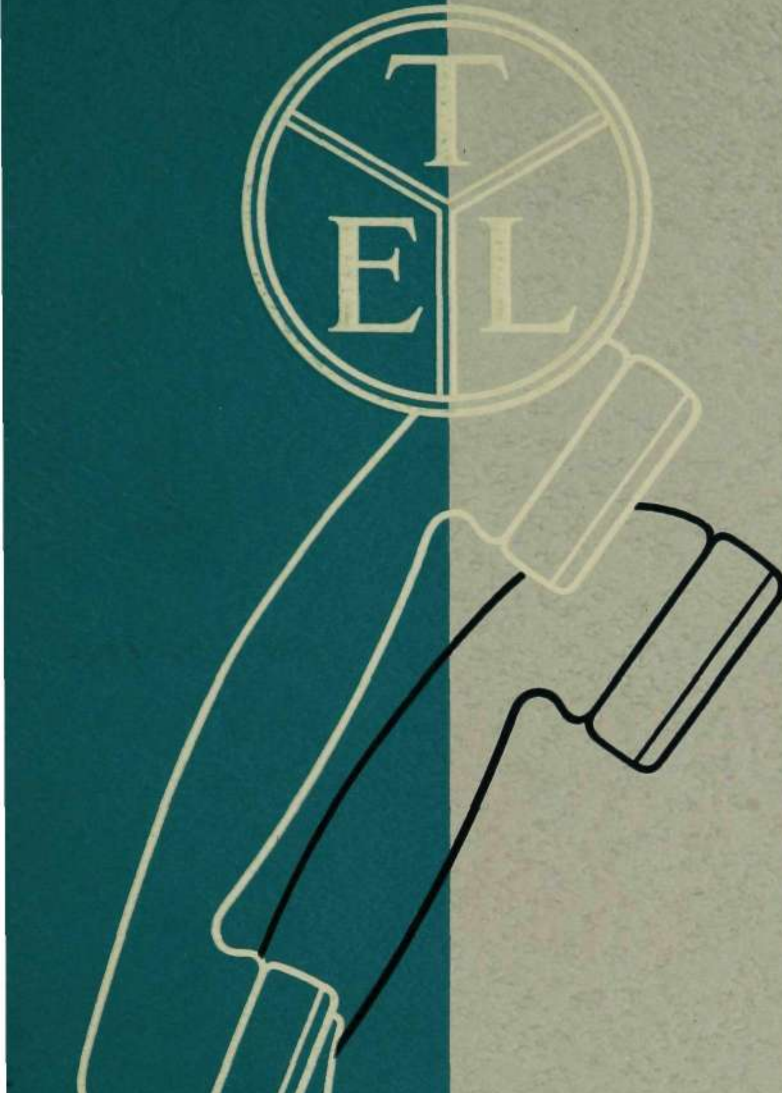
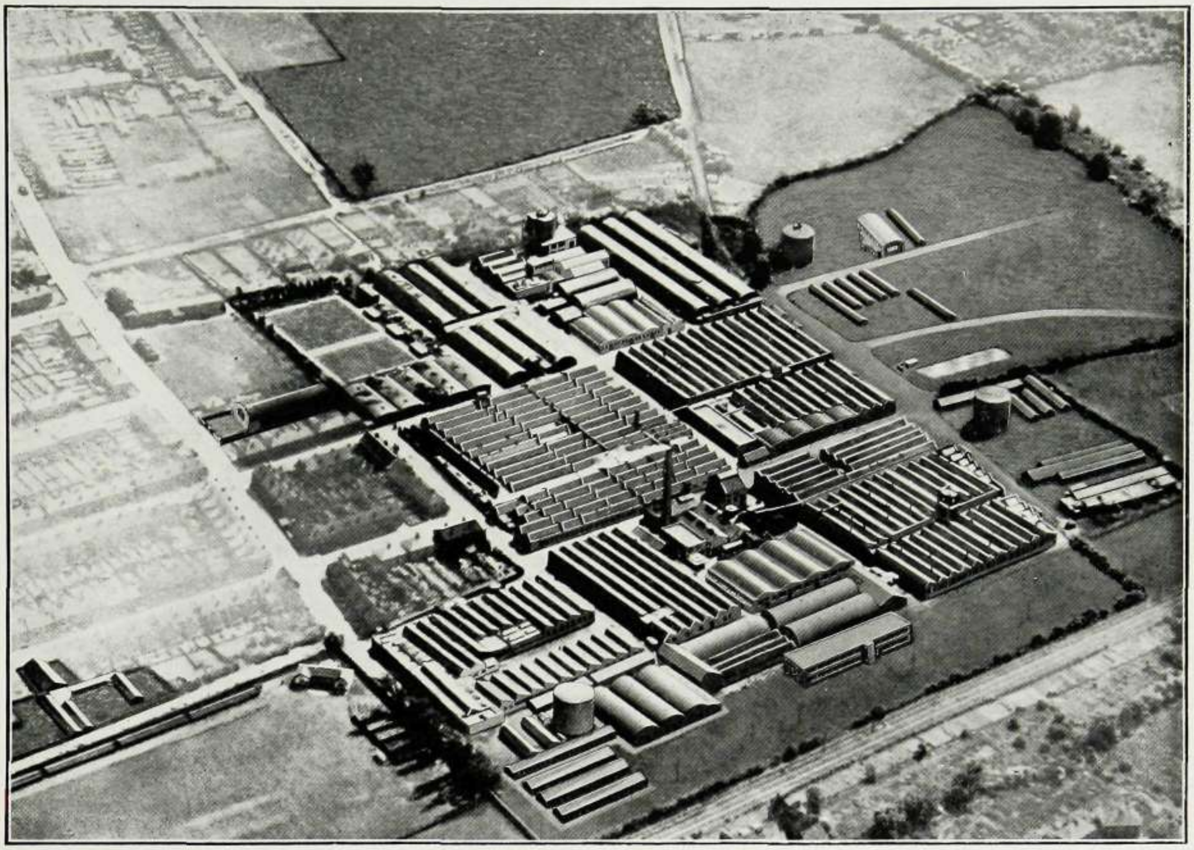


JANUARY 1955

BULLETIN



Aerial View of The Telephone Works, Beeston, Nottingham

THE ETELCO BULLETIN

No. 30
JANUARY, 1955

CONTENTS

Published by

Etelco LIMITED

TELEPHONE WORKS,
BEESTON, NOTTINGHAM
Telephones: Beeston 254831 (6 *Lines*)

Head Office:
22, Lincoln's Inn Fields, London, W.C. 2
Telephones: Holborn 6936 (5 *Lines*)

A SPEECH + DUPLEX VOICE FREQUENCY TELEGRAPH SYSTEM

TYPE FMT 11A

The equipment described enables a telephone channel to be used simultaneously for telephony and teleprinter service, by extracting part of the speech band of frequencies for the telegraph circuit.

The telegraph equipment employs a frequency-shift principle and can therefore be used on circuits which are too noisy for the more conventional tone-on tone-off type of equipment.

The unit is mounted on a chassis which fits into radio bays, or into a metal cabinet of overall dimensions 20″ wide x 15″ deep x 10″ high.

IN response to a number of requests for equipment which would enable a telephone channel to be used simultaneously for speech and one duplex telegraphy circuit, the Company has developed the Type FMT 11A Speech+Duplex System. Two versions of this system are available : one for two-wire, the other for four-wire working over physical, carrier-derived or radio circuits.

The duplex telegraph channel is frequency modulated and occupies the frequency band 1730 to 2120 cycles. These frequencies are eliminated from the telephone band without noticeable impairment of the quality of speech, for which voice frequency signalling at 500 cycles is provided.

The adoption of the principle of frequency modulation for this type of equipment has resulted in a performance which shows a marked improvement over that of both " on/off tone " and " two-tone " systems, and, more particularly in a reduction of pulse distortion, to which amplitude modulated systems are prone when the tone is suddenly suppressed. It has also provided a system that operates reliably in conditions where " noise " and " fading " may be experienced, that is, on radio circuits. Since the frequency modulation is (above a certain minimum) independent of level, there is no diminution of efficiency with sudden changes of level down to 25 decibels below normal, and " noise " of the order of 8 to 10 decibels above that on an equivalent amplitude modulated system can be tolerated.

Electronic circuits are employed in place of the more conventional polarized relays, in order to eliminate bias distortion due to the mechanical inertia inherent in such devices, and to obviate the necessity for the periodic adjustment of contacts, etc.

The complete system comprises two terminals each consisting of the equipment shown in the relevant block schematic diagram Fig. 1 or Fig. 2, the former illustrating the two-wire and the latter the four-wire system.

In the two-wire system, the voice frequency telegraph circuit includes actually two channels, the

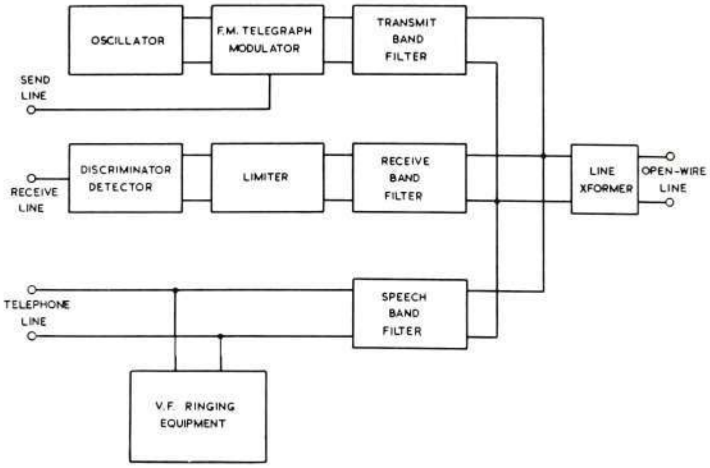


Fig. 1—Block Schematic of Terminal Unit. Two-Wire System

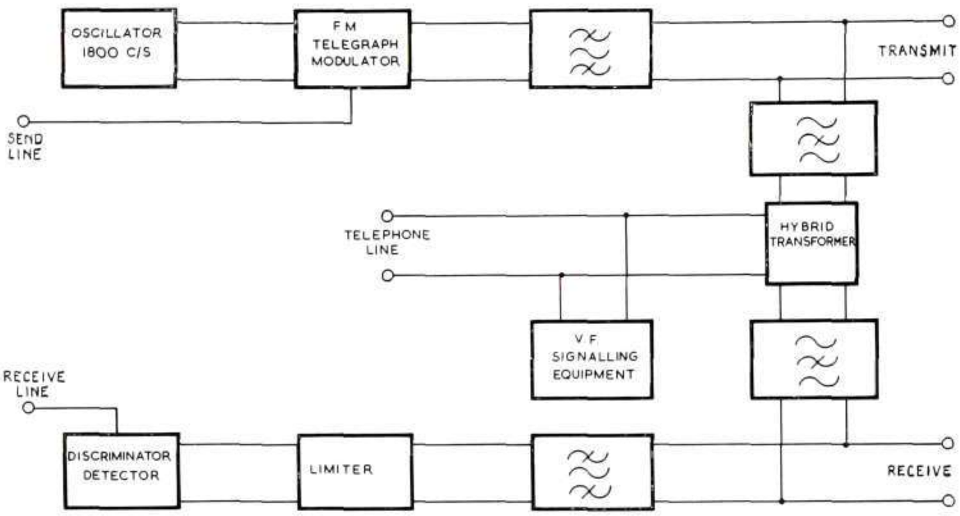


Fig. 2—Block Schematic of Terminal Unit. Four-wire System

" A " terminal transmitting the higher frequency and receiving the lower from the " B " terminal.

In the four-wire system the two terminals are identical, and only one voice frequency channel is used. The telephone circuit in both cases incorporates a telegraph band-stop filter.

THE TRANSMITTER (Fig. 3)

Before being applied to the modulator, the d.c. telegraph signals pass through a 50-cycle band filter which suppresses unwanted harmonics of the fundamental telegraph frequency. The modulator circuit consists of a valve oscillator which is tuned by the reactive elements, L1, C1, to the mid-band frequency of the channel over which it is to operate. Coupled to L1 are two circuits ; one contains capacity C, the other consists of inductance L, and either can be switched in parallel with the tuned circuit L1, C1, by means of the series rectifier bridges W1 and W2, so as to alter the frequency of the oscillator.

The two rectifier bridges are connected in opposition to each other : thus, a d.c. telegraph signal from the transmit line, of negative polarity with respect to Earth, will cause W1 to conduct and W2 to become high resistance ; consequently, inductance L will be introduced into circuit L1, C1, and the oscillator frequency will rise.

Conversely, a telegraph signal of opposite polarity will make W2 conductive and W1 high resistance, thereby causing the oscillator frequency to decrease because of the introduction of capacity C into the tuned circuit. The amount of frequency deviation is dependent upon the value of current flowing through the rectifier. Twenty milliamps will produce a deviation of 50 cycles.

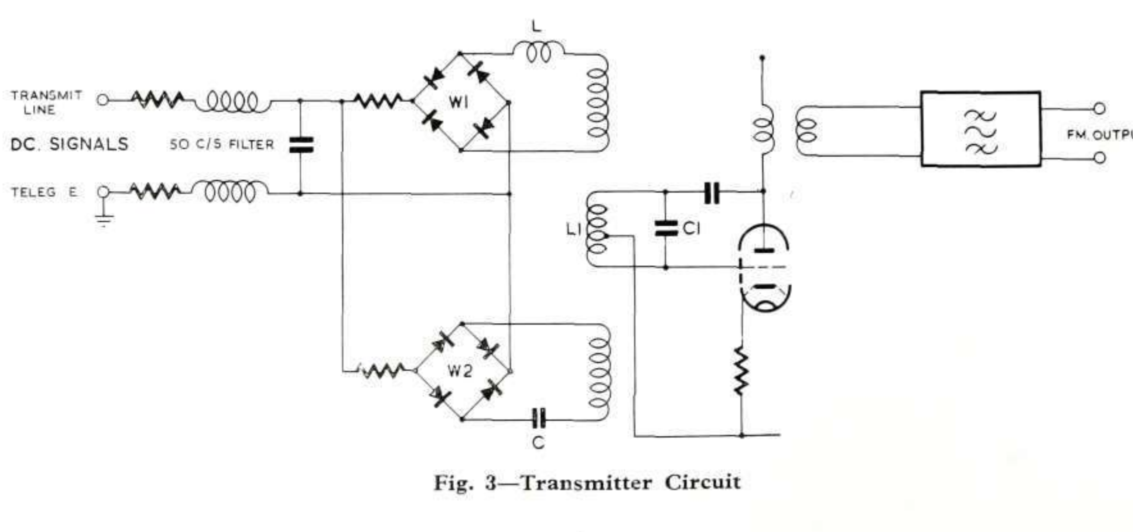


Fig. 3—Transmitter Circuit

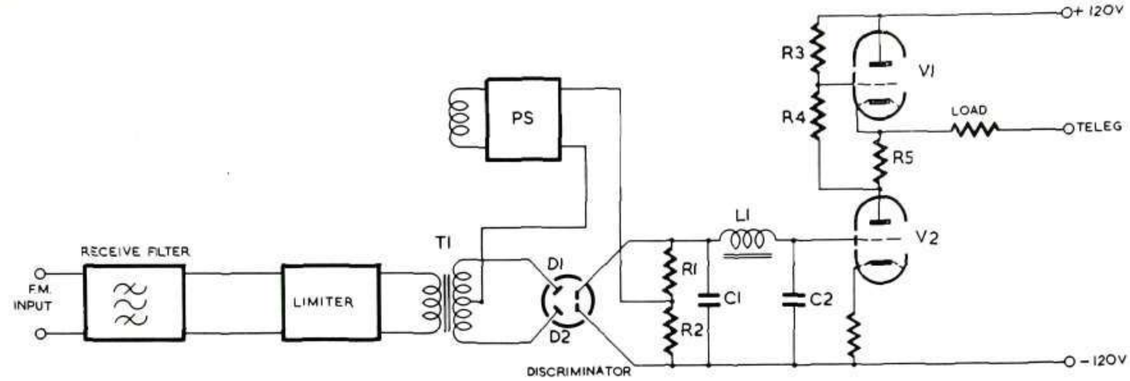


Fig. 4—Receiver Circuit

THE RECEIVER (FIG. 4)

Frequency-modulated signals enter the receive circuit via a receive band pass filter and pass to a limiter circuit. This is an arrangement of valve circuits which gives a constant voltage output over a range of input levels down to —30 decibels.

The output of the limiter is fed via transformer T1 to a detector circuit consisting of diodes D1 and D2 ; R1 and R2 are load resistors connected across the cathodes. From a third winding on the same transformer, a de-modulating voltage is fed via a phase-shift network PS, the output of which is connected between the centre-tap of T1 and the junction of R1, R2. When the frequencies being fed to the diodes and through PS are in phase (that is, the mid-band frequency), the rectified voltages developed across R1 and R2 will be equal and opposite. An increase or a decrease in frequency would initiate a phase shift through PS which would bias either D1 or D2, so that unequal voltages would be developed across R1 and R2 and a difference of potential would exist across the ends of these load resistors.

The phase network is so designed that an increase in frequency makes R1 positive with respect to R2, and a decrease reverses this polarity. This rectified voltage, suitably filtered via L1, C1, C2, is applied to the d.c. amplifier stage. This consists of two power valves connected in series, the h.t. supply to which is centre-tapped to telegraph Earth. The Load resistance shown represents the telegraph equipment receive coils.

When V2 has a negative potential applied to the grid and is thus cut off, V1 passes current via the load to Earth in a positive direction. When V2 grid becomes positive, current flows through the load in the opposite direction, since V1 is cut off by the negative bias developed across R5. These currents operate the receive telegraph mechanism.

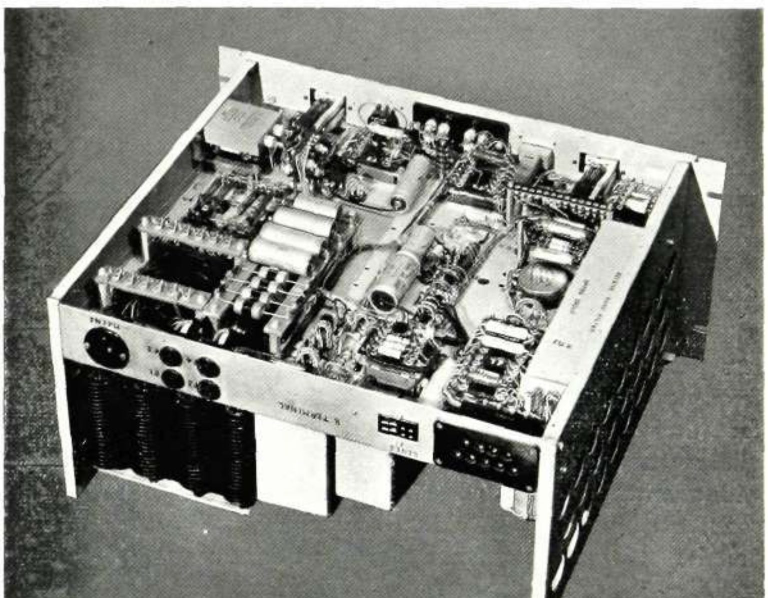


Fig. 5—Underside view showing wiring of Terminal Unit for Rack Mounting

Fig. 6—Terminal Unit enclosed in a Metal Cabinet

The power supply provides h.t. and 6·3 volts a.c. for all valve circuits, and ±120 volts for the telegraph transmitter. The 17 cycles ringing supply is also provided. One hundred and thirty watts are dissipated under full load conditions.

The mid-band frequencies of the voice frequency channels used are :—

" A " Terminal :—2040 cycles,
" B " Terminal :—1800 cycles,

the deviation per channel being ±50 cycles. The frequencies are derived from Hartley type valve oscillators having a frequency stability of ±3 cycles. The output level is also stabilized, to compensate for ±10% changes in power supply voltage and ±25% changes in output load impedance. The normal voice frequency transmit level is 0 dBm. Fig. 7 shows the attenuation-with-frequency graph of the three filters used in this equipment. All filter units and tuned circuits which could possibly be affected by humidity are mounted in hermetically sealed cans, and all components are designed for use in tropical climates.

TELEPHONE CIRCUIT SIGNALLING

An incoming 17-cycle signal from the switchboard operates a relay to switch on a 500-cycle oscillator and simultaneously connect its output to line via the telegraph band stop filter. Incoming 500-cycle signals from the distant terminal are detected, and operate a relay circuit which applies a 17-cycle ringing voltage to the switchboard line. The circuit arrangement of the detector ensures immunity from operation by speech currents.

Each terminal is a self-contained unit complete with power supply. It is accommodated on a chassis which is 14 inches deep and has a standard-type 19-inch front panel, $8\frac{3}{4}$ inches high. As all the wiring is beneath the chassis, access to the components is not impeded. The unit is suitable for rack mounting (Fig. 5) or can be fitted into a specially designed steel cabinet, shown in Fig. 6.

The front equipment permits direct access to test points on both the send and receive voice frequency circuits, and a monitor jack is provided for the telephone circuit. A centre-reading milliameter is also mounted on the panel, together with a switch by means of which the meter can be connected in series with either the ' transmit ' or ' receive ' telegraph circuit, to show the magnitude and direction of the current. A *Test Transmit* key applies either a ' mark ' or ' space ' signal as required to the transmit circuit for test or lining-up purposes.

The unit operates directly from 40-60 cycles a.c. mains, taps being provided on the mains transformer to permit the use of any standard supply from 100 to 250 volts.

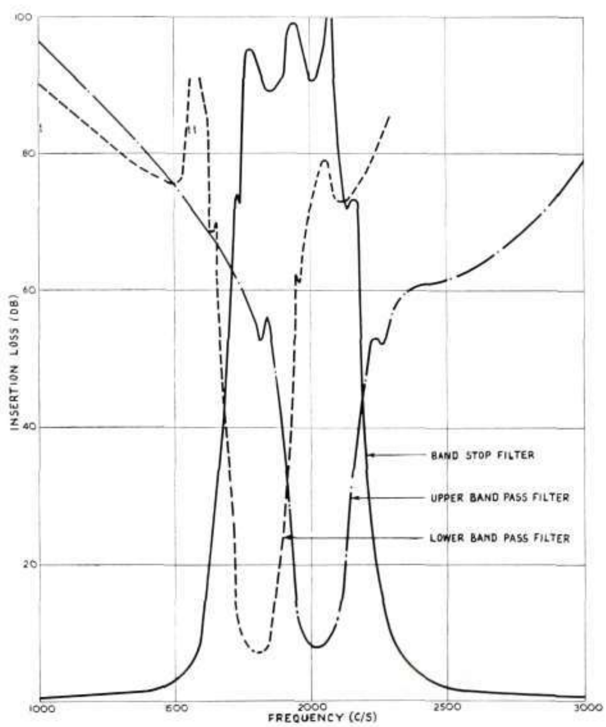


Fig. 7—Filter Characteristics

REMOTE OPERATING EQUIPMENT FOR A RIPPLE CONTROL SYSTEM

There is an increasing demand for the electrical control of industrial plant over conductors from a distant point, but the number of conductors available for this purpose is usually limited. This article describes a circuit which employs very little equipment, yet which can transmit a multiplicity of operational indications over one pair of wires. The basic principle employed precludes the possibility of false indications being transmitted. An application to the remote control of a system that injects signals of low frequency into an electrical mains distribution network to control consumer circuits is described.

WITH the increasing use of automatic switch-gear in many branches of engineering, centralized control and supervision at a point distant from the switch-gear is often demanded.

Each application of remote control produces its own problems, but all applications must meet two common requirements ; first, that a minimum of paths shall be used for the transmission of the interconnecting signals between the control point and the controlled points ; secondly, that the same positive control shall be given remotely as is exercised locally.

The first requirement is dictated by economic considerations, because transmission paths, whatever their form—direct wires, carrier or radio—are costly items, and the second requirement is absolutely essential if remote control is to be of practical value.

The smaller the number of paths, the greater the number of signals which must be sent over any one path and, therefore, the more complex the sending and receiving apparatus must become.

In theory, the falling cost of the paths, due to a reduction in their number, should be compared with the resultant rising cost of the apparatus, and the most economical balance obtained. In practice, however, the number of paths is generally fixed by one or more factors unrelated to remote control requirements and is invariably too low to permit the use of comparatively simple apparatus.

The commercial reaction to these pre-determined conditions is to produce a basic circuit element that can send and receive a large number of signals over one path, and to use ancillary circuits to adapt the element to any application.

The amount of apparatus involved is reduced as far as possible by skilful design, and positiveness of control is ensured by some ingenious feature embodied within the signal form or the circuitry.

The Company, in its work in the remote control field, has met the special requirements summarized above by devising the Position Indicator, covered by British Patent No. 698335.

Position Indicator

This consists of two almost identical circuits, a sender and a receiver, which react to each other over a connecting path.

Its object is so to position the wipers of a uniselector in the receiver circuit that, without any element of doubt, they stand on the same relative contact in the bank as that occupied by the wipers of another uniselector in the sender circuit.

The novel feature of the Position Indicator is that the inter-connecting signals are generated directly from, and received directly on, the banks of these uniselectors. Thus, as the ultimate criterion of the position occupied is the resting of the wiper on the contact desired, this feature ensures that its purpose has been achieved with complete certainty.

In its practical application, each contact of the sender uniselector may be said to represent a particular operational action and is marked, from an external source, when this action is to be carried out. The uniselector positions itself on the marked contact and then, from its banks, sets-up a coded signal which is indicative of the contact upon which it stands. This signal is sent to the receiver and applied directly to the banks of its uniselector to mark the contact indicated by the code. The uniselector drives to this contact and, when it stops, a coded " check-back " signal derived from its banks is returned to the sender. Here, this signal is compared, on the banks of the sender uniselector, with the signal originally sent. If the two are identical, but not otherwise, the sender transmits a final signal to the receiver, which reacts to control the operation of external equipment indicated by the controlling source at the transmitter. Thus, a positive remote control is achieved which is not endangered by circuit failure or by imperfect transmission.

With one path only, transmission of the signals must be as fast as possible ; otherwise control operations become protracted, and a sequence of them may take longer than is acceptable in many applications.

To achieve the necessary speed, the signals are transmitted in the binary code, which is a well-known device for indicating any number by using only two symbols. A coded number is shown by a series appearance of the two symbols, and is thus admirably suited to conversion to and from the code by relay operation.

The signals may be constituted from direct currents or from voice frequency currents, according to the nature of the path. Direct current is used in one direction for one symbol of the code and in the opposite direction for the other ; alternatively, each symbol may be represented by a different voice frequency.

The avoidance of earth return allows the Position Indicator to be used in areas where the presence of large earth currents from generating, traction or industrial plants might otherwise prevent its satisfactory operation. The current and voltage used over the signal paths are within the limits set by the British Post Office regulations governing the use of rented lines.

In their fundamental form, the sender and receiver each consist of two uniselectors and only six relays. With this small amount of equipment, a maximum of twelve two-state indications, that is, " on " or " off ", " start " or " stop ", etc., can be passed from transmitter to receiver.

Two Position Indicators working in opposite directions may be connected to one path so that twelve indications may be sent from both ends.

With ancillary circuits, the number of indications may be increased as required, and the circuitry may be elaborated to enable a multiplicity and variety of switching operations and meter readings at one end of a transmission path to be accurately reproduced at the other.

Application to Superimposed Ripple Control System

An unusual application was recently carried out, in collaboration with Messrs. Measurement Ltd. of London, in the Hazel Grove area of Manchester for the North Western Electricity Board.

Remote control of an " Actadis " installation was required. " Actadis " is, itself, a remote control system permitting an electricity undertaking to control consumer circuits over the supply network.

At a central transmitter, it injects into the network any chosen frequency, from a group of twelve, to operate ripple-responsive relays located at those points where switching is required. The twelve frequencies fall within the range : 370 cycles to 830 cycles, and are spaced at intervals of 30 to 60 cycles.

The relays may control any load or service but are primarily used to switch street lighting and off-peak loads. Control of the latter permits the load factor for the network to be maintained near an economical level.

The chosen frequency is injected into the high-tension side of the network, and the resultant ripple passes in the same way as the 50-cycle power supply through the sub-station transformers to the low-tension feeders, to appear as an appreciable voltage at all points simultaneously with the 50-cycle supply.

Actadis Central Transmitter

Fig. 1 illustrates the main circuit arrangements at Hazel Grove, where five h.t. feeders are connected to the 6,600-volt bus-bars.

The ripple frequency current is produced by a 3-phase alternator directly coupled to a variable d.c. motor which receives its current from a d.c. generator driven by a synchronous motor. The ripple output is 30 kvA at an emission voltage of up to 550 volts,

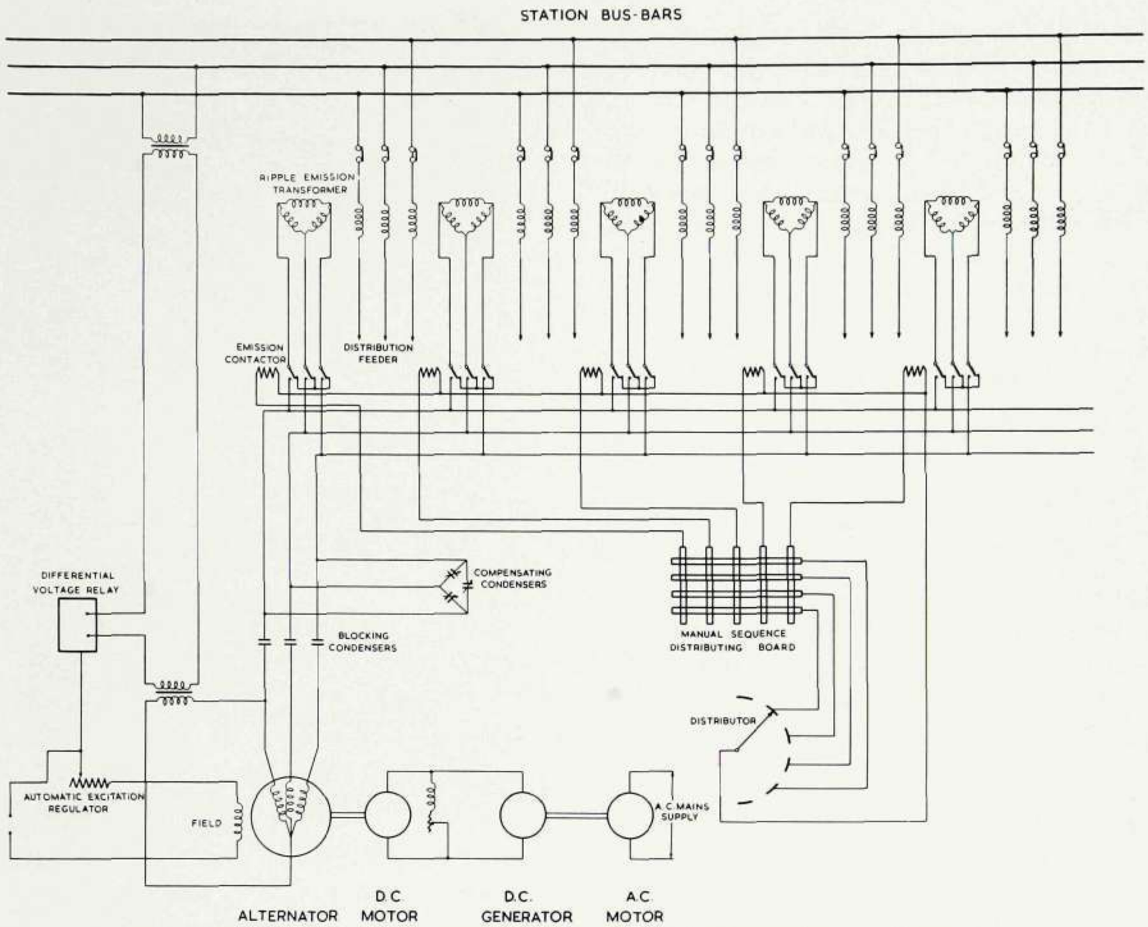


Fig. 1—Main Circuit arrangements of "Actadis" Transmitter at Hazel Grove

the frequency being determined by the speed at which the alternator is driven by the d.c. motor.

The ripple is injected through transformers, the secondary windings of which are permanently connected in series with the feeders, their primary windings being delta-connected. The primary winding of each transformer is energized through a contactor during emission, but is normally short-circuited to reduce insertion loss in the 50-cycle supply.

To avoid damage to the Actadis equipment should a short-circuit occur on a feeder during an emission, the transformers are so designed that the iron circuit reaches saturation before the primary current becomes dangerous. This necessitates an air-gap in the iron circuit, and, consequently, a large magnetizing current. To relieve the alternator of this load, delta-connected compensating condensers are used ; their capacity being adjusted to each ripple frequency. Between these condensers and the alternator are connected blocking condensers to prevent any transformation of the 50-cycle supply appearing in the alterator windings.

The emission contactors are closed sequentially by a rotary distributor ; this permits the use of a smaller ripple alternator than would be necessary if all feeders were injected simultaneously.

At a manual control board the control leads of the distributor can be connected as desired to the contactors so that the feeders may be injected in any sequence, or any feeder may be omitted from the emission cycle. Each feeder is given a ripple injection for 21 seconds. The total time required for the full emission operation over the five feeders is approximately three minutes.

To ensure that the ripple-responsive relays receive a constant operating voltage, in spite of network load changes during emission, a special differential relay is connected across the bus-bars and across the alternator output. It measures and compares the ripple voltage appearing at these two points. The impedance across the bus-bars is known, and the voltage measured at this point is indicative of the feeder losses at any alternator loading. The relay adjusts the ripple output accordingly by means of a servo-motor-driven rheostat connected in series with the alternator excitation field.

The alternator is brought to, and held at, the desired frequency by a tuned relay which controls the excitation regulator of the d.c. motor.

Load Switching Relays

The responsive relays are, in effect, motor-operated switches and will respond satisfactorily to a ripple voltage which produces a modulation above 3% of the 50-cycle supply. The relay mechanism consists of a tuned magnetic circuit with two reed-type armatures, each resonating mechanically at a different ripple frequency. Attached to each reed is a flexible steel pawl, with its end resting on the milled edge of a fibre wheel. As the reed vibrates, the wheel is rotated by the pawl—in one direction by one reed and in the reverse direction by the other. When the wheel attains a certain speed, a centrifugal clutch comes into action and engages a train of reduction gearing, which moves a mercury tube contact from one tilted position to the opposite position. When the mercury tube reaches the limit of its travel in either direction, a cam disengages the actuating pawl from the wheel and allows the other pawl to engage in readiness for the reverse drive. The clutch ensures that the relay is not operated by transient voltage fluctuations, but only when the wheel is rotated at a constant speed, synchronous with the ripple frequency, for a definite period.

Local Control

Fig. 2 shows the control cabinet of the Actadis transmitter behind which is a large cubicle containing the switch-gear. Fig. 3 shows a typical panel in the cubicle, and Fig. 4 the emission transformers with the associated contactors above.

External to the main equipment is a case, Fig. 5, enclosing three mechanical time switches. These automatically bring the Actadis transmitter into action to inject one of three street lighting control frequencies at the appropriate times. In the centre of the case is a lock switch operated by a large key. This key is the sole means of controlling the Actadis equipment manually. It can only be removed from the lock when turned to the *OFF* position. To make an emission, the key is removed from the time switch case, the switches being thus rendered ineffective.

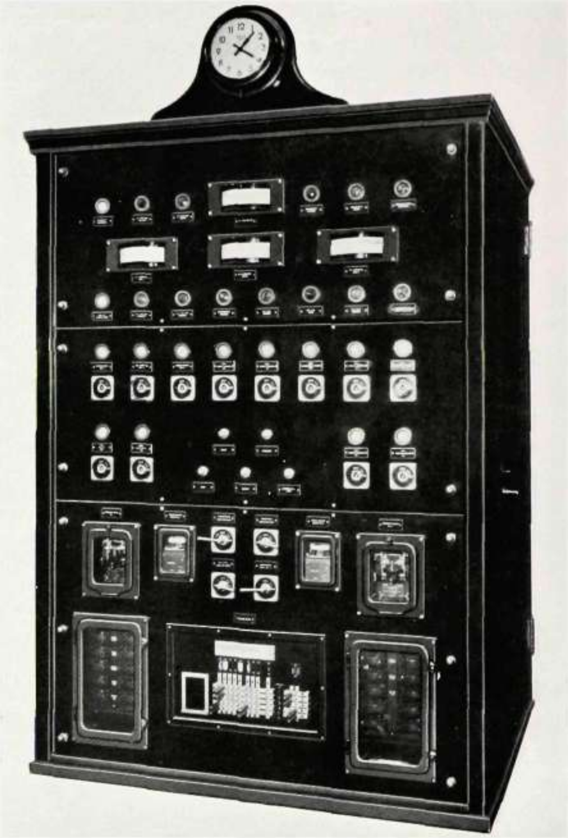


Fig. 2—Control Cabinet of the "Actadis" Transmitter

In the centre of the control cabinet, Fig. 2, are twelve similar lock switches, one for each emission frequency ; the desired frequency is chosen by placing the key in the selected lock and turning it to the *ON* position. The use of a single key eliminates any possibility of more than one frequency being selected by misoperation.

Each frequency switch represents the *ON* or *OFF* condition of one type of consumer circuit, the switches being paired so that any type of load may be connected to, or disconnected from, the network.

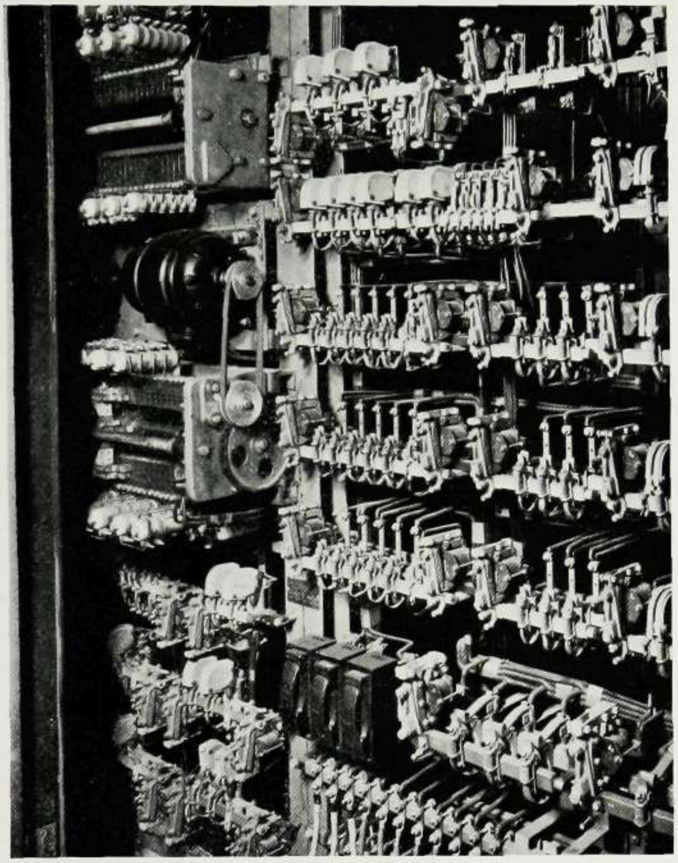


Fig. 3—Some of the Switchgear inside the Cabinet shown in Fig. 2

In the centre of the cabinet are five push-button control switches, one of which, the *Start*, is operated momentarily to start the a.c./d.c. machine set, after which the d.c. motor driving the alternator is automatically started.

The ripple frequency control relay brings the alternator to the required speed for the chosen frequency and indicates on two lamps whether, at any moment, it is raising or lowering the speed. When the required speed is reached, the two lamps flash alternately as the control relay hunts to maintain the speed within the limits of its sensitivity.

At this point, the *Emission* button is operated momentarily and the distributor begins to rotate to make the emission on the network.

Inside the switch-gear cubicle, but connected to the feeders, are relays functionally identical with the network switching relays. One relay is associated with each pair of frequency switches and is tuned to the same two frequencies. A lamp above each switch is lit by the relay when the latter has been operated by the frequency concerned. Each lamp, therefore, indicates that the ripple has appeared on the feeders ; in conjunction, the lamps give a display of the loading of the network.

At the end of its run, the distributor automatically shuts down both the transmitter and the machine sets.

For various reasons, it is not advisable to restart the machine sets for some minutes after they have been shut down ; should it therefore be necessary to inject sequentially a number of frequencies, the *Repeat Emission* button is operated and the machine sets are kept running until shut down by the *Stop* button.

Should a fault occur during an emission, an alarm bell is actuated. It may be silenced by pressing the last of the five buttons. The *Stop* button can be used as an emergency shut-down control.

REMOTE CONTROL

The Actadis equipment was installed by Measurement Ltd. some years ago, and the transmitter was housed on the site of what has now become a sub-area administrative building. Recently, a transformer station was erected about half a mile from this building, and the transmitter was transferred to the new station. A remote control system was supplied by the Company so that the Actadis transmitter could be controlled from its original site.

Two pairs of conductors in a pilot cable were allocated to the signals, and a number of modifications were made to the transmitter switchgear to enable our equipment to effect control and checking operations.

The two pilot pairs are used as shown in Fig. 6. All control operations from the remote control board are passed to the Actadis equipment over pair 1, and all supervisory indications from the latter to the former over pair 2. Sender A and receiver A deal with operations of secondary importance, such as frequency selection, while sender B and receiver B

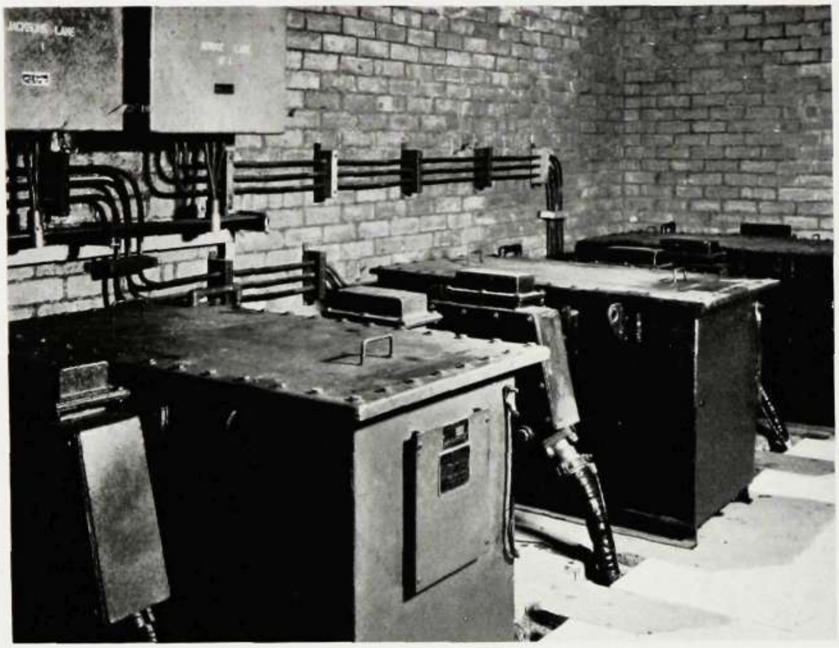


Fig. 4—" Actadis " Emission Transformers with Contactors above

are used for the more important operations initiated by the push buttons. By this segregation, the B circuits are concerned with only a few operations ; thus, the amount of information contained in their signals is small and can be conveyed by a code of short length. This permits the high speed of transmission so essential to these operations, especially to the *Stop* signal, which is given priority over all others and will break down any other transmission that may be occupying the line.

Fig. 7 shows our wall-mounted control panel, upon which are the essential equivalents of the Actadis controlling and indicating devices, together with certain additions peculiar to the remote control.

The apparatus rack associated with the control panel is shown in Fig. 8, and the Actadis transmitter control rack, situated in the transformer-station, in Fig. 9.

At the bottom of the control panel are the five primary control push buttons. Above these are the twelve frequency keys and their load-indicating lamps, the keys being electrically inter-locked so that it is impossible to select more than one frequency. Immediately above each key is a small white lamp concerned with the remote operation of the Actadis frequency selection switch-gear. It glows when the switch-gear has responded correctly to the operation of its associated frequency key.

Above the load lamps are six supervisory lamps. Of these (viewed from left to right) the first lamp glows to indicate the completion of the switching operations which start both machine sets. The second glows as long as the output frequency of the alternator is too high, and the third when it is too low. When the frequency is correct, these lamps flash alternately, as on the Actadis equipment. Should the *Repeat Emission* button be

Fig. 5—" Actadis " Mechanical Time Switch Cabinet

operated, the fourth lamp will glow to indicate that the machine sets are switched to run continuously, that the shut down is not automatic and that the *Stop* button must be used. The fifth lamp glows as the distributor moves over the feeders. The last lamp indicates when the machine sets are shut down, and continues to glow until they are re-started.

The top row of lamps has no counterpart on the Actadis equipment. The *Local Failure* lamp, on the left, indicates any fault or power failure at the control panel end. An audible alarm is also given, and this can be silenced by means of the key above the centre push button at the bottom of the panel. When the failure is rectified, a signal is sent to the Actadis equipment to cause all indications at that end to be re-transmitted, so that the control panel is set-up

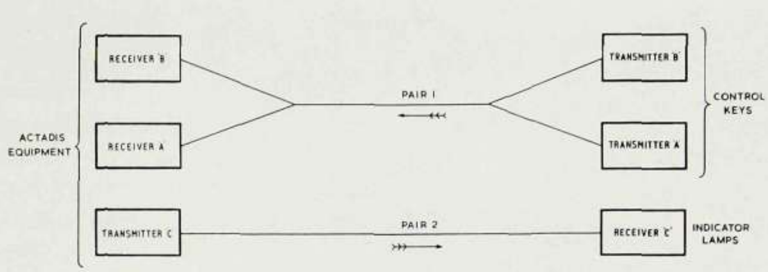


Fig. 6

again with the correct information. The right-hand lamp, *Remote Failure*, glows, and an audible alarm is given, when any fault or power failure occurs at the Actadis end, and when there is a fault in the pilot cable.

The centre lamp warns the attendants when operation of the control panel is affected by conditions at the Actadis. The lamp flashes when the Actadis transmitter is being controlled, either manually or by the time switches, at the transformer station. It also flashes during the rest period of about four minutes that follows a shut-down signal. This rest period is timed by the relay equipment at the Actadis end. The remote control panel is rendered ineffective while the lamp is flashing ; this ensures that remote control cannot interfere with local control and that the machine sets cannot be started during their rest period. However, all Actadis operations and load changes made locally are shown on the remote panel.

When the time switches operate, they apply the automatic start conditions to the Actadis equipment for a limited period only. During remote control operations, the time switches are made ineffective ; thus, should they operate, the street lighting control would be lost. To avoid this, the time switch frequency is registered by our equipment and transmitted after the rest period that follows the remote control. To prevent a street lighting switching operation being unduly delayed, the warning lamp flashes continuously from the moment the time switch is actuated, to warn the attendant to terminate his control as soon as possible.

Should it be necessary to over-ride a time switch operation for any reason, such as maintenance of street lighting during fog, a frequency key is operated just before the switch is expected to come into action. This deprives the time switch

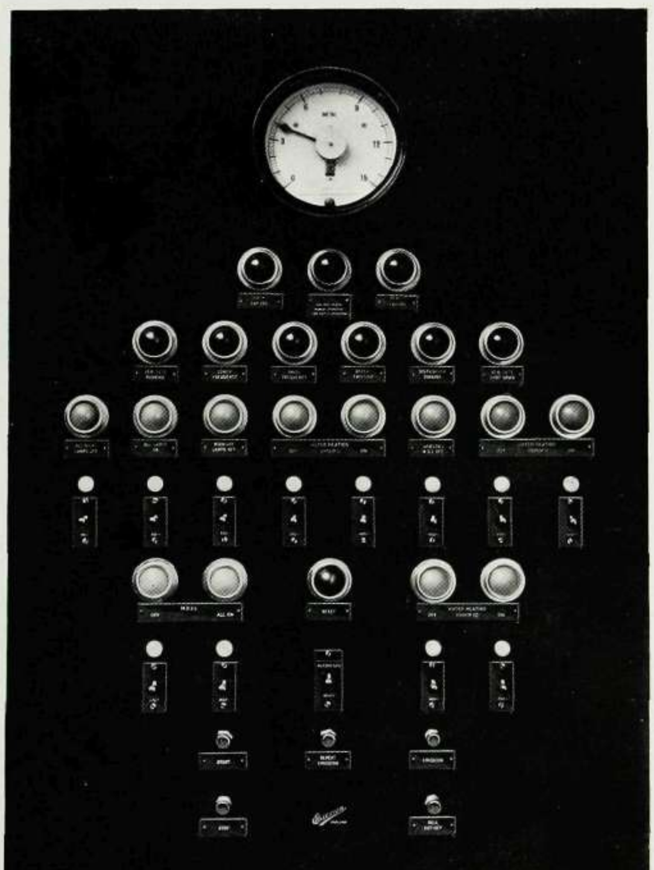


Fig. 7—The Remote Control Panel

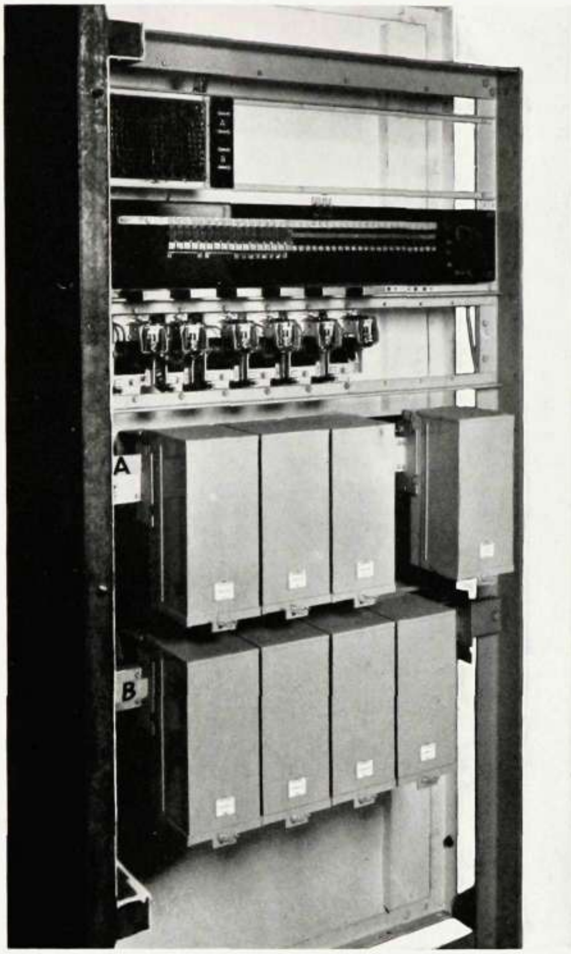


Fig. 8—Remote Control Panel Apparatus Rack

of control, but no registration of the frequency is made under these circumstances. The warning lamp flashes during the period of time switch actuation. The frequency key is restored when the flashing ceases, and, since there has been no registration, the street lighting load remains unchanged. The *Reset* key, and lamp, situated in the centre of the lower row of frequency keys, are concerned with the signal senders and receivers. If, for any reason, these circuits cannot complete the transmission of a signal, or the check-back code is not identical with the original, the circuits return to normal and are locked in this position. The *Reset* lamp is flashed, an audible alarm is given and the *Reset* key must be operated momentarily to free the circuits so that they can make another attempt to transmit the signals.

Load Control

At the top of the control panel is a Megawatt meter which shows the total load on the network, and is controlled over a separate telemetering channel.

The attendant can, therefore, control the total load by operating the frequency key of the load he wishes to connect to, or disconnect from, the network. When the small white lamp glows, he operates the *Start* push button, verifies that the machine sets are started up, and watches the frequency of the alternator being brought to that required. When the frequency is correct, he operates the *Emission* key and is informed by a return signal that the distributor is turning. The emission on the feeders is registered by the lighting of the load lamp, the resultant change in the total load being indicated on the meter. Finally, when the emission ceases, the shut-down of all the transmitter equipment is displayed.

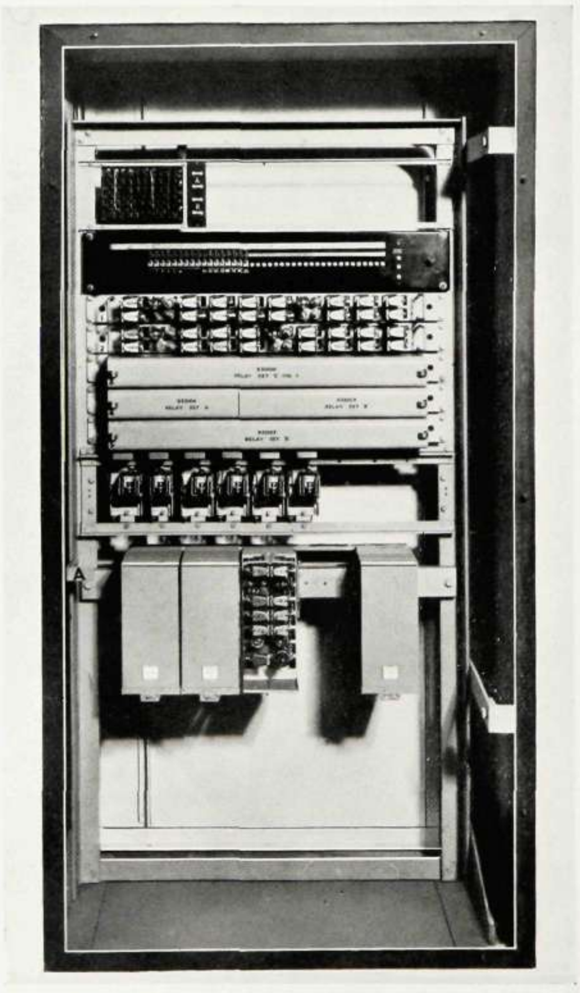


Fig. 9—" Actadis " Transmitter Control Rack Located in Transformer Station

This article is published by kind permission of the North Western Electricity Board.

A MAGNETO INTERMEDIATE TELEPHONE

The intermediate telephone enables a subscriber having two premises but only one public exchange line to have access to the line from both premises, and intercommunication between them. The telephone incorporates an extension switch for effecting the desired connections and is installed at one of the two stations, an ordinary extension instrument being used at the other. The magneto telephone described is of the moulded type and comparable in size with the ordinary table telephone.

AN Intermediate Telephone combines the functions of an ordinary subscriber's instrument with those of an extension switch. It is normally used with one extension telephone when it is desired that two stations (a considerable distance apart) should have inter-communication and access to the same exchange line, the intermediate telephone being located at the point most convenient for controlling exchange calls. For instance, it might be installed in a subscriber's office where an assistant is normally in attendance, and be connected by an extension line to an ordinary telephone at the subscriber's residence. With such an arrangement, exchange calls could be made from either point, intercommunication between the office and residence is made possible, and incoming exchange calls would normally be answered by the assistant and switched through to the residence only when desired.

In a previous issue were described two types of intermediate instruments for working to either an automatic or a manual C.B. exchange ; one type was for external working, i.e. where the two stations are a considerable distance apart and are connected by a two-wire circuit, the other for internal (short distance) working where battery ringing over a four-wire extension line is economically possible.

This article describes a magneto intermediate telephone designed for external working with an extension telephone of orthodox type, such as would normally be supplied to a subscriber in the magneto exchange area concerned.

The style of the intermediate or " main " instrument, as it is often termed, is based upon that of the Type N.2121 moulded magneto table set. It is known as Type N.2140A and is made in the usual range of colours, i.e. ivory, chinese red, jade green or the standard black, the associated moulded desk terminal block being coloured to match. The external fittings are chromium plated.

Fig. 1—The Intermediate Telephone

A view of the telephone is given in Fig. 1. There are three push-button keys for effecting the various switching operations, and a star indicator which actuates as a " calling " and a " ring-off " signal. The indicator is restored to the unoperated condition by pressing the button below it. The internal components are mounted on the removable metal baseplate of the telephone, as shown in Figs. 2 and 3. All parts are so arranged that they are easily accessible for maintenance.

In addition to the bell in the telephone, an all-metal a.c. bell, suitable for mounting on a wall, is supplied. The manner in which the bells are connected or disconnected by the various switching operations is shown in the explanatory diagram Fig. 4. In this diagram, the internal ringer is Bell 1, and the external ringer Bell 2.

The standard designations on the label below the three push-buttons on the telephone are, reading from left to right :

MAIN TO EXTENSION (KE)
EXCHANGE TO EXTENSION (KT)
MAIN TO EXCHANGE (KX)

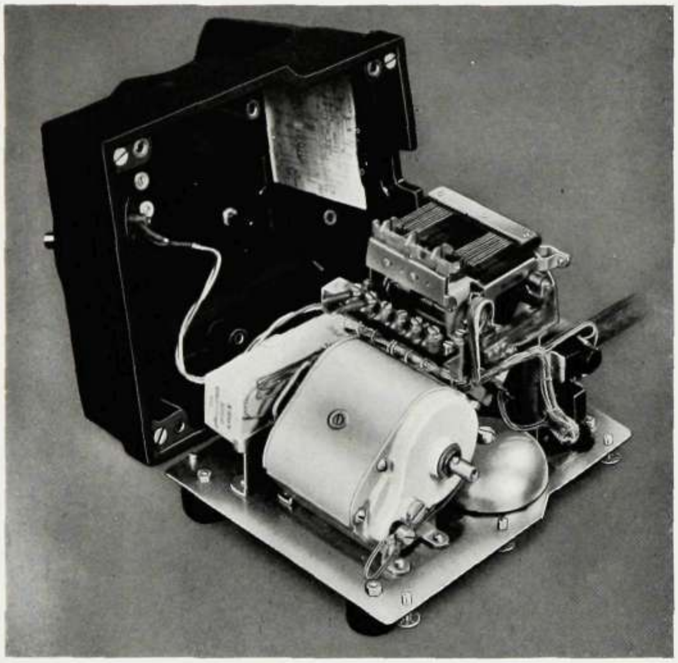


Fig. 2—Interior View, Front Aspect

The letters in brackets are used in Fig. 4 to indicate which buttons are operated, and in Fig. 5—a schematic diagram of the telephone circuit—to designate the key springs.

FACILITIES

The normal connection for the intermediate (main) telephone is Main-to-Exchange, in order that incoming exchange calls shall be answered by the main station ; in the following description of facilities this connection is therefore considered first.

(*a*) *Main-to-Exchange*

This is the receiving condition : the internal bell and the indicator are across the extension line, and the external bell is across the exchange line. The main station can initiate or receive exchange calls without further switching. An extension call operates the internal bell and indicator, the latter signifying that a button must be pressed to answer.

(*b*) *Main-to-Extension*

The internal bell and the indicator are across the exchange line, whilst the main telephone and Bell 2 are on the extension line. The operation of the indicator now signifies that a button should be pressed to answer exchange calls.

(*c*) *Exchange-to-Extension*

The internal bell and the indicator are across the exchange line, and Bell 2 is disconnected. In this condition the main telephone cannot be used to overhear, or take part in, the conversation, unless both the keys *Main to Extension* and *Main to Exchange* are pressed simultaneously, as described under (*d*).

The indicator operates on incoming exchange calls, and also as a clearing signal when the extension rings off, signifying in either case that the main telephone can be switched to the normal position. Should the handset be left off the main telephone, audibility of the incoming or outgoing ringing signal will not be diminished, as a capacitor is included in the telephone circuit.

(*d*) *Exchange-to-Extension with Main in parallel*

This is the non-secret condition. When both of the keys *Main to Extension* and *Main to Exchange* are pressed simultaneously, the extension and exchange

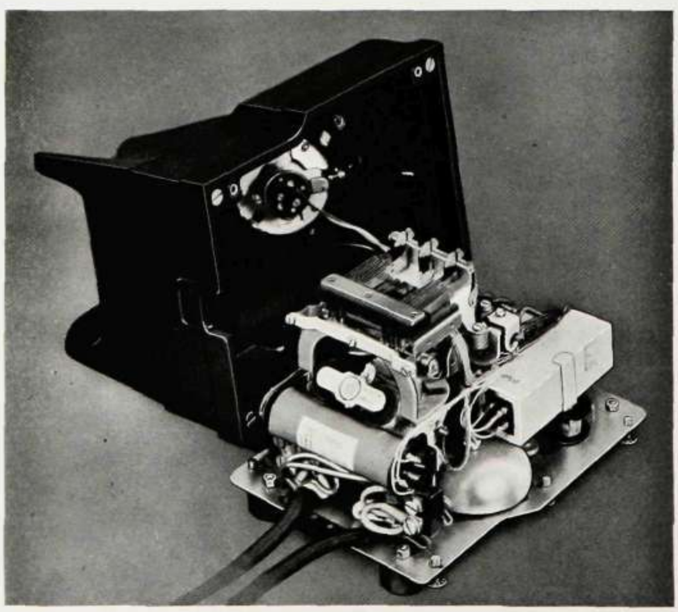


Fig. 3—Interior View, Rear Aspect

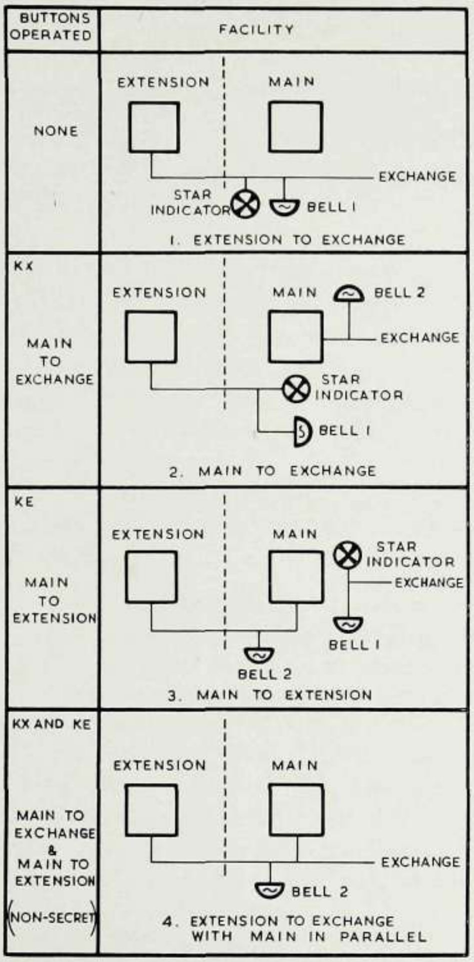


Fig. 4—Schematic of Connections Set up by Operation of the Push Buttons

lines are connected to the main telephone circuit, thus permitting the attendant to listen to, or take part in, the conversation. This facility can be eliminated, and complete secrecy given, by strapping terminals inside the main telephone.

Circuit Operation (Fig. 5)

In the following description of the circuit functions, it should be borne in mind that KT, the centre key on the telephone, has no contacts but serves to restore either of the other keys to normal when they are previously operated. KT is non-locking; therefore, when it has been depressed and released all keys are normal and the facility given is that indicated for KT on the label, i.e. exchange-to-extension.

(1) *Exchange-to-Extension.* In this condition the exchange line is connected to the extension line via KE and KX, with the indicator and Bell 1 across the inner contacts. Bell 2 does not function at this stage, as calls from either the exchange or the extension are signalled on Bell 1. In this condition the indicator will act as a "ring-off" signal to inform the attendant that the call is concluded and that the key KX should be operated to restore the connection to the normal Main-to-Exchange condition.

(2) *Main-to-Exchange.* With KX springs operated, the extension line, Bell 1 and indicator, are all disconnected from the exchange line which is now through to the main telephone circuit. Bell 2 and the hand generator are connected across the line via the cradle-switch contact ; exchange calls can thus be answered or originated without further switching.

A ring from the extension will operate the indicator and Bell 1. As the switch is not in the through condition, this will signify a call and not a ring-off ; moreover, it serves to remind the operator to press the button to answer. In this case the button pressed would be KE, giving the following facility :—

(3) *Main-to-Extension.* KE operated releases KX (if operated). KE disconnects the extension line from Bell 1 and indicator at the break contacts, and connects the main telephone and Bell 2 to the extension line. KX, restoring, disconnects the exchange line from the main telephone circuit and connects the line to Bell 1 and indicator for the reception of incoming exchange signals. Operation of the indicator again signifies that a button should be pressed to answer. Since button KE has already been pressed, no further operation is required to answer calls from the extension, so the ringing is received on Bell 2.

(4) *Exchange-to-Extension with Main in parallel.*

In condition (1), above, that is, with all keys normal, the main station is excluded from the line. However, as there is nothing to prevent keys KE and KX being operated together, the circuit is arranged to utilize this condition if required, that is, to permit the main station to listen to, or take part in, exchange-to-extension conversation. At the same time, provision

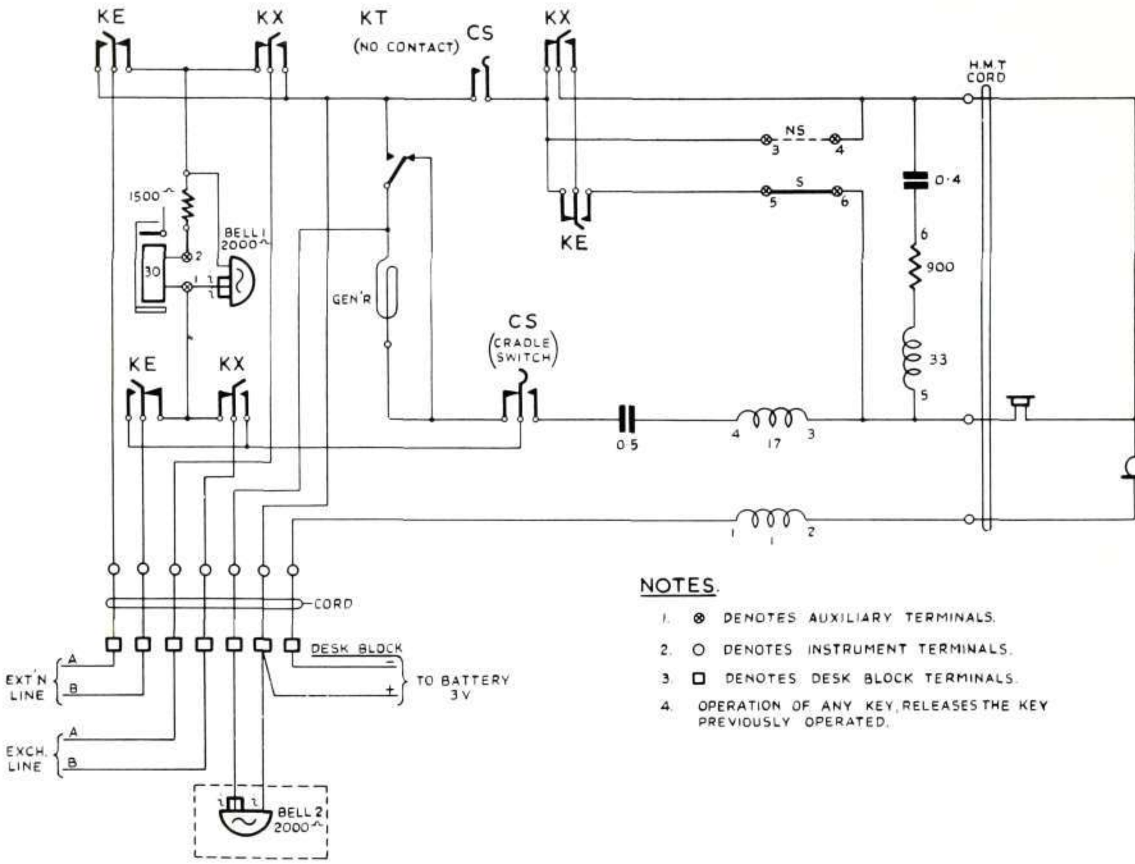


Fig. 5—The Telephone Circuit

is made for this facility to be excluded and complete secrecy ensured.

Key springs KE and KX shown in the centre of Fig. 5, and the alternative straps between auxiliary terminals 3–4 or 5–6, are concerned with the secrecy feature.

If keys KE and KX both are operated, with terminals 3–4 strapped, the main telephone circuit is connected to the exchange and extension lines via the cradle-switch springs, and the attendant may take part in the conversation. The indicator and Bell 1 are disconnected at the back contacts of KE and KX, while Bell 2 is connected in parallel with the through connection.

With terminals 5–6 strapped and 3–4 open, the main telephone circuit is always disconnected from the line during a through connection, irrespective of whether all keys are normal, as in condition (1), or whether keys KE and KX are operated together.

Application

Application is unrestricted. Instruments for use in tropical climates have ventilating apertures which are gauze screened to prevent the entry of insects, while special cords and varnish impregnated coils are used to withstand conditions of high humidity. The standard and tropical models have p.v.c.—insulated connecting wires.

MOMBASA TELEPHONE EXCHANGE

A factor in the economic development of the African continent, which is now taking place, is the modernization of telecommunications. The Company's contract for automatic exchanges at Accra, on the Gold Coast, was completed in 1953. Last year, a further advance was marked by the opening of the 4000-line auto/manual exchange at Mombasa. A brief description of the exchange is given.

IT is a coincidence that two of the exchange equipments forming part of the Company's recent exports have been required to operate in almost identical situations in Africa, although some 3,200 miles apart. Both are installed in coastal towns, one at Accra about 5° north of the equator, the other at Mombasa, Kenya, an equivalent distance south of the line ; but whereas the whole Gold Coast area has a hot and moist climate, the district lying immediately behind the Kenya coastal strip is, in places, almost desert.

A description of the Accra exchange was published in *Bulletin No.* 28.

Mombasa possesses perhaps the finest harbour on the eastern seaboard of Africa. It has a coast wireless station and is connected with Europe by telegraph. A cable also connects the port with Zanzibar, some 200 miles to the south. The population is mainly European, Arab and Indian, and the principal crops in the coastal region are copra, maize, sisal, sugar, cotton and cashew nuts.

The new Mombasa auto-manual exchange, brought into service on November 27th last year, provides modern telephone facilities for 3,450 ordinary and P.B.X. subscribers, together with 50 coin box lines. Accommodation is available for a designed ultimate of 6,500 subscribers' and 100 coin box circuits, the final selector multiple providing initially for 4,000 and ultimately for 7,200 numbers.

Fig. 1 shows part of the exchange building, the ground floor of which accommodates the power plant, the first floor the distribution frames, test desk and automatic equipment, and the top floor the meter and manual switch rooms.

Equipment and circuits conform, in the main, to the standards for British Post Office type '2,000' exchanges, the initial and ultimate quantities of circuits being as shown in the trunking diagram, Fig. 2. The group selector racks incorporate grading

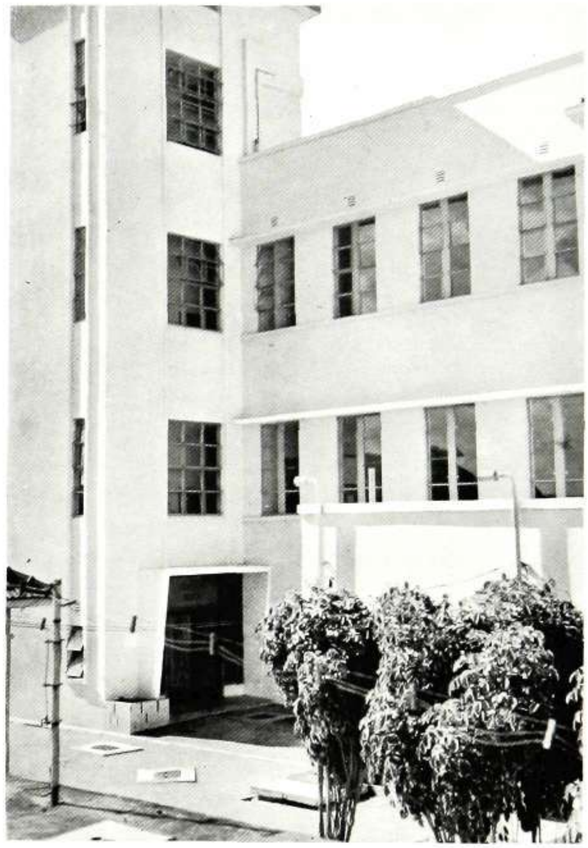
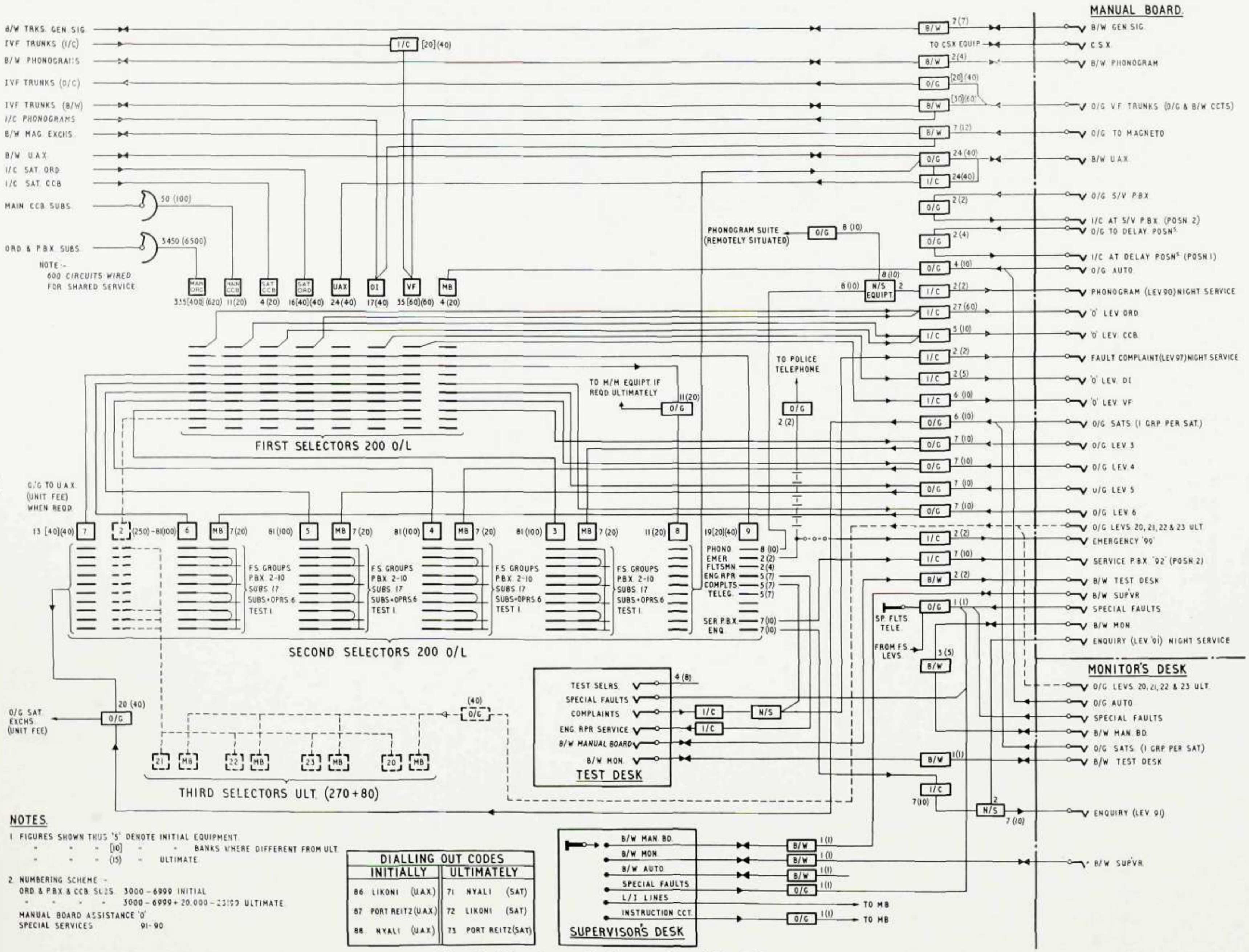


Fig. 1—Part of "Telephone House", Mombasa

facilities, but a separate trunk distribution frame is provided for grading the uniselector outlets. (In the more recent British Post Office exchanges, provision for grading is made on each uniselector rack).

In view of the impetus given in recent years to the economic development of many districts of Africa, and the importance of Mombasa as the main eastern port, it is possible that there will be a fairly rapid rise in the demand for telephones in the Mombasa area within a comparatively short time. The authorities, not unmindful of this possibility, stipulated that 600 of the initial subscribers' lines be wired for shared service, thereby making provision for urgent demands



NOTES.

1. FIGURES SHOWN THUS '5' DENOTE INITIAL EQUIPMENT.
   " " " [10] " BANKS WHERE DIFFERENT FROM ULT.
   " " " (15) " ULTIMATE.
2. NUMBERING SCHEME –
   ORD. & P.B.X. & CCB. SUBS. 3000 – 6999 INITIAL
   " " " " 3000 – 6999 + 20,000 – 23,999 ULTIMATE
   MANUAL BOARD ASSISTANCE '0'
   SPECIAL SERVICES 91 – 90

DIALLING OUT CODES

INITIALLY	ULTIMATELY
86 LIKONI (U.A.X.)	71 NYALI (SAT.)
87 PORT REITZ (U.A.X.)	72 LIKONI (SAT.)
88 NYALI (U.A.X.)	73 PORT REITZ (SAT.)

Fig. 2—Mombasa Exchange Trunking Diagram

pending any necessary extension of the main equipment. Each subscriber on shared service has a meter at the exchange and a telephone with a push button. When the button is pressed, earth is connected to the "A" leg by one party or to the "B" leg by the other party, the calls made by each being thus registered separately.

It will be seen in Fig. 2 that the second selector level "99" has alternative connections permitting emergency calls to be directed either to the manual board or to a police telephone. The appropriate connections are made by means of jumpers at the intermediate distribution frame.

Pending the completion of the new exchange, a relief scheme was operated in the Mombasa area, the Company supplying "Rurax" equipment for the purpose. Since the cut-over, some of the relief equipment has been used for satellites in the area.

There would be little point in describing the Mombasa equipment in detail, since it is largely of conventional type ; however, some departures from standard practice have been made. For example, a special master clock is installed. It is of a type developed by the Company in collaboration with Messrs. Gents' of Leicester, with the object of improving the method of generating clock pulses, especially in areas where facilities for synchronization or Observatory control are unavailable. Exchanges at Accra and Kuwait have been supplied with clocks of this type.

In British Post Office exchanges, two master clocks are used ; type No. 36, providing pulses at intervals of 1, 6 and 30 seconds for the requirements of the automatic plant—for example delayed alarm and routine test timing—and type No. 46, providing pulses for manual switchboard circuits associated with call timing. The functions of both of these clocks are combined in the new one, the design of which is based on the Gents' Type C7 gravity-driven impulse transmitter, so that a higher degree of chronometric accuracy can be achieved than would be possible with Clock No. 36 used under similar conditions.

The Mombasa clock has a maximum daily error of only half-a-second, and a monthly error which may be

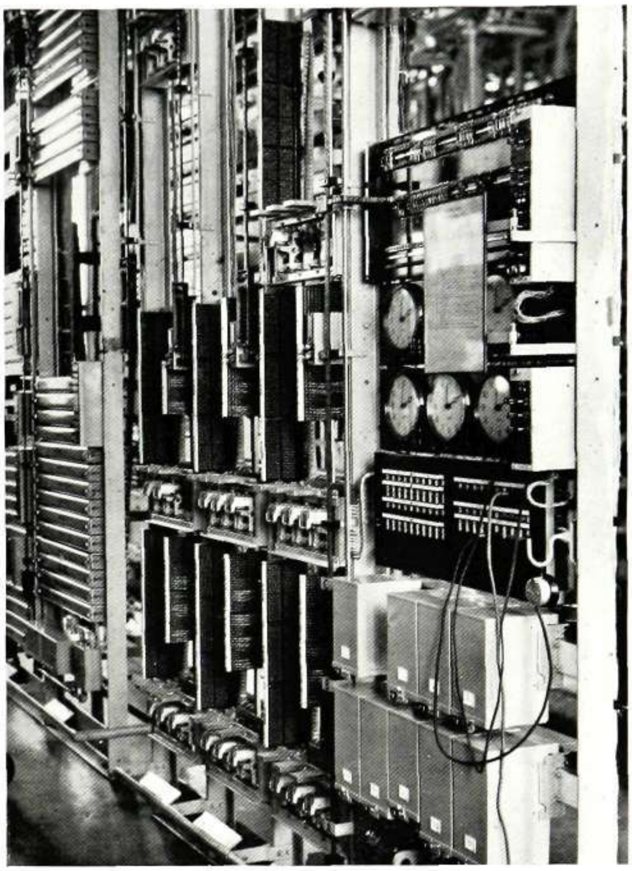


Fig. 3—Miscellaneous Apparatus, Traffic Recorder and Alarm Equipment Racks

less than three seconds. A monitoring secondary movement for each distribution circuit is mounted on the alarm equipment rack (Fig. 3), and provision is made for the control of public clocks, etc., over external cable pairs.

The qualities of p.v.c. (polyvinyl chloride) as an insulant for switchboard wires and cables are being increasingly appreciated, particularly where conditions of high humidity prevail or where wire coverings may be subject to damage by insects or fungoid growth. The Company has given much attention to the improvement of wire coverings, and has investigated the properties of various insulants under diverse conditions of temperature, humidity, etc., with the result that an improved type of p.v.c. has been developed and is now used on all our contracts abroad. At the time of installation, our production of p.v.c. sheathing for switchboard cable outer coverings was not sufficiently advanced to

Fig. 4—Group Selector Racks

ampere-hours capacity, two automatic charging rectifier units each having an output of 125 amperes with a voltage range of 51·6—52·3 volts, mains-and battery-driven ringing machines, and the power board shown in Fig. 8.

In the ultimate stage of the exchange growth, a third identical charging unit, together with a third main battery of 1,000 ampere hours capacity, will be installed. The two initial 505 ampere-hour batteries will then be paralleled and used as one. All conductors have been rated to meet this ultimate condition, and the power board is designed and equipped accordingly.

An unusual feature of the power plant is that, while one of the rectifiers is permanently connected across the two batteries in parallel, the second (and ultimately the third) rectifier is automatically switched into or out of service as the current consumption increases or decreases. The actuating medium for this facility is a contact ammeter which is inserted in the main discharge leads to connect the control current to, or disconnect it from, the relative mains contactors ; these, in turn, connect or disconnect the input supply to the charging units.

permit its use in the Mombasa exchange, consequently, while all the conductors have p.v.c. insulation, specially treated textile outer covers are provided on the cables.

In passing, it may be remarked that cables having p.v.c.—insulated conductors and cream-coloured p.v.c. sheathing are being used on one of our current home contracts. The light colour adds brightness to the switchroom and will not diminish with age, since any dust which may settle on the smooth surface can be easily removed. The opposite is the case when wax-impregnated textiles are used for covering wires ; indeed, after a few years, the original wire colours are practically indistinguishable.

The Mombasa power plant is basically of the straight-forward " double battery float " design. It comprises two 24-cell main batteries each of 505

With this arrangement, precautions had to be taken to prevent all the charging units being reconnected simultaneously should a mains failure occur and the power supply be restored during a period of heavy load. Consequently, provision is made for a 20-seconds delay between the re-introduction of chargers Nos. 2 and 3, the delay being uniselector controlled. The contact ammeters may be seen at the top of the rectifier panel—second from the left in Fig. 8—while at the bottom is a knife switch which is operated in conjunction with a lever-type key when changeover from automatic to complete manual control is desired.

The manual switchroom equipment on the top floor of the building comprises a twelve-position switchboard, a two-position monitor's desk and a supervisor's desk of the latest type, employing rotary switch selection for listening-in. The timber used throughout is teak with an oil and wax finish.

The switchboard, composed of single-position sections, has 140 answering and 200 outgoing multiple circuits, both types being arranged for four-panel repetition. Each position is equipped with seven cord circuits and time clocks. A desk with a lamp display panel for service observation is installed in a partitioned-off section of the manual switchroom.

Phonograms are dealt with at eight cordless-type switchboards which are located, together with an enclosed-type relay rack, at a distance from the exchange equipment; this necessitates the provision of separate line protecting equipment in the form of fuse and protector mountings similar to those on the main distribution frame. They are fitted on the relay rack accommodating the visual-engaged-signal relays.

Facilities for testing the exchange equipment and external lines are provided on the usual basis, there being a three-position test desk, automatic routiners for group and final selectors, and sundry manual testing sets. The test desk, made of oiled and waxed teak, is equipped with all the standard circuits and, in addition, means of checking the efficiency of subscribers' dial switches by direct readings of impulse speed, count and weight on the specially calibrated voltmeter. Access to junctions for testing purposes is gained via break jacks on a test jack frame of orthodox type.

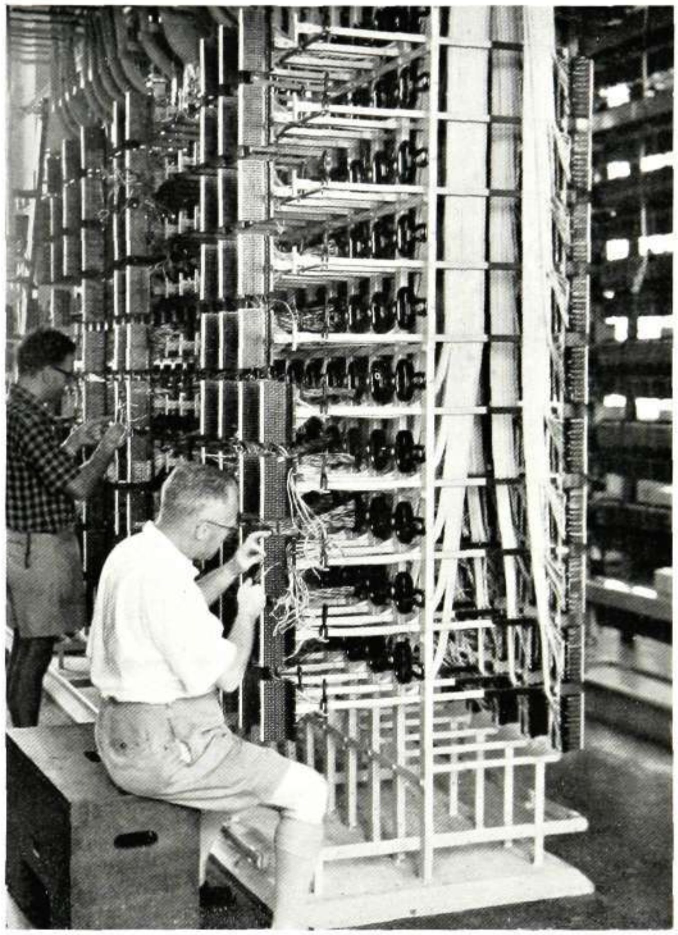


Fig. 5—Terminating Cables at the Equipment I.D.F.

The main distribution frame has 34 verticals, each with capacity for 220 circuits on the line side and 200 circuits on the exchange side, while the intermediate distribution frame is in two 25-vertical sections, the connection strips used being of the latest type, i.e., moulded in black bakelite, with a white strip on the front on which circuit designations are signwritten in black. One section of the I.D.F. is used for cross-connecting subscribers' lines, the other for selector, manual board and miscellaneous circuit terminations.

4,000 subscribers' meters and equipment for their routine testing are accommodated on four meter racks. Meters for registering traffic overflow are mounted on one of three miscellaneous apparatus racks in the automatic switchroom, which also contains the traffic recorder equipment by means of which the traffic through selected groups of switches may be analysed, so that any necessary steps can be taken to relieve congestion.

Each of the twelve uniselector racks has capacity for 300 circuits. There are also the following main equipment racks: eight first selector, seven second selector, ten final selector and five relay set racks, all of standard type and 4′-6″ wide. Relay sets for the country satellite exchange junctions were supplied by the Department for mounting on a separate rack 2′-9″ wide.

While the Mombasa exchange is not large in comparison with some equipments supplied by the Company for densely populated cities such as London, the amount of material used for the equipment and the labour involved are nevertheless appreciable.

This fact emerges clearly from the following list of typical approximate quantities :

Relays of various types	..	21,600
Precious metal contacts	..	460,000
Bank contacts	..	750,000
Soldered joints	.. ..	2,500,000
Miles of wire	.. ..	12,000

This article is published by kind permission of the Engineer-in-Chief, East African Posts and Telecommunications Administration.

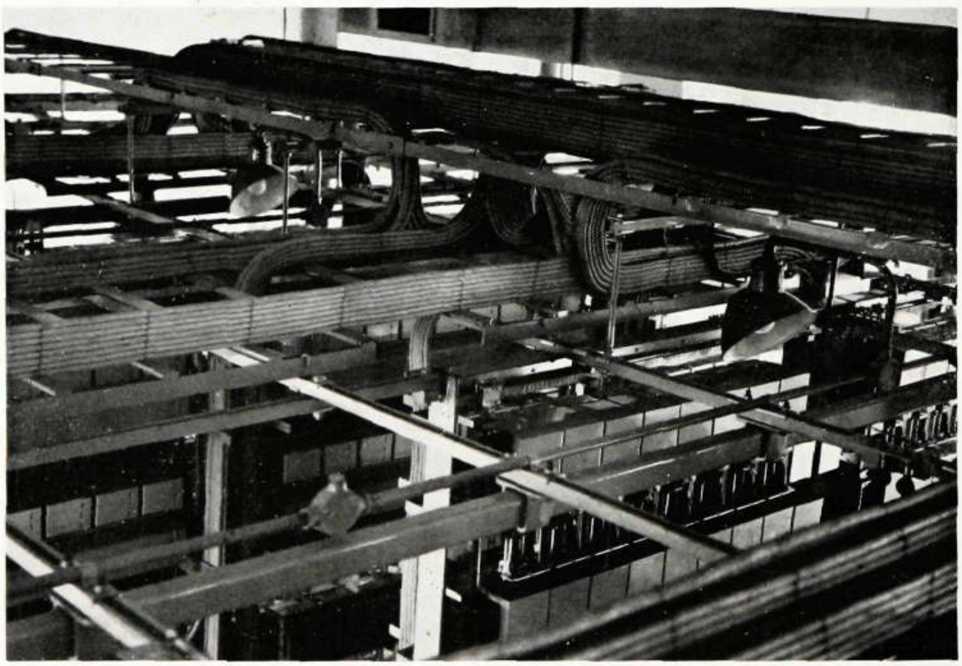


Fig. 6—View of Cabling over Automatic Racks

Fig. 7—The Manual Switchroom, Mombasa

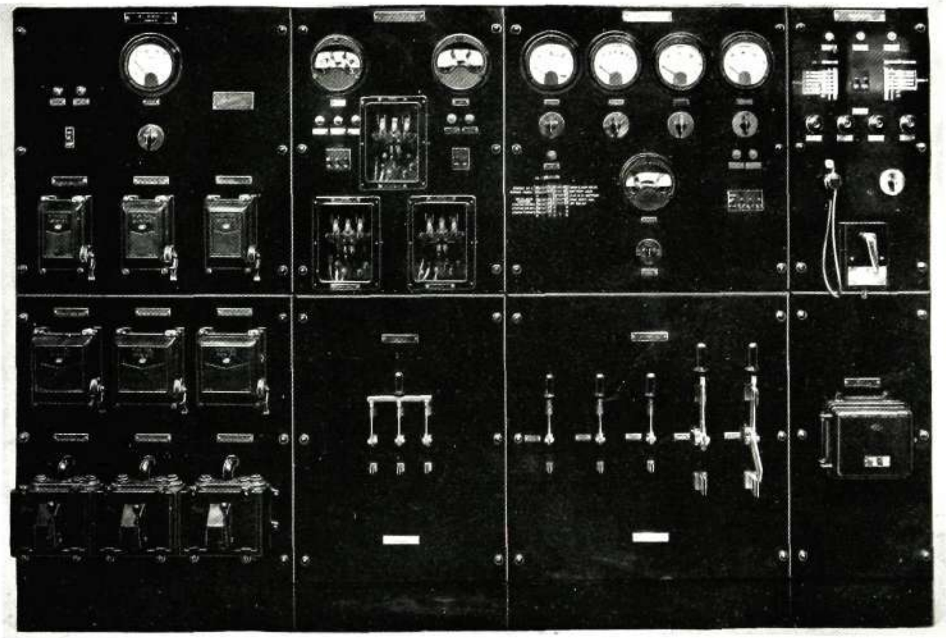


Fig. 8—The Power Board, Mombasa

KINGSTON-UPON-HULL TELECOMMUNICATIONS EXHIBITION

THE Telephone Undertaking of Kingston-upon-Hull Corporation, the only municipal telephone undertaking in the United Kingdom, celebrated its Golden Jubilee in December 1954 by arranging a Telecommunications Exhibition. The Company was among those invited to display some of their products.

As stand space was limited, our designers expanded the display area by arranging curved shelves diagonally across the space, as seen in the illustration. The shelves were in light oak with polished black edging, the front in Burgundy flock, and the panelling at the rear of the stand in blue-grey perforated sheeting. Concealed lighting was used throughout.

Our exhibits showed some of the latest technical developments in the fields of insulation, plastic moulding, electronics, switching mechanisms, die casting and shell moulding.

The method of manufacture of polyvinyl chloride (p.v.c.) was demonstrated by means of a series of models, and the use of p.v.c. as an insulating material for wires and cables by a number of samples from current production, one of the samples showing large-bore p.v.c. tube used as a bus-bar insulant. The advantages of the material—its good appearance, readily recognizable colours, smooth, easily cleanable surface—were clearly demonstrated in these practical examples.

The modern trend towards the decorative, as well as functional, treatment of plastics was illustrated by a number of moulded telephone instruments ; these were in a variety of colours, and one was completely transparent. A cordless switchboard with replaceable " Warerite " plastic panels in birds-eye maple may be seen on the extreme right of the illustration, and on the extreme left a cream convertible wall-table intercommunication telephone. A variety of other components served to indicate the purely functional aspect of plastic moulding.

In the electronics field the " Dekatron " cold-cathode counter tube originated by the Company was highlighted, and an application of this type of tube to the problem of counting extremely rapid impulses was demonstrated in an Add-On Counting Equipment. The model was operated from the a.c. mains and was arranged to count hundredths and tenths of seconds, seconds and five seconds, and minutes and five minutes, a complete revolution on the five minute counter display being completed every hour.

Among the latest developments in relays shown were miniature general-purpose, special and polarized types, their availability in the open, enclosed or hermetically sealed form being indicated.

A selection of die castings and shell mouldings from current production completed the display.

A RECENT SCIENTIFIC PUBLICATION

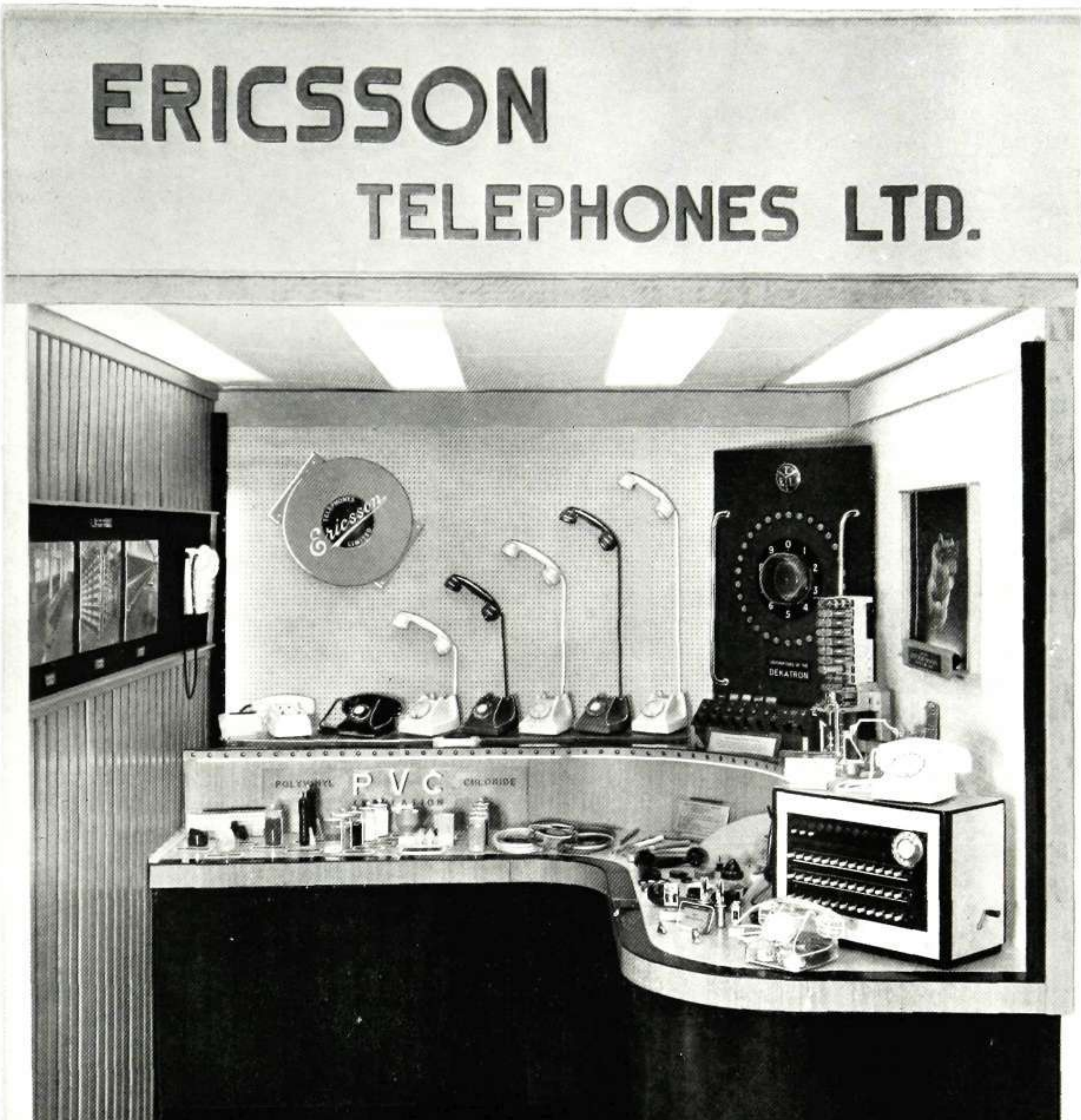
BY ONE OF THE COMPANY'S STAFF

THE ELECTRONIC MUSICAL INSTRUMENT MANUAL

SIR ISAAC PITMAN & SONS. 2nd edition, 1954

ALAN DOUGLAS *(Electronic Instruments Dept.)*.

This book explains the relationship between electrical tone sources and their acoustic counterparts and describes all the modern circuits and commercial instruments. Every design phase of electronic music is covered, and in addition there are chapters on sound, waveforms, loudspeakers, room acoustics and musical scales and tuning. There is no instrument now in production which does not basically employ one or other of the circuits shown in this edition.



The Company's Stand at Kingston-upon-Hull Telecommunications Exhibition

Products

TELEPHONES

Domestic, Field, Flameproof, Intercom., Loudspeaker, Mines, Police, Portable, Public Service, Railway, Ships, etc.

SWITCHBOARDS, MANUAL

For all Types of Private, Private Branch, or Public Exchanges. CB Auto, CB or Magneto Multiple Boards for any number of lines. Single-position Switchboards in a wide range of Types including Cord, Cordless, Keyless, Mines, etc.

EXCHANGES

Auto, CB or Magneto. Private, Private Branch or Public Exchanges for any number of lines. Trunk Exchanges.

TRANSMISSION EQUIPMENT

V.H.F. Multi-Channel Radio-Telephone Links. V.F. Dialling Equipment. Carrier Telephone Systems. Repeaters for Speech or Music Circuits. Single or Multi-Channel V.F. Telegraph Systems.

REMOTE CONTROL EQUIPMENT

Remote Control Units for power switching in dangerous atmospheres. Equipment for Remote Indication of Water Levels, etc.

TOTALISATORS, AGGREGATORS

Automatic Totalisators for Racecourses and Dog Tracks. Attendance Aggregators for use with Turnstiles.

RELAYS AND VIBRATORS

Ordinary and Miniature Type Relays. Long Life Vibrators meeting British Grade I Services Specification. Vibrator Power Packs.

ELECTRONIC AND NUCLEONIC INSTRUMENTS

Cold-Cathode Scaling Units, Batch Counters, Add-on Counting Equipment, Pulse Generators, Radiation Monitors, Kits for Survey of Radio-active Ores.

COLD-CATHODE TUBES

For Switching, Counting, etc. Long life and high reliability Dekatron Gas-filled Counting and Selector Tubes operating generally to a base of 10 or 12. Stabilizer Diodes and Trigger Tubes.

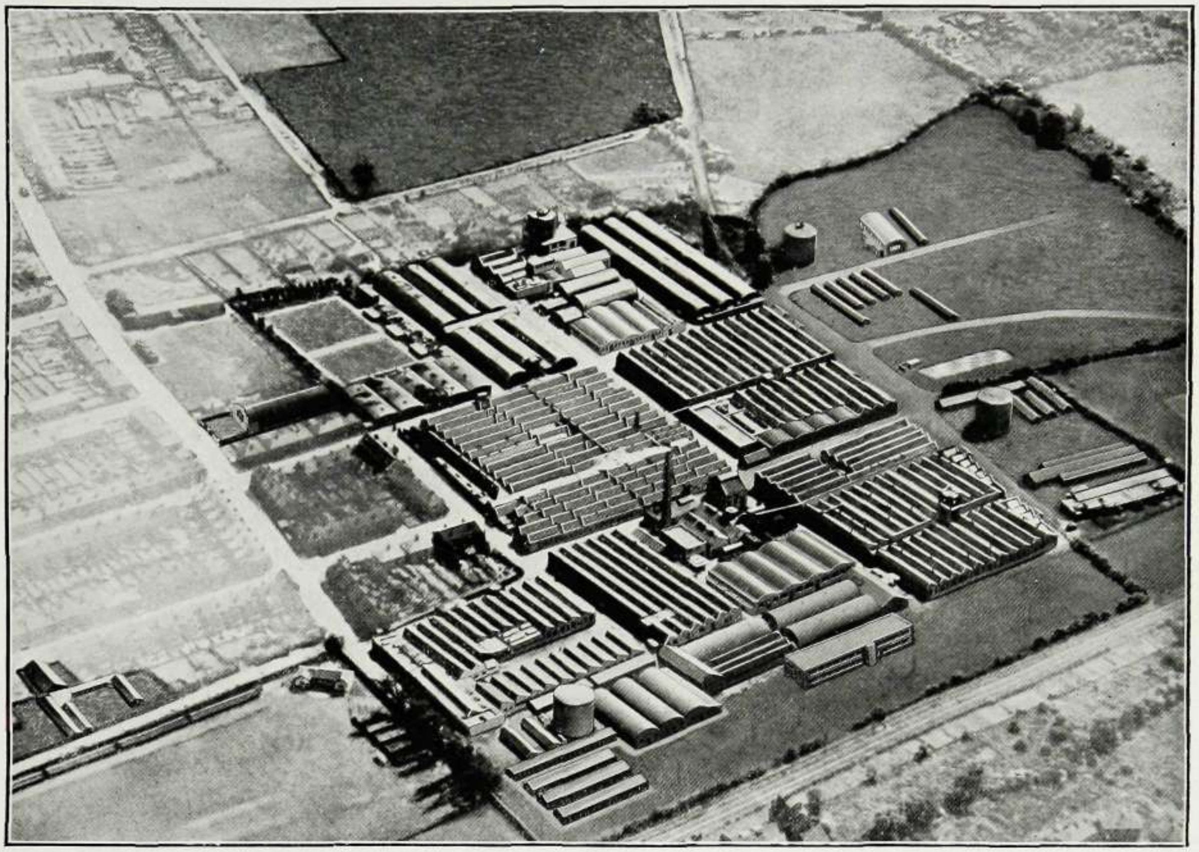
MISCELLANEOUS

Bells, Headphones, Indicators, Keys, Plugs, Protective Apparatus, Terminals, Screws, Nuts and Washers. Turned Parts, Enamels, Paints, Lacquers, Varnishes. P.V.C.-covered Cable, Cords and Wire.

REQUESTS FOR QUOTATIONS, OR INFORMATION ON ANY OF THE ABOVE PRODUCTS SHOULD BE ADDRESSED TO HEAD OFFICE :—22 LINCOLN'S INN FIELDS, LONDON, W.C.2

DERRY & SONS, LTD.
PRINTERS, NOTTINGHAM, ENGLAND

PROCESS BLOCKS BY
THE MIDLANDS ENGRAVING
SERVICE LTD. NOTTINGHAM



Aerial View of The Telephone Works, Beeston, Nottingham