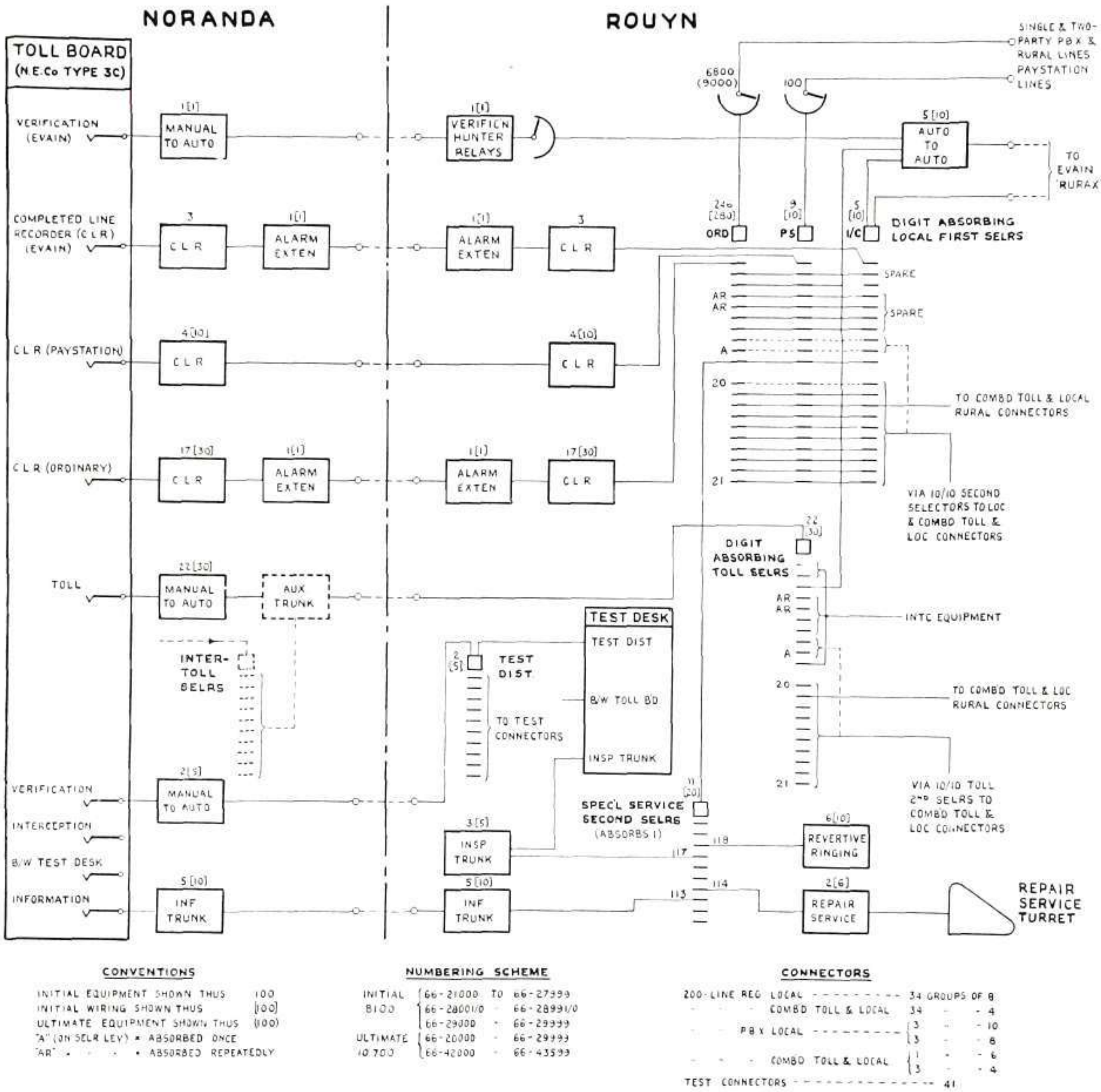


Fig. 1—The Exchange Trunking

(*e*) search over the appropriate level when any digit is dialled after one which discriminates for single-digit absorption.

As previously stated, the two prefix letters of the subscriber's number must be discarded if dialled on a local call. These letters are either RO(uyn) or NO(randa) and, with American dial numbering, correspond to the numbers 76 and 66 respectively. The dialling of " 7 " or " 6 " is therefore arranged to actuate the absorption element irrespective of the number of times these digits are dialled.

When the digit 2 is dialled it is absorbed, but the absorption element is then rendered ineffective to allow the switch to respond to the next impulse train and search for a free trunk. This occurs when digit 1, 3, 5, 8, 9 or 0 is dialled.

The connector circuits are conventional except for one feature which is peculiar to North American practice for toll calls. This feature permits the toll operator to establish the connection but defer the application of ringing until both subscribers are available for the call. Should the distant subscriber try to make a call after the connection has been established, the removal of his handset will cause a signal to be given to the operator, who can then inform him that a toll call is imminent. By this means much time can be saved. The circuit operation (see Fig. 2) is as follows :—

Assuming that the connector has been seized via the toll path and that dialling has been completed, relays A, B, CD and TL are operated and E is slowly releasing. On the final release of relay E, relay H operates to a free condition. H2 completes a circuit for relay F to earth via TL3, OC1 and B5 ; H8 removes the short circuit, and F operates. Contacts F3 and F6 switch the outgoing negative and positive wires to line, and connection is established. Supervision is afforded by relay D, which operates in the event of the called subscriber removing his handset.

Operation of the ring key at the appropriate time creates an unbalanced line condition which causes relay OC to operate and release relay F at OC.1 Relay HR operates via H1 and applies ringing to the line.

The automatic apparatus, distribution frames and the test desk are on the first floor of the exchange building, the cable chamber and power plant being below. From the equipment viewpoint, the principal departures from current British exchange practice are the provision of connection strips instead of fuse mountings on the line side of the main frame, and of separate trunk distribution frames for grading purposes. It is in the appearance of the exchange that the most notable difference occurs. Telephone switchrooms are usually rather drab although there is no reason why they should not be made as attractive as possible provided that undue expense is not incurred. The Rouyn installation is an example of how pleasing an effect can be achieved at reasonable cost by using brighter colours for equipment finishes with an appropriate scheme of interior decoration.

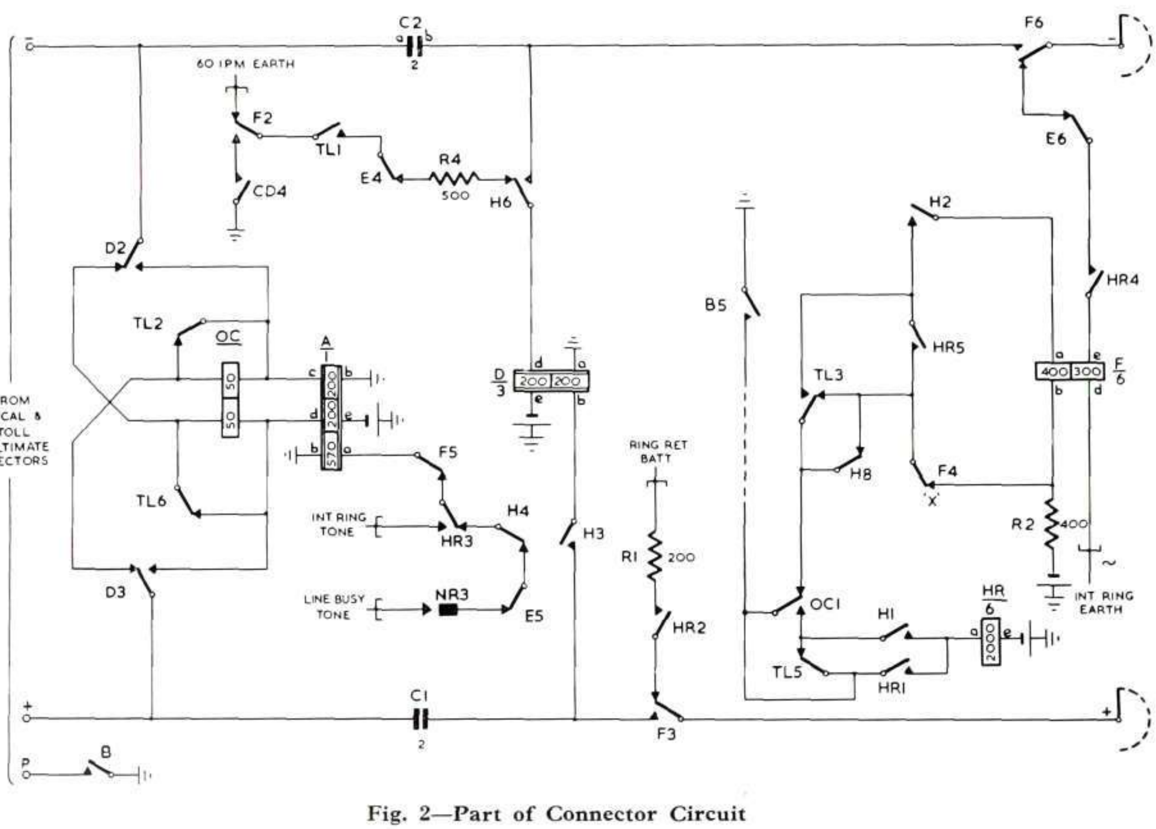


Fig. 2—Part of Connector Circuit

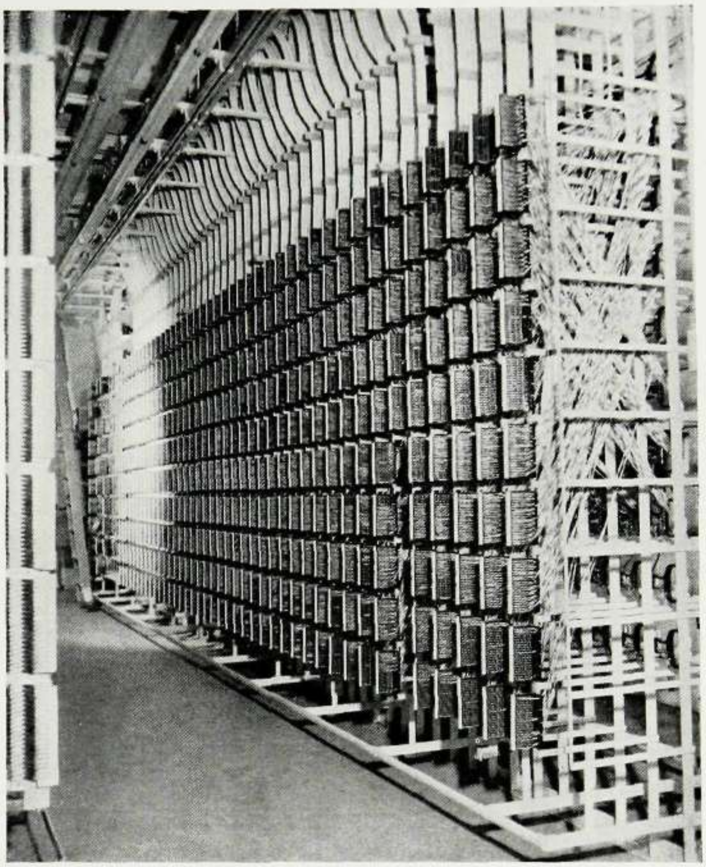


Fig. 3—Intermediate Distribution Frame with Main Frame protectors just visible on the left

There is a trend toward such improvements, more particularly in manual switchrooms, but in apparatus rooms little has been done apart from those few instances in which cream plastic-sheathed cables relieve the dullness of the grey painted apparatus. The Northern Telephone Company welcomed our proposal not only to have cream-coloured cables and overhead ironwork but to finish the equipment predominantly in opaline green with beagle green and cream appointments. The telephone company's scheme of interior decoration, i.e. cream painted walls and mottled green floor covering provides an admirable background.

All the connecting wires are p.v.c. insulated. This is our standard practice. Apart from the excellent insulating and other properties of p.v.c., its smooth surface does not promote the adherence of dust and can easily be cleaned.

The main and intermediate distribution frames together with the test jack frame and test desk are partitioned off from the switchroom. The desk is made of light oak, finished in its natural shade and relieved by black facings as shown in Fig. 7. Alongside the desk is a repair service turret at which all subscribers' service enquiries and complaints (dial 114 calls) are received. If the turret operator is unable to deal with a particular matter it can be referred to the test desk.

The power board is shown in Fig. 9. The power plant operates on the " duplicate battery automatic full float " principle described in Bulletin No. 32, January 1956. It consists of two batteries of 24 Fauré cells floated in parallel across the outputs of one, or both, of two 3-phase selenium rectifier charging units. The control panel switching arrangements permit battery isolation for boosting with one

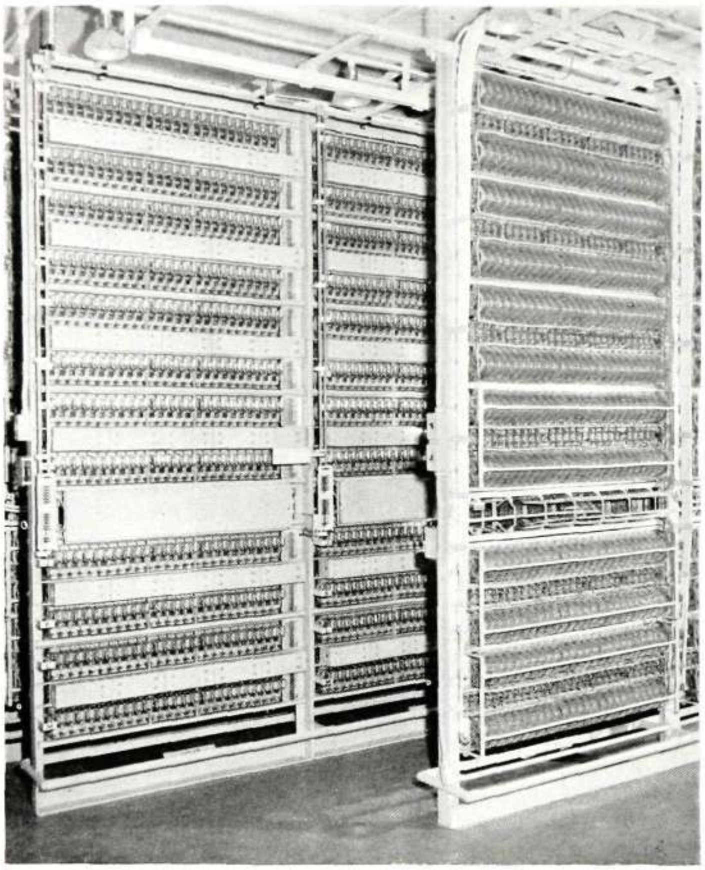


Fig. 4—Front and rear views of Uniselector Racks

charging unit every few months to counteract the slight loss incurred whilst on float. Only during boost charging need the plant be attended.

The combined output of 170 amperes from the float chargers will maintain the ultimate busy-hour load. The output of each is held at 51-52 volts by a regulator having a potentiometer winding which controls the current passing through the d.c. windings of a transductor circuit. Hence, apart from the regulator, the circuit is entirely static in operation. The boosting output imparts an automatic charge to 62 volts.

To obviate manual selection and increase the energy efficiency of the plant, the power control panel incorporates a duplicated contact-ammeter circuit by which one float charger is kept in service and the other is cut in when the first is nearly fully loaded. However, facilities for manual selection are also provided.

The panel mounted ringing machines are both battery operated. In the event of the regular machine developing a fault, the second one is automatically switched into service and returned to the standby condition when necessary. The machines generate ringing supplies and tones in accordance with Canadian practice. Continuous ringing is 105 volts 20 cycles, and interrupted ringing 84-88 volts 20 cycles, provision being made for five codes for party-line ringing. Ringing tone is 20 cycles superimposed on 420 cycles. Supervisory equipment and fault alarm arrangements conform with current standards.

The installation was completed without difficulty and in the spirit of co-operation which has always marked the Northern Telephone Company's association with our representatives.

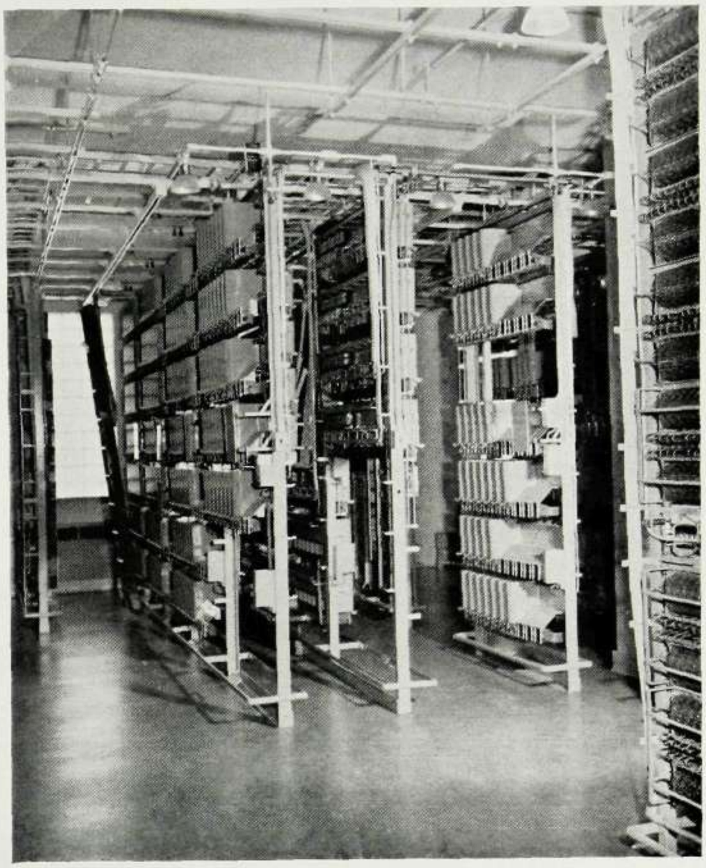


Fig. 5—Some of the Selector Racks

The exchange was brought into service at midnight on the 6th October, 1956, and all concerned agreed that it is worthy of the modern towns it serves. A fairly rapid increase in the number of telephone subscribers in the area is to be expected in view of the rate of development of the district ; however, the exchange equipment is readily extensible. The facility for extension applies also to the 100-line " Rurax " type exchange (see Bulletin No. 28, January, 1954) which was supplied for the settlement of Evain and which at present is working as a dependent on Rouyn. In the near future it will become a full satellite, the planned ultimate number of lines being 200.

Fig. 6—Connector Racks

Fig. 7—Test Desk

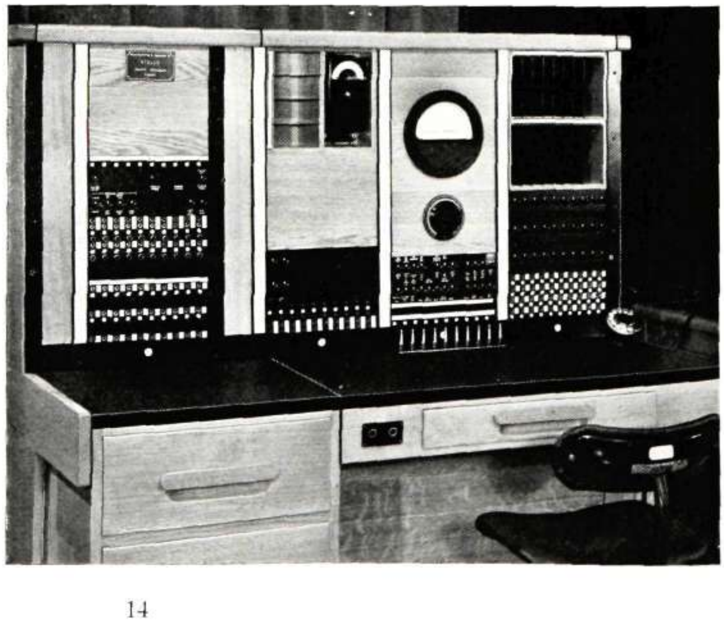


Fig. 8—Repair Service Turret

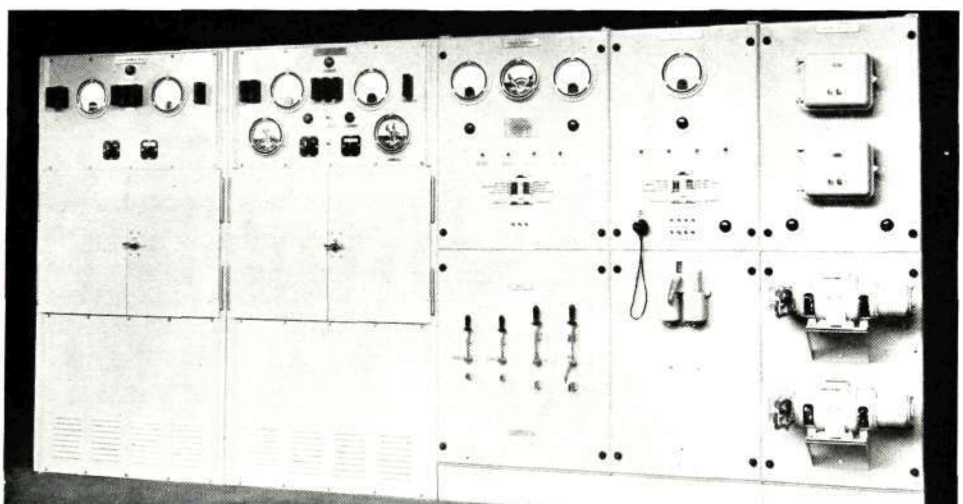


Fig. 9—Power Board

Left to right :—Charging, Power Control, Ringing Control and Ringing M C panels

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UDC.621.395.631.4.
UDC.621.313.823.2.

ROTATING MAGNET HAND GENERATORS

W. SINCLAIR, Apparatus Development Department

The Alnico magnet hand generator with rotating armature and static magnet is gradually being superseded by the rotating magnet type, which is of simpler construction on account of the absence of brushes and requires lower starting and running torque. A generator of the new type is described below, with discussion of the factors which must be taken into account to ensure an efficient design. A typical application of the new generator is in the new magneto telephone described elsewhere in this Bulletin.

THE demand for magneto generators continues notwithstanding the general use of C.B. and automatic systems for public exchanges. Even the development of apparatus specifically designed to replace the generator has not seriously reduced the demand. For many years our " Alnico " type generators have met all requirements very reliably so that there has been little incentive to the production of new designs. However, developments in permanent magnet alloys and their effect on generator design have been constantly under review, and this has led to the introduction of the new rotating magnet generators shown in Fig. 1.

General Objectives of the New Design

In view of the large number of " Alnico " generators in use, complete interchangeability both in size and fixing was considered essential. The various types of feet are shown in Fig. 2.

The power to be produced was estimated from previous requirements and the specifications of various customers, and it was decided that the minimum output for light duty generators should be 2.8 watts and for heavy duty 4.5 watts, measured at the optimum load. It was also decided that the operating torque should be as low as possible under full load, and that improvements must not unduly increase the cost.

Factors Deciding Type of Generator

Anisotropic materials with high coercivity make it possible to obtain the necessary power with a relatively small magnet, although at higher cost. By careful design of the iron circuit, both the starting and peak running torques can then be reduced. This factor outweighed cost considerations and decided the form the generator would take. The fixed coil eliminates the use of slip rings and collecting brushes, and thus simplifies manufacture.

LIGHT DUTY HEAVY DUTY

Fig. 1—Rotating Magnet Generators

Design of Magnet

The magnet design is determined by two main considerations. Firstly, in conformity with normal practice the metal is magnetized before assembly so that subsequent maintenance will not involve remagnetization. Secondly, in order to reduce the starting and running torque the flux density in the air gap is kept relatively low.

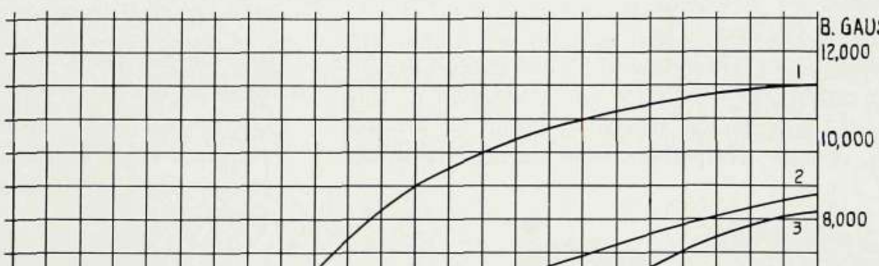
Fig. 2—Types of Feet Available

Magnetization before assembly results in the magnet being subjected to a severe de-magnetizing force in the interval before insertion into the iron circuit. The magnitude of this effect is increased by the limitation of magnet length which the dimensions of the generator impose. Hence it is essential to use a material with high coercivity, that is, a high resistance to de-magnetization. The length to cross-section ratio of the magnet should be within definite limits in order to obtain maximum field energy. However, the previously mentioned requirements of low flux density in the air gap and open circuit demagnetization impose limitations on the shape, and a compromise has to be reached between all the factors involved so that the field at the working points on the de-magnetization curve of the material is rather less than the theoretical maximum.

Fig. 3 shows the de-magnetization curves for various materials and it will be seen that the anisotropic material selected (Hycomax) has the required properties. Points B1 and B3 on the curve are the positions of flux density (B) with respect to de-magnetizing force (H) under open circuit conditions. Working points B2 and B4 represent the recovery of the magnet when inserted into the iron circuit of the generator. For a specific load, however, the magnet works at a point between B1 and B2 or B3 and B4.

STATOR

The stator assembly (Fig. 4) consists of a coil fitted on interleaved laminations securely bolted between diecast end cheeks. Fig. 5 shows the characteristics of some of the soft magnetic materials which could be considered for forming the fixed poles of the generator. The electrical quality iron compares favourably with the alloys ; it has a high saturation figure and in view of possible shortages and high costs

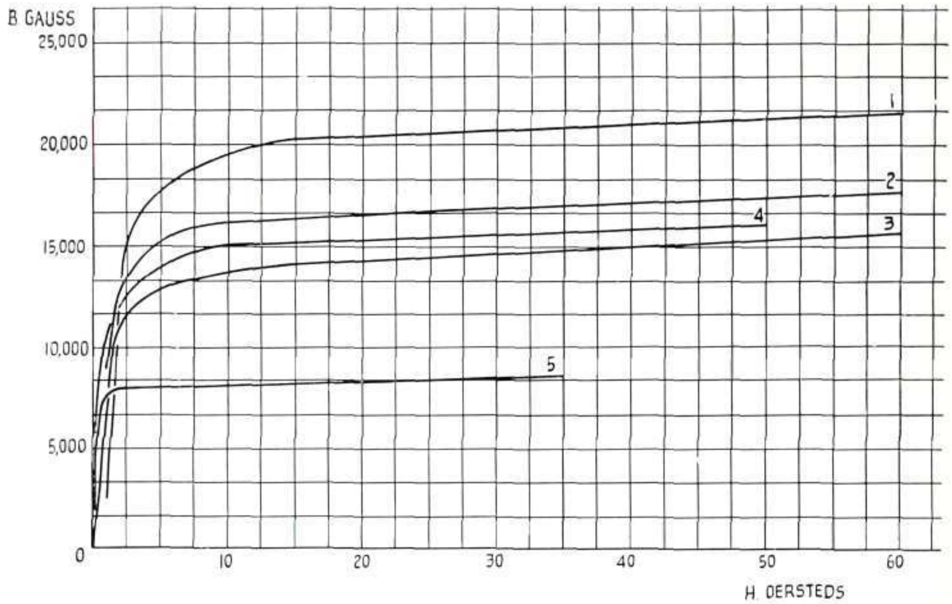


	Remanence (B).	B/H max (Gauss-Oersteds).	Coercivity (Hc).
1. Alcomax IV.	11,200	$4\cdot300 \times 10^6$	750
2. Hycomax.	8,530	$2\cdot749 \times 10^6$	790
3. Alnico.	8,200	$1\cdot740 \times 10^6$	507

B3—B4. Recoil loop and working point of light duty generator in Hycomax.
B1—B2. ,, ,, ,, ,, ,, heavy ,, ,, ,, ,,

Fig. 3—De-magnetization Curves for Various Alloys

of special metals this material was selected as being the most suitable.



		Saturation B. max.	Composition Iron.	Nickel.	Silicon.	Cobalt.	Copper.	Vanadium.	Molybdenum.
1.	Permendur ...	24,000	49%	—	—	49%	—	2%	—
2.	Elect. quality iron ...	18-19,500	99·6%	—	—	—	—	—	—
3.	Stalloy 92 ...	18,000	—	—	4%	—	—	—	—
4.	Radio metal ...	16,000	50%	50%	—	—	—	—	—
5.	Mumetal ...	8-9,000	13·8%	Rem.	—	—	5%	—	3·8%

Fig. 5—Magnetization Curves for Lamination Materials

One of the most important considerations in magneto generator design is the reduction of the peak torque at maximum load ; much work has been done on the subject over the last forty years with particular reference to the shape of the polepieces. In the new rotating magnet generator, the gradual reduction in flux required for low torque is attained by using a progressively increasing air gap with poletips extending well round the magnet to provide an alternative path for the flux. The poletips are made as thin as tooling permits in order to obtain the reduction in permeability which occurs towards the saturation point of the iron. Fig. 6 shows the polepiece and magnet arrangement and the flux paths for varying degrees of magnet rotation. Accuracy in the contours of the iron circuit has been ensured by manufacturing the polepiece from laminations, which are made from heavy gauge iron sheet to reduce the number required.

Fig. 4—Stator Assembly

Coil production is simplified by winding on a separate bobbin made from a phenolic resin plastic material. Terminations are made with flexible wires which are soldered directly on to the cut-out spring-set.

Mechanical Design

Little or no maintenance is expected to be necessary on the generators but the construction is so simple that dismantling and assembling present no problems.

Fig. 7 shows an exploded view of a generator. The magnet, which is fitted with brass bushes and pinion, rotates on a fixed stainless steel spindle ; this ensures adequate length of bearings with good alignment, irrespective of small discrepancies in the end cheeks.

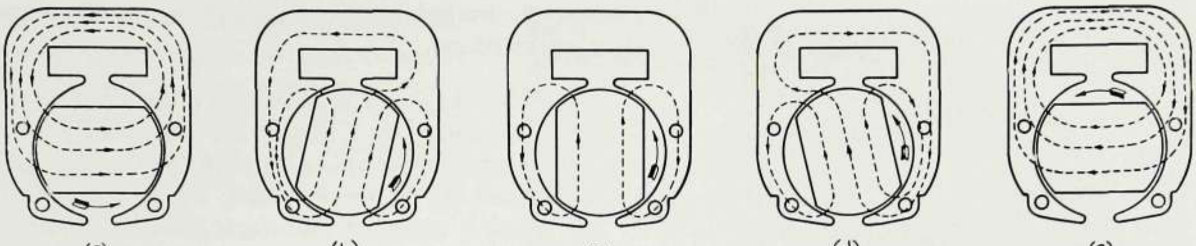


Fig. 6—Magnet and Polepiece arrangement showing variation of Flux with Rotation

A cavity in the centre of the magnet holds a substantial supply of lubricant which should last throughout the life of the generator. Absolute security of drive from the pinion is obtained by undercutting the teeth for approximately 1/32″ so that, as the pinion is pressed on, the teeth are located in grooves formed in the flange of the bush. The cut-out springset is mounted inside the end cheek of the stator assembly and is well protected by a clip-on cover. As shown in Fig. 8, contacts are readily accessible for cleaning when the cover is removed. A metal plate projects from the springset through the cheek and is operated by the axial movement of the gearwheel.

The gearwheel assembly is shown in more detail in the sectional drawing Fig. 9A. It comprises a central spindle and bush on which the gearwheel is retained by a star-shaped spring and circlip. Three conical indentations in the gearwheel and central bush locate hardened steel balls which form the drive between these two parts. Fig. 9B shows how the balls roll in the conical indents, forcing the gearwheel axially back against the spring and circlip, thereby permitting the cut-out springset to operate. The rolling action of the balls virtually eliminates wear, and the cut-out movement is obtained in the minimum space.

Gearwheel teeth are cut in accordance with B.S.S. 978 for clockwork gears ; this ensures a larger clearance between teeth than has been usual in the past. A further contribution to smooth action is the tip relief introduced on the pinion teeth.

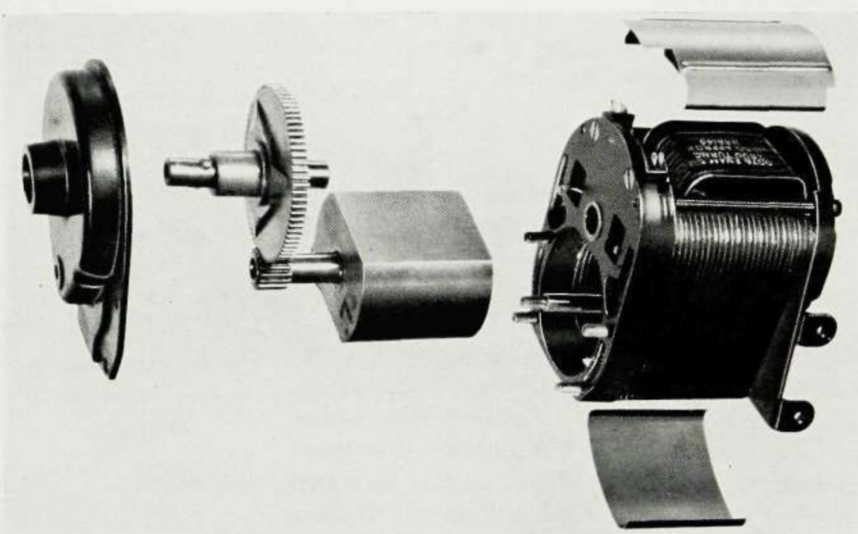


Fig. 7—Exploded View of Generator

Lubrication

To ensure long and trouble-free life for the generator and in an effort to eliminate maintenance, full consideration was given to all types of bearing materials and lubricants including, for example, the plastic polytetrafluorethylene for bearings and molybdenum disulphide for lubrication. However, there was no evidence that for this application they offered any appreciable advantage over the proven efficiency of manganese brass bearings lubricated with a mixture of colloidal graphite and oil. Capilliary action plays a large part in determining the amount of lubricant supplied to and retained in the bearings. Bearing clearance and lubrication channels are proportioned in accordance with the results of laboratory

Fig. 8—Showing Cut-out Springset

investigations ; Fig. 10 shows a typical curve for the vertical rise of a particular lubricating mixture between surfaces and in holes of various sizes.

Generators are mounted at all angles and conventional types of oil hole into the main bearings are not accessible in all circumstances. This led to the provision of an oil hole down the centre of the handle spindle with transverse holes supplying the bearings. In the rare cases when additional lubrication is required it is a simple matter to remove the handle and insert a few drops of lubricant.

Ancillary Equipment

The development of apparatus such as the generator often entails the provision of new equipment for test purposes. It is particularly important to make comparative measurements on the output and torque of various types of generator. The output can be accurately measured by using standard meters, but the measurement of torque is a more difficult problem. Fig. 11 shows a machine for obtaining torque figures of reasonable accuracy. The generator is mounted vertically on a pivoted platform coupled by a steel strip to a weighted arm which provides an increasing torsional resistance when the platform is rotated in a clockwise direction. This loading has been calibrated and is marked in gramme-centimetres on a disc below the platform.

When the generator is operated at the correct speed of 230 r.p.m. by a flexible drive from an electric motor, the torque causes the mounting to rotate until balanced by the weighted arm, and at this point a reading is made. A centrifugal governor similar to

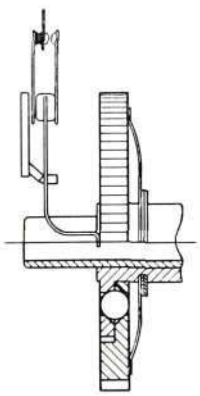


Fig. 9A—Cut-out at Rest

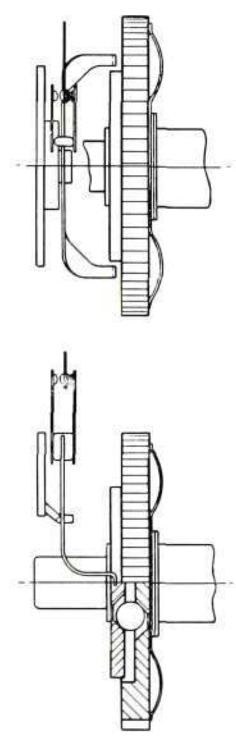


Fig. 9B—Cut-out Operated

that fitted in the automatic telephone dial is used to prevent the too rapid return of the mounting platform, which would otherwise occur on account of the cyclic variation in torque. Figs. 12A, 12B, show typical output and load curves, and Fig. 12C typical torque/load curves.

Life tests are an essential part of the development work on any mechanism required to give long service. They also provide a constant check on the quality of production. The value of life tests is only fully realized when the test conditions are closely related to the operating conditions. In the case of the generator, the requirements are a smooth acceleration to operational speed, a short run at constant speed and finally a complete release of the handle in order to allow the cut-out springs to return to normal.

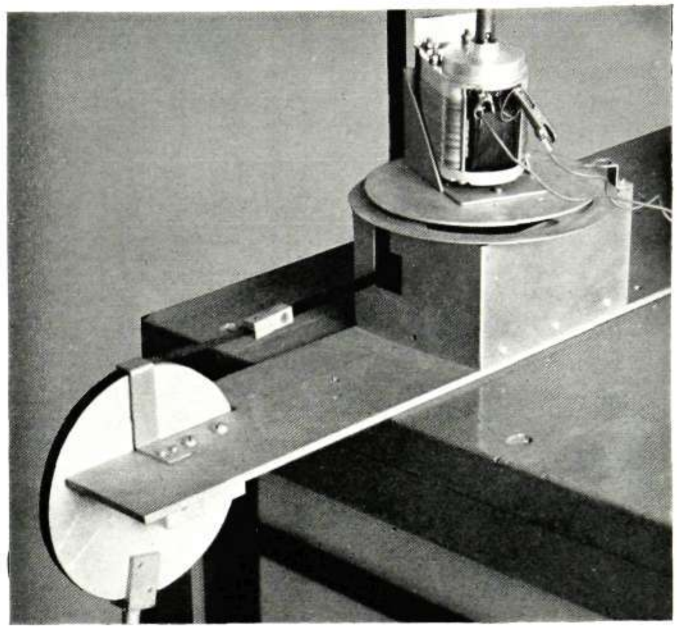
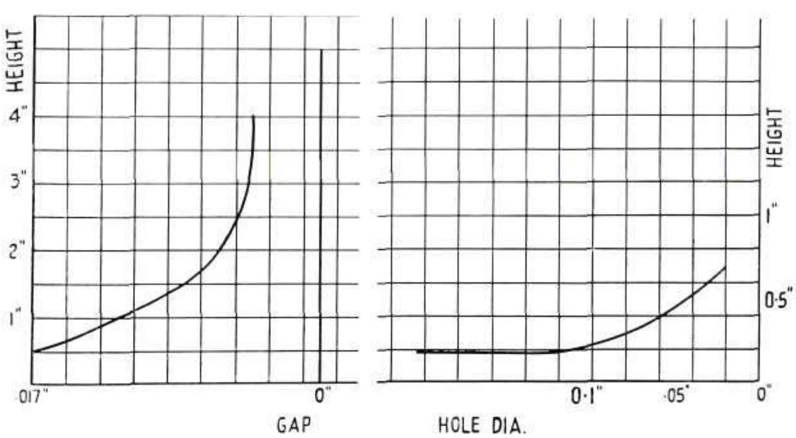


Fig. 11—Torque Tester

A life testing machine meeting all these conditions is shown in Fig. 13. There is accommodation for five generators and the operating cycle is five seconds running at normal speed on maximum load with a rest period of 10 seconds. A synchronous motor controls three cam-operated contacts through which current is supplied to a d.c. motor. This latter motor is coupled to a gearbox and drives the generators. One cam switches on a low starting current in order to simulate actual operating conditions and avoid excessive speed in starting, the second cam controls normal running time and speed and the third reverses the supply momentarily to disengage the drive and check the cut-out operation.

ELECTRICAL OUTPUT

The heavy duty and light duty generators have optimum outputs of 4.5 to 4.6 watts at 600Ω, and 3 watts at 1200Ω respectively. In order to obtain the full output of the generator, the impedance of the load must be equivalent to that of the generator. To facilitate this, the generators can be supplied with various coil windings usually specified by resistance, for example; 150Ω, 300Ω or 500Ω, the high resistance type being used for long lines with a small number of ringers and the low resistance ones for shorter lines with large numbers of ringers in parallel.



VARIABLE SPACE BETWEEN GLASS PLATES

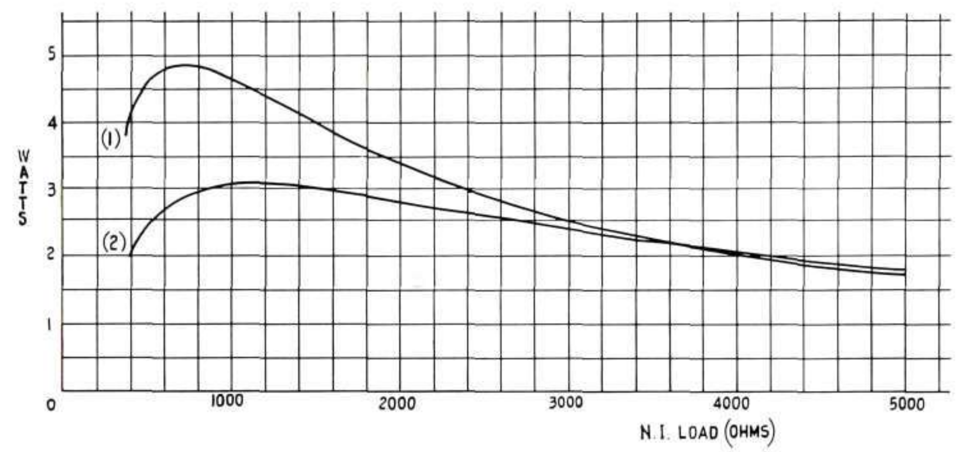
VARIABLE HOLE SIZES

Fig. 10—Variable Rise of Oil and Colloidal Graphite Mixture due to Capilliary Action

The output of the 150Ω heavy duty generator has been designed to meet the requirements of various administrations where high output is required with low operating torque on heavily loaded lines.

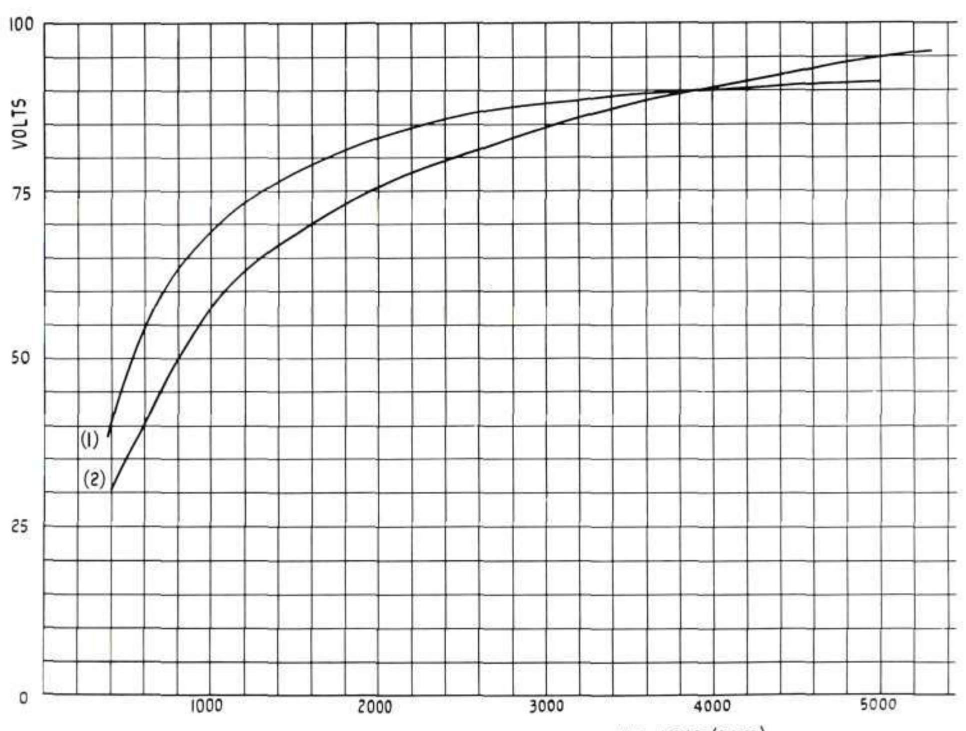
The 500Ω light duty generator meets the requirements of both the G.P.O. and War Office specifications for output, i.e. 2.9 watts average at 1200Ω, with 28 volts on 400Ω and 80 volts on open circuit, measured with a rectifier voltmeter.

The care taken in reaching the best compromise between all the factors affecting the design and manufacture of these generators has resulted in a very satisfactory product.



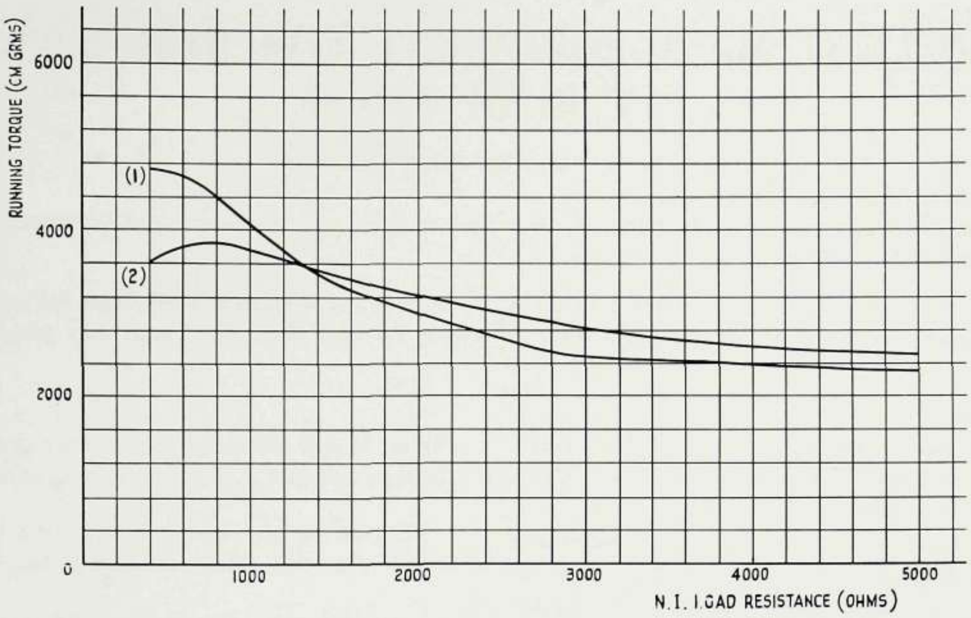
(1) Heavy duty generator. (2) Light duty generator

Fig. 12A—Typical Output (Watts) Load Curves



(1) Heavy duty generator. (2) Light duty generator

Fig. 12B—Typical Output (Volts)/Load Curves



(1) Heavy duty generator. (2) Light duty generator

Fig. 12C—Typical Torque/Load Curves

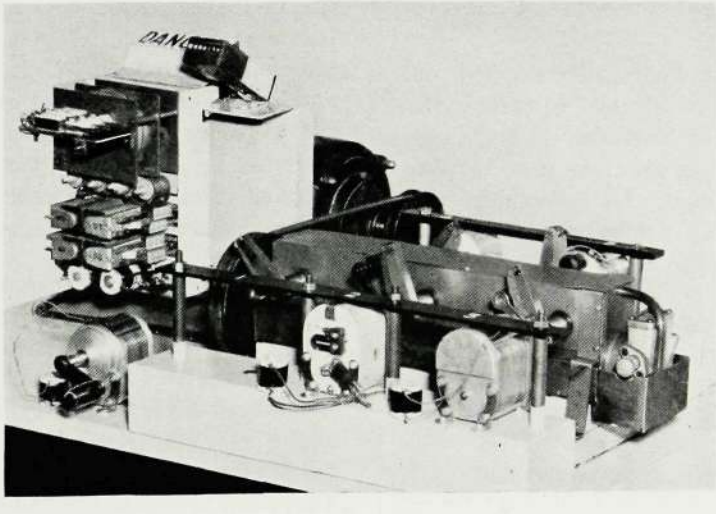


Fig. 13—Life Testing Machine

UDC.621.395.722.

P.A.B.X. No. 3 EQUIPMENT FOR THE B.B.C. AT BUSH HOUSE

S. DENTON, Publicity Department

It is questionable whether the activities of any organization are more dependent upon telecommunication than are those of the British Broadcasting Corporation.

The article describes in general terms a P.A.B.X. No.3 equipment installed in Bush House last year to replace a C.B. manual system and provide for extra lines. Details of our P.A.B.X. No. 3 units were given in Bulletin No. 31, July, 1955.

THE accommodation occupied by The British Broadcasting Corporation at Bush House, London, was extended in 1955 to cater for the future regrouping of their External Broadcasting Services. This created a need for more telephone lines. The capacity of the existing C.B. manual switchboard was insufficient for the requirements and in August 1955 we were invited to tender for the supply and installation of a 1000-line automatic exchange of the P.A.B.X. No. 3 type to replace the manual system. The necessity for early delivery was stressed.

We were able to meet this requirement (it is our policy to stock a range of standard equipments for such eventualities) and in November 1955 the contract was received. Power plant was to be supplied by the British Post Office, this being their prerogative for all P.A.B.X's within their jurisdiction.

The B.B.C. agreed that 1200 lines could be considered the maximum ultimate requirement ; an important point because the changes in specification which are stipulated for exchanges of more than 1200 lines would in this case have necessitated special engineering work and modification of the stock equipment which together could have caused delay.

A certain amount of engineering work had to be done. Firstly, machine ringing rather than the usual vibratory ringing supply was considered desirable for an exchange of this size, more especially as machine ringing may become the P.O. standard alternative for all sizes of P.A.B.X. No. 3. Secondly, terminating equipment was required for 40 tie lines to Broadcasting House and associated premises which, at present served by manual exchanges at Egton House and some of the other premises, may have its own P.A.B.X. No. 3 equipment in the future.

Ringing circuits complying with the known proposals of the Post Office were prepared and approved.

A complication with respect to the tie line terminating equipment was that manual inter-switchboard relay sets to P.O. Diagram SA.8162 would be required initially, but these might subsequently have to be replaced by larger auto. inter-switchboard relay sets to P.O. Diagram SA.8161, together with the associated incoming selectors. It was agreed in consultation with the B.B.C. engineers that we should provide accommodation and wiring on the relay set rack to permit easy replacement of the smaller relay set by the larger, and they would amend the current order to include the necessary incoming selectors, thereby facilitating the change-over.

Fig. 1 shows the exchange trunking. It provides for a four-digit numbering scheme employing second group selectors for extension to extension calls. First selector level 2 is allocated for extensions, levels 6 to 8 afford access for dialling out to other exchanges, level 9 is for calls to the public exchange, and level 0 for assistance calls to the P.A.B.X. switchboard. The B.B.C. consider the " Hold for Enquiry " and " Operator Recall " facilities to be of particular value to them.

The accommodation provided for the private telephone exchange equipment at Bush House is satisfactory in all respects as two rooms of adequate size were reserved for the automatic equipment and the manual switchboard respectively (Fig. 2). It made possible a clear layout of the racks in cabling

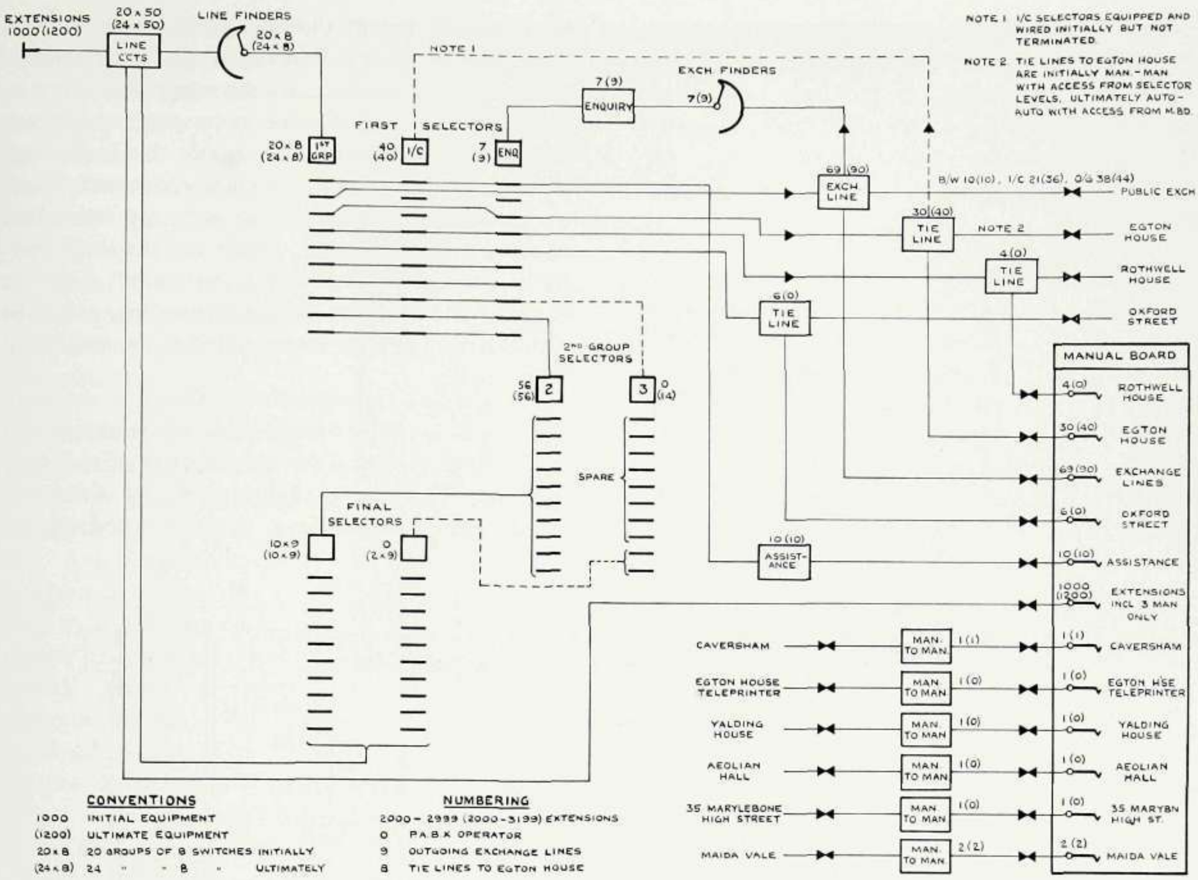


Fig. 1—The Exchange Trunking

sequence, and rendered angle sections unnecessary in the manual room.

Attention is drawn to the absence of a trunk distribution frame from the floor plan. Facilities for grading were provided instead at the rear of the group selector racks. The arrangement is exclusive to the Company's version of P.A.B.X. No. 3 and has the advantages that much less cable and less floor space are needed than would be required when using a separate T.D.F. The scheme imposes no limitations and is just as flexible as the more orthodox arrangement.

All the switching equipment racks are of standard size, i.e. 7 feet 9 inches high and 4 feet 6 inches wide. A departure from normal practice was made in using bus bars instead of cables for power distribution, whilst the rack lighting equipment which for P.A.B.X's is normally provided by the customer in accordance with Post Office requirements, was in this instance supplied as part of the exchange order.

For all our contracts for P.A.B.X. No. 3 equipment we now provide cables sheathed in cream p.v.c., the overhead ironwork also being coloured cream. By this means the appearance of the switchroom is much improved. The visitor seeing the switchroom at Bush House will at once notice its brightness.

The distribution frame is equipped with standard type fuse mountings and protector mountings, but a few of the verticals carry connection strips as shown in Fig. 3. Some explanation of the large cables seen above the connection strips is warranted. The Post Office had underground cables and internal distribution cables terminated at a frame in the basement of Bush House. It was necessary that the circuits be extended to the new frame. For this purpose the Post Office supplied and installed a 1400-pair, paper-cored lead cable which, at the joint seen in the illustration, was divided into quad cables to permit distribution to the fuses and connection strips. The individual conductors are enamelled and silk and wool covered.

In the foreground of Fig. 4 are three relay set racks, the centre one of which accommodates the Egton House manual inter-switchboard circuits which eventually may be replaced by auto circuits. It should be explained that both of the Post Office standard circuits concerned include a relay which performs the switching for ancillary calling lamps. The circuits current at the time provided for this particular relay to be external to the relay set, whereas it was known that by the time auto-to-auto working might be required, the Post Office will have standardized a circuit which includes the relay within the set. Accordingly it will become necessary to dispense with the external relays. To enable this to be done conveniently the wires to the relays concerned, which are mounted at the top of the rack, are segregated from the rack local cable. Later on, the shelf complete with relays and wiring can quite easily be removed and the new circuits connected, since the wires for the latter are incorporated in the rack form.

The ten-position manual switchboard is shown in Fig. 5. It might be thought that ten positions is a high rate of provision for an exchange of this type and size. In fact it is slightly in excess of the calculated traffic requirement, but with good reason.

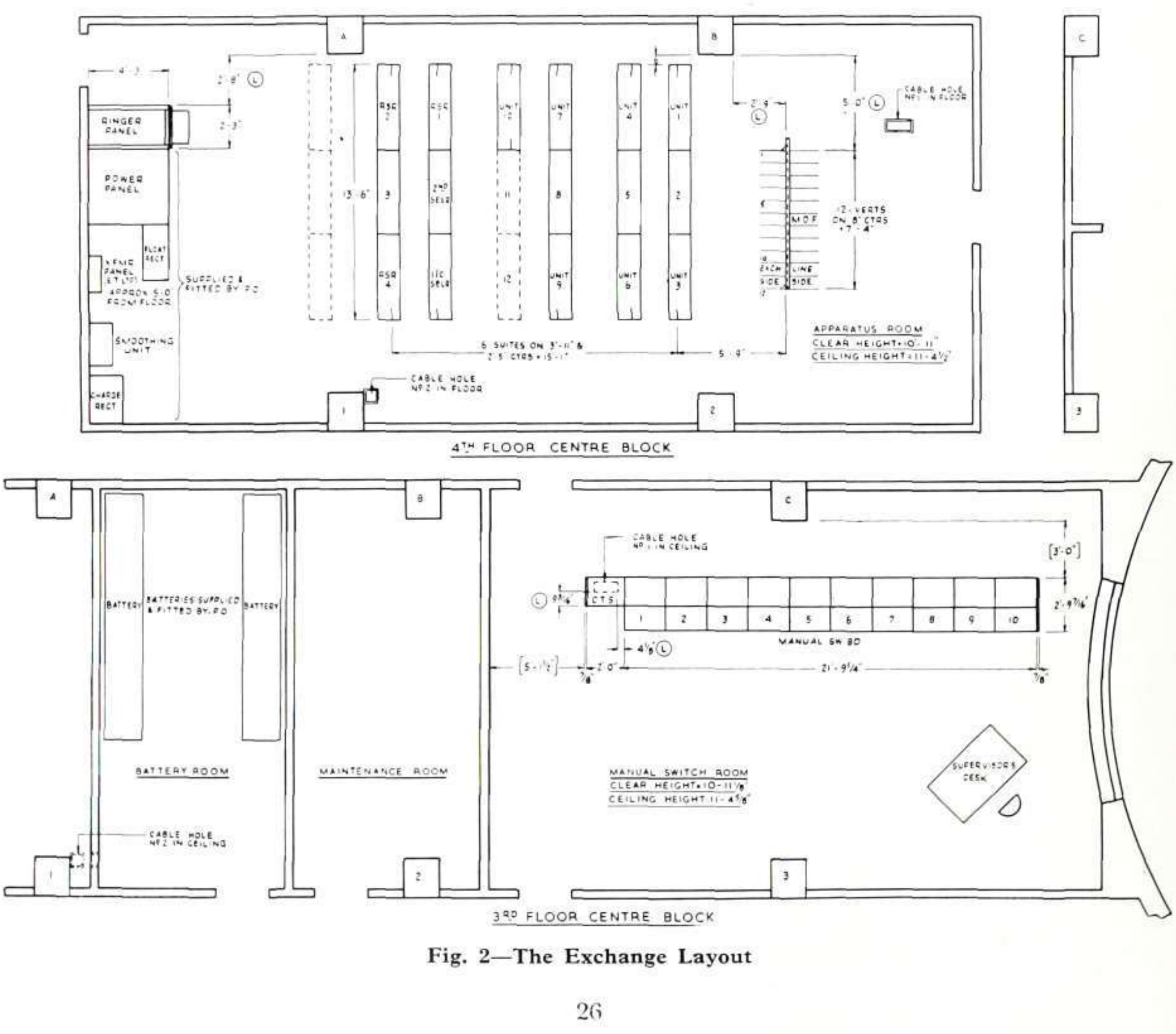


Fig. 2—The Exchange Layout

B.B.C. engineers have learned from past experience that there are conditions under which the volume of switchboard traffic can assume unusually heavy proportions and therefore the B.B.C. prefer to have a margin of safety in the number of operating positions.

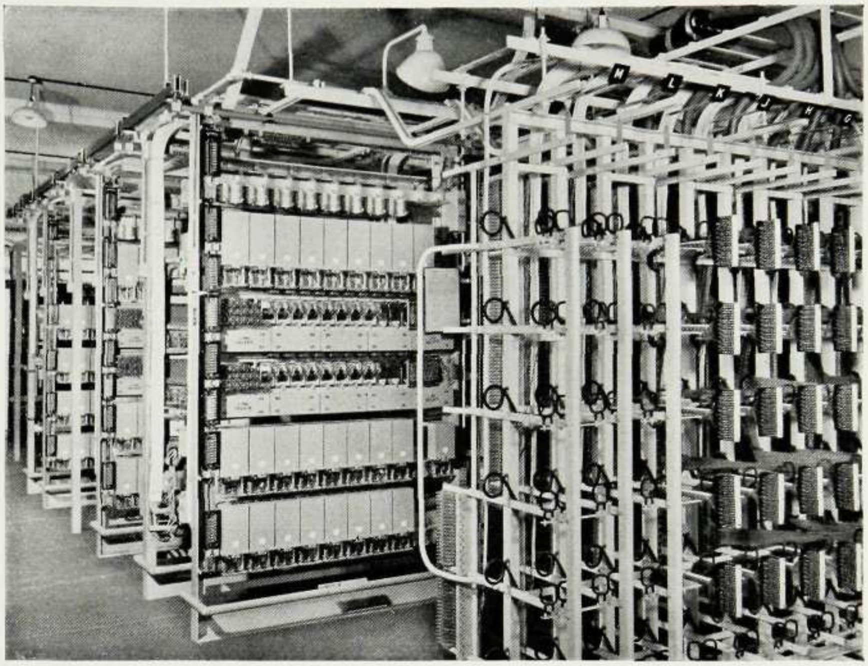


Fig. 3—Auto Units and part of the Distribution Frame

The switchboard construction conforms with the Post Office standards for P.A.B.X. No. 3 but distinction is given to its appearance by using light oak timber finished in the natural shade, green Warerite facings with black edges and fillets for the keyshelves, and green spacing strips in the panels. The operators' chairs also are green. Non-glare illumination of the board is obtained from diffused lighting units under the metal cowls seen in the illustration. These units were designed and supplied by the B.B.C.

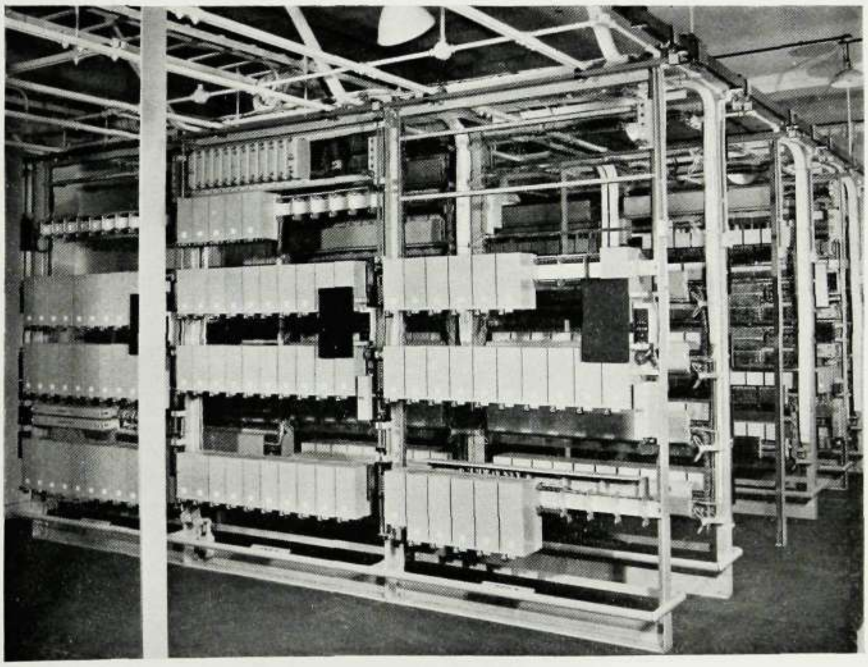


Fig. 4—General view with Relay Set Racks in the foreground

Each switchboard position has panel equipment for exchange line, inter-switchboard line and extension line circuits respectively, in ascending order, the jack multiple being repeated every four panels.

Installation posed no problem other than that of getting the equipment up to the third and fourth floors. The lifts are designed only for passengers, so every item had to be carried up the stairs, with no small exertion and at the expense of a few skinned knuckles. The final call-through test was completed on the 4th September, 1956, exactly ten months from the day that the order was placed. This was quite an achievement, bearing in mind the size of the exchange. The completion of the contract calls to mind another occasion when we had the privilege of assisting the work of the B.B.C. In 1931 we supplied a private automatic exchange and a special intercommunication telephone system for Broadcasting House, prior to the transfer of staff from Savoy Hill. Both systems are still operating satisfactorily and there is every reason to forecast an equally long and efficient service life for the new equipment at Bush House.

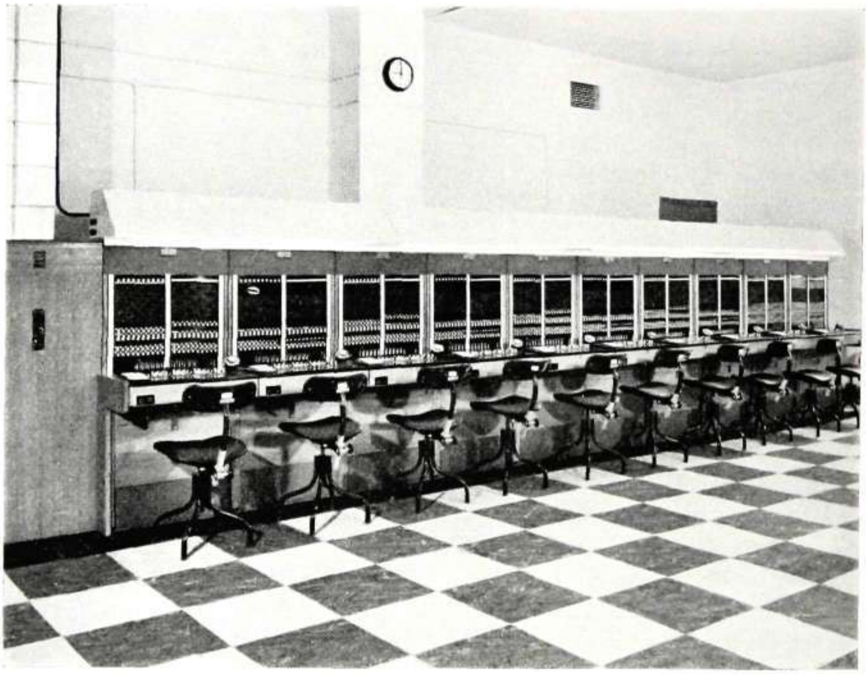


Fig. 5—The Manual Switchboard

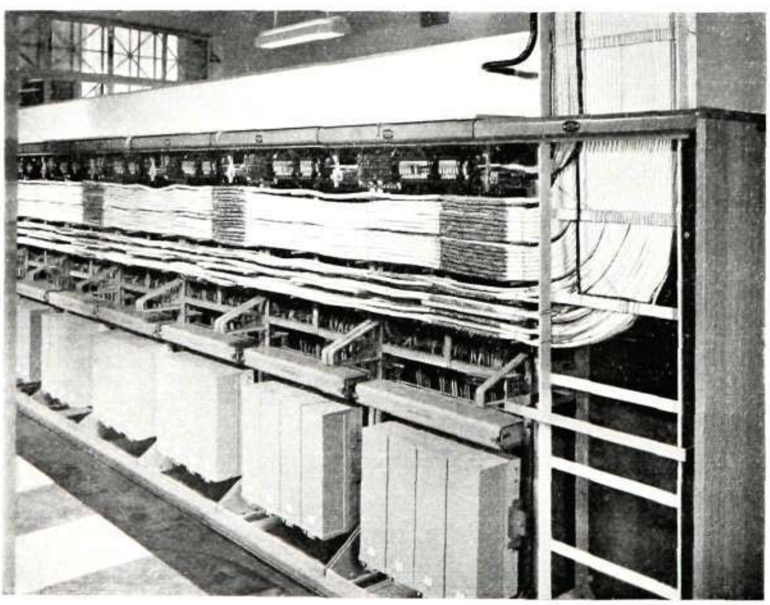


Fig. 6—Interior view of the Switchboard

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UDC.621.395.721.3/4.

MAGNETO TELEPHONES

GENERAL SERVICE TYPES N.2124 AND N.2206

G. R. GUNSON, Circuit Development Department

Magneto telephones can be operated under difficult conditions which make C.B. or automatic systems impracticable. The magneto instrument came into use at an early stage in the development of telephone communication, and many existing installations employ telephones which do not take advantage of the improved techniques and materials now available. The new N.2124 and N.2206 instruments are designed on modern principles to fulfill the requirements of magneto systems in an efficient manner.

THE magneto telephone is still the most reliable means of communication in many parts of the world where conditions are unsuitable for C.B. or automatic systems. Generally speaking, magneto working is indicated where no skilled maintenance is available, where lines are situated in difficult terrain and may be long or of poor quality from the transmission point of view, or where there is no power supply for charging central batteries. The advantages of the magneto telephone in such situations arise mainly from the fact that the functioning of the instrument is less dependent on line and exchange conditions than is the case with other systems. For instance, the microphone current is obtained from local dry cells instead of from a central battery, so that the sending level is always adequate regardless of the line length. Similarly, the inclusion of a hand generator in the instrument ensures that ample ringing current is available independently of external factors. The simplicity and robustness of magneto systems ease the maintenance problems caused by lack of skilled staff, and adverse climates.

Since magneto working lends itself to communication service under arduous conditions, it is natural that instruments should sometimes be required in teak or other hardwood cases built mainly for durability. However, the majority of new installations are in premises where such cases would be out of place and a modern design is needed. For this reason magneto telephones were made available some years ago in borrowed finery, as it were, by housing them in the moulded cases designed for automatic telephones. The new instruments, depicted in Figs. 1 and 2, have cases specially designed for magneto telephones, separate models being available for wall and table mounting. The cases are polished one-piece mouldings of modern form with the generator handle included as a pleasing part of the design. Their shapes, with the ribbed front, are interesting but simple enough to avoid the collection of dust. The handset is of the new curved type and its contours match those of the cases. Both wall and table models are made in black, ivory, jade green and chinese red.

To ensure satisfactory service in tropical atmospheres ranging from extremely humid to dry and dusty, the instruments are dust-screened and insect-proofed, and nylon covered cords, p.v.c. insulated wire and varnish impregnated coils are used. The table model has cup-shaped ventilation grilles fitted in the sides of the case ; these grilles also form convenient lifting holds.

The handset is fitted with an inset transmitter and the new rocking armature inset receiver, which is

Fig. 1—Magneto Telephone Type N.2124

Fig. 2—Magneto Telephone Type N.2206

substantially more sensitive than the type previously used. The cord conductors are taken through the bore of the handle and are attached to screw terminals. At the instrument end the cord passes through a protective grommet, which in the table model has separate entry holes for the handset and desk cords.

The internal apparatus, illustrated in Figs. 3 and 4, is mounted on a die-cast base. The induction coil is of the closed iron circuit type in which the core is made up of grain-oriented silicon iron laminations forming a complete loop round the windings. This coil is designed for use with the rocking armature

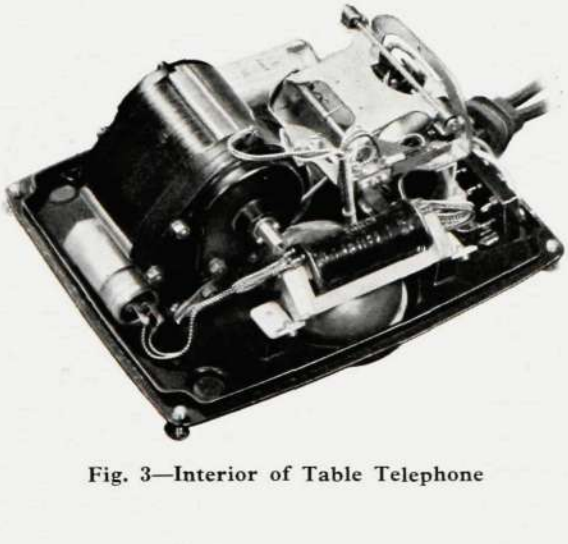

Fig. 3—Interior of Table Telephone

receiver in the handset, and is much more efficient than the older type of coil with open iron-wire core. A rotating magnet generator with laminated pole pieces is employed, this type of generator having a particularly smooth and easy action. A light-duty generator is normally fitted but a heavy-duty version is available to meet requirements for additional ringing power. A change-over contact operated by the rotation of the generator handle disconnects the bell during ringing out. When wired to the standard circuit, shown in Fig. 5, the instruments are not fitted with capacitors in the receiver or bell circuits ; however, on certain party or omnibus lines it is desirable to introduce a capacitor to guard against shunting

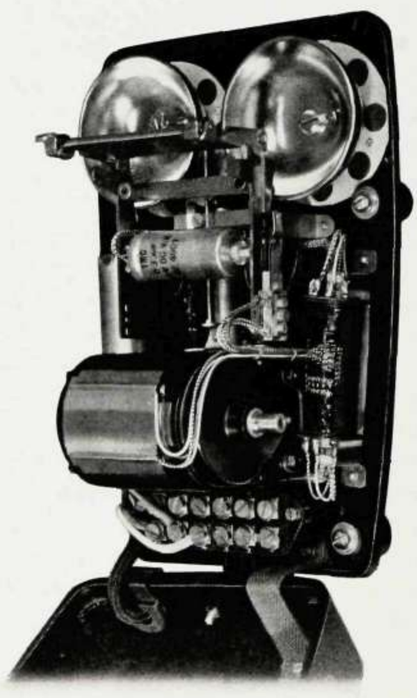

Fig. 4—Interior of Wall Telephone

effects caused by failure to restore handsets at the end of conversation. Also, some magneto systems have auto clear facilities which necessitate a capacitor in the bell circuit to break the d.c. loop during conversation. Alternative models are available, in both wall and table patterns, to meet these requirements, one with a 0.5 μF capacitor in the receiver circuit and another with a 2.0 μF capacitor in the bell circuit. The bell normally fitted is the B.P.O. No.

59A type with two 500-ohm coils, but higher resistance coils can be fitted if required. Cradleswitch operation is effected by removal of the handset from the rest, the contacts being actuated through a virtually frictionless and dust-proof mechanism of simple design.

The instruments are designed to permit plan number types to be provided in addition to direct exchange line telephones. Plan number instruments are fitted with buttons, key springsets, terminals and cords in accordance with the needs of each particular installation.

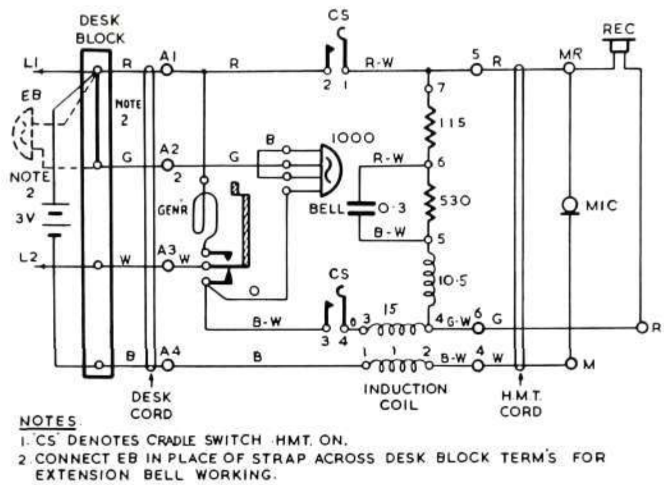

Fig. 5—Circuit of the Standard Instruments

Fig. 6 shows the induction coil circuit in schematic form. It will be seen to have the character of a bridge in which the line forms arm A. The line impedance is matched, under average conditions, by the network making up arm B, which contains resistive and capacitative elements. During reception the speech current passes from A through arm C of the bridge and the receiver R ; at the same time an antiphase current is induced in arm D. This current passes through arm B and aids the current in the receiver, as shown by the dotted arrows in the figure. During transmission, current is induced in coils C and D from the microphone winding 1-2. In this case the currents are in opposition in the receiver, thus producing an anti-sidetone effect, but are additive in the line, as shown by the solid arrows. Since the bridge is designed to operate over a wide range of line lengths, exact balance is not obtained and some sidetone is always present, but the level does not exceed the value usually considered desirable to denote a " live " telephone.

The transmission performance of the new instruments is significantly better than that of previous magneto local battery telephones. Tests made with the standard circuit, Fig. 5, gave results 1.5 dB better than SFERT for sending and 3.0 dB better than SFERT for reception. This represents an improvement over the N.2121 type telephone, formerly regarded as the standard table set, of 2.0 and 3.0 dB for sending and transmission respectively. Figures for the alternative instruments with capacitors would not be appreciably different. The bridging loss for the new type is 0.4 dB less than for the older instrument.

The improved performance and appearance of the N.2124 and N.2206 telephones, together with the choice of materials and techniques used in their manufacture make them suitable for use in modern installations where circumstances of the kind previously indicated demand the use of a magneto telephone system.

The new instruments available are as follows :—

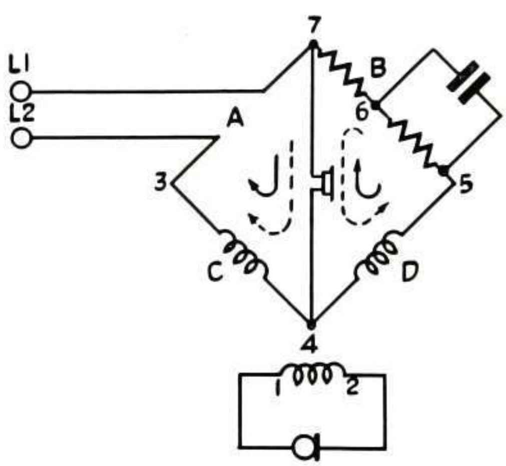

Fig. 6—Schematic of Induction Coil Circuit

Magneto telephones N.2124, table type, or N.2206, wall type :—

(*a*) With light duty generator, and without 0.5 or 2.0 μF capacitor.

(*b*) „ „ „ „ with 0.5 μF in receiver circuit.

(*c*) „ „ „ „ with 2.0 μF in bell circuit.

(*d*) With heavy duty generator without 0.5 μF or 2.0 μF.

(*e*) „ „ „ „ with 0.5 μF in receiver circuit.

(*f*) „ „ „ „ with 2.0 μF in bell circuit.

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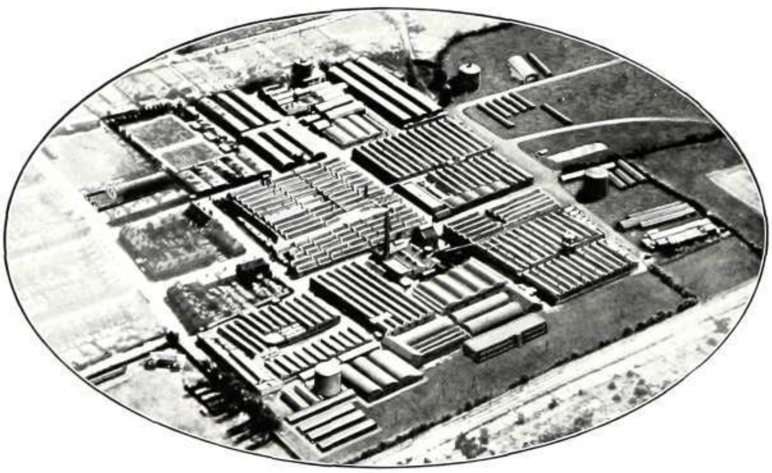
Part of the Model Room at the Beeston, Nottingham, Works



The Main Works at Beeston, Nottingham, England

Some of the Modern Plant used in Metal Finishing Processes at Beeston