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Teleprinter No. 23: A New Teleprinter for the Telex Service

W. F. GARRETT, B.Sc. (ENG.), C. ENG., M.I.E.R.E., A.M.I.E.E.†

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A high proportion of the annual capital investment in the UK Telex service is devoted to the customers' equipment; the introduction of a new teleprinter is therefore a significant event in the evolution of that service. The Teleprinter No. 23 is only the third teleprinter terminal to be supplied by the British Post Office for Telex and represents a revolutionary technological advance over its predecessors. The article details the main features of this first generation electronic teleprinter.

INTRODUCTION

Telegraphy, the oldest form of long-distance electrical communication, is notable for the evident increase in complexity, with time, of the line terminating apparatus. The achievement of a wide range of facilities through the development of complex mechanisms, and the ability to produce terminals in large quantities at low cost and with high reliability, made possible the introduction of Telex—by far the most successful of the non-speech communication services introduced to date.

Telex is a world-wide service, the basic characteristics being defined by the International Telegraph and Telephone Consultative Committee (CCITT); this service continues to show considerable growth despite the introduction of competing services. Within the UK, there are 79 500 Telex connections and growth in 1978-79 was 11%; system growth in 1979-80 is expected to be nearly as good.

With home and export markets of such long-standing potential, the introduction of electronic technology, with its capacity for reducing complex mechanisms and control sequences to silent, easily manufactured modules, might have been expected to take place in the early-1960s. However, although developments involving electronic tube and transistor circuitry were undertaken by a number of companies world-wide, very few came on the market. This was because of the highly-developed state of the mechanisms used in the well-established page-printing teleprinter products, and the volume of the electronic circuitry needed to achieve equivalent functions.

Although integrated circuits offered an improvement in the cost-reduction of electronics, it was not until the availability of large-scale integrated (LSI) circuits that electronics could be used in place of complex mechanisms on a cost-effective basis. Thus, teleprinter technology is unusual in that it has changed from the traditional (electro-mechanical) to the modern (LSI electronics) with little evidence of the intermediate stages seen elsewhere.

The extent to which electronics can be substituted for mechanical systems is determined by practical considerations, such as the need to move paper and the necessity for an impact printing method where more than one copy of recorded information is required, as is usually the case. Evolution in the office environment and practice may lead to changes in both these areas, but the first-generation of electronic teleprinters give much the same customer facilities as their predecessors, although with some enhancements.

The British Post Office (BPO) Teleprinter No. 23 is a first-generation electronic teleprinter, which is currently being introduced to UK Telex customers' use after considerable evaluation and field-trial experience. It replaces the Tele-

printer No. 15, which was introduced in 1968 and which is now being phased out of production.

TECHNICAL FEATURES OF TELEPRINTER No. 23

Terminal Configuration and Construction

Where electro-mechanical technology is used, most Telex/telegraph terminals comprise a teleprinter and a separate control unit joined by a signalling and power-supply cord. The teleprinter performs only the very basic functions, while the control unit carries all the operator controls, control circuitry, power supplies and signalling components. Flexibility is achieved by associating a range of control units with a common teleprinter. In the Teleprinter No. 23, the use of electronics has enabled the teleprinter and control unit to be integrated into a single unit of modest size and weight; the line-signalling supply and associated components (that is, barretter and line filter) are, however, mounted in a small external unit. Flexibility is achieved firstly by the presence or absence of diode straps on a printed-wiring board (PWB), and secondly by exchanging the PWB carrying the line interface components for another having a different capability.

The normal arrangement at a customer's premises (Fig. 1) is for the Teleprinter No. 23 to be mounted on a purpose-designed plinth (Plinth, Teleprinter No. 1), which has an internal shelf to accommodate the line signalling unit (Unit, Terminating No. 11). A card callmaker (Auto-dial No. 302)† can be attached to the right-hand side of the plinth. If the customer does not wish to use the plinth, the teleprinter can be mounted on a table and the line signalling unit fixed to a wall or to some other suitable surface.

It is currently intended that all Teleprinters No. 23 supplied to the BPO will be to the automatic send-receive (ASR) configuration and will therefore have paper-tape ancillaries as standard.

Construction is modular, and the units are mounted on a rigid cast-aluminium base. Overall protection is effected by a single-piece moulded Noryl thermoplastic cover, having a clear polycarbonate visor designed to minimize sound emission and spurious light reflections.

Operator access is through a lift-up lid, to which a polycarbonate lectern is fitted. The page-printer paper is mounted internally, and the paper tape for the punch is mounted externally. Tape punch cuttings (chads) are collected in an externally mounted see-through plastics box. Light and mid-grey, the BPO house-style colours for telegraph apparatus, are used on the cover and base respectively; the plinth is mid-grey overall.

Printer

The page printer (Fig. 2) is the major mechanical unit of the

† Marketing Executive, Product Development Unit, Telecommunications Headquarters



FIG. 1—Teleprinter No. 23 Telex terminal

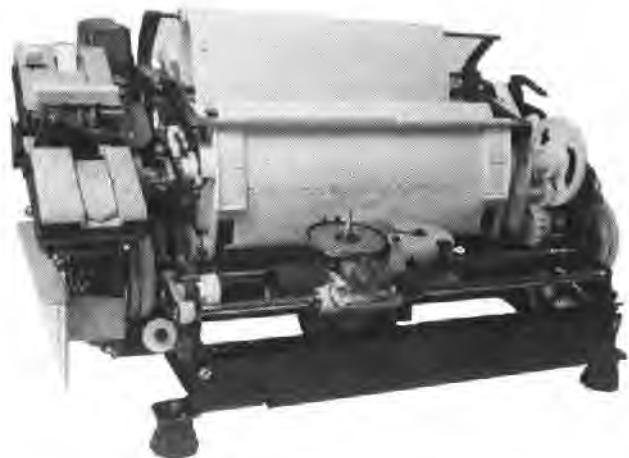


FIG. 2—Page printer unit

teleprinter. It includes the common drive motor, paper-tape punch and the mounting for the internally-stowed paper roll. Removal is effected by withdrawing the cover and power-supply plugs and the connector to the main electronic logic board, whereupon the unit can be lifted upwards away from

the base. The punch unit is mounted on this unit, so as to derive motive power and synchronism from the printer; its presence or absence does not affect printer operation.

The printing method incorporated in the Teleprinter No. 23 is known as *printing-on-the-fly*. A horizontal, continuously-rotating print wheel, with fully-formed symbols facing outwards at the periphery, is positioned in front of the paper. At the time required to print a given character, an electronically-controlled hammer, located behind the paper, impacts on the selected character face through the single or multi-ply paper medium. As the fount is continuously inked, the top (outward-facing sheet) is imprinted with the character; undercopies are produced through the impact on interleaved carbon or pressure-sensitive papers. Because the paper is trapped between the moving type fount and the hammer for only a short time, no paper drag or perceptible smearing of the printing occurs.

The print wheel and hammer assemblies are mounted on carriages on either side of the paper. The carriages are linked through a common towing wire, and move across the paper, one character pitch (2.54 mm) at a time. A feed-and-print action is used, this being completed in one revolution of the print wheel; if printing stops for more than 500 ms, the print wheel drops so that the last character printed is visible.

Because the paper must be fed behind the paper feed-roller and upwards between the print wheel and the hammer, the combined paper-guide/feed assembly and hammer carriage can be unlatched and rotated to simplify loading of paper. This allows the paper leading-edge to be fed into a slot in the paper guide so that when the assembly is restored to its normal working position, and the paper torn off by the saw-tooth knife edge, it is accurately placed ready to feed upwards through a slot in the cover. Continuous rolls of paper of width 210 mm (A4) and 216 mm, from either the internal roll or an external dispenser, can be used without resetting the paper guides.

Inking of the fully-formed type faces is achieved through the use of a porous, ink-impregnated plastics roller, which rests against the print wheel and is enclosed in a simple cassette. Renewal of the cassette is substantially less frequent than that usually associated with ink ribbons and it only requires the operator to clip in a replacement.

Discrimination between the text of incoming and outgoing calls is usually achieved using a 2-colour ink ribbon. As an ink-roller can provide only single-colour printing, an alternative method of marking is required. The method adopted in the Teleprinter No. 23, as a customer option, is to print 4 hyphen-like marks beneath the first 4 character positions of each line where the related printing is the local copy of transmitted information (see Fig. 3). This has the advantage

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... IN THE YEAR ENDING 31 MARCH 1979, WE ACHIEVED A TOTAL PROFIT OF £275.1 MILLION (LAST YEAR £367.7 MILLION). THE THREE BUSINESSES, TELECOMMUNICATIONS, POSTS AND NATIONAL GiroBANK, EACH TRADED PROFITABLY AND MET THE FINANCIAL TARGETS SET BY THE GOVERNMENT.

(a) Transmitted message print-out

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(b) Received message print-out

FIG. 3—Illustration of the two types of print-out obtained

against the feed movement, is coiled inside the left-hand drum, and each feed movement is held by engagement of a retention pawl on the right-hand drum; disengagement of this pawl triggers carriage-return. End-stop retardation of the carriage is effected through a combined friction brake, acting on the inside surface of the left-hand drum, and an air dashpot.

Keyboard

The Teleprinter No. 23 keyboard module is readily removed for maintenance and is basically mechanical in operation; that is, a small number of transducers is shared by mechanical means between all the keys, rather than by each key having an individual transducer, as is usually the case with 'electronic' keyboards. Designs of the shared-transducer type are relatively cheap, they also have the operational virtues that the key forces can be easily changed and the keyboard can be physically locked in those circumstances where it is required to be ineffective.

The principle of operation is that 6 identical, freely-moving, castellated bars are drawn by a single electromagnet towards the left-hand end of the keyboard, against the action of 6 springs. When any one key is depressed, the edge of a metal plate, which forms part of each key, enters the slots in the castellated bars. After a total movement of 4 mm against an average key force of 2 N, a microswitch operates, causing the electromagnet to release and allowing the bars to move in the direction of the spring pull. The bottom edge of each key plate is slotted to represent a particular code combination; consequently, each key when depressed allows some bars to move while impeding others, the combination being unique to each key. Those bars that move strike piezo-electric crystals in a mounting block located at the right-hand end of the keyboard. The resulting simultaneous pulses from the struck crystals, having an amplitude of about 18 V peak, correspond to the code combination for the depressed key, and are fed to a storage stage in the electronic logic.

To generate the required ITA2 code combination, 5 moving bars are required; the sixth is used to indicate whether the transmitted code combination needs to be preceded by *letter-shift* or *figure-shift*. Used in association with a 7-character keyboard store, this permits automatic case insertion, thereby removing the need for the operator to key the shift separately. This same store also permits the new-line facility, and eases for bursts in operator keying speed when the short-term generation of characters exceeds the cadence rate to line; if the store becomes full, the keyboard is locked until the store has emptied. Dual operation of adjacent keys on the same row, a major cause of operator keying error, is mechanically prevented by means of a saw-tooth slider at the front of the keyboard assembly.

Operator Controls

Operator control of a Teleprinter No. 23 terminal is effected primarily through the row of push-button switches (see Fig. 5) mounted on an acoustic baffle immediately behind the keyboard assembly. The switches have (in most cases) integral lamps, which serve to indicate the facilities selected, calling state or alarm condition; the switches are arranged in functional groups to assist operator selection. The functions of the push-buttons and associated lamp indicators are shown in Table 1.

In addition to the main operator controls, there are 3 ancillary controls located under a flap cover at the right-hand end of the keyboard. The switch at the front controls the incoming call alarm, the central one gives single or double line spacing of the printed text, and the switch at the rear can be used to control other optional facilities.

Electronic Logic

The electronic control system (excluding electronics in the

power-supply unit) is mounted on 4 PWBs (Fig. 6), which are identified as follows:

(a) Main Board

This board embodies the terminal control and unit interface logic, the most complex parts of which are realized in high-threshold metal oxide silicon (MOS) custom-designed LSI circuit elements. Five MOS/LSI chips are used, each having separate functions as follows:

- IC No. 1—logic circuitry associated with the paper-tape punch,
- IC No. 2—logic circuitry associated with the transmitter and paper-tape reader,
- IC No. 3—logic circuitry for Telex and machine control,
- IC No. 4—logic circuitry associated with the keyboard unit and answer-back board, and
- IC No. 5—logic circuitry associated with the printer unit.

To link the functions performed by the different chips, a time-division multiplexed data bus system is used. Six bus lines carry data, and a seventh is the flag line, which carries the signal for data transfer. The whole logic operates from signals generated by a crystal-controlled oscillator, except for the printing and associated mechanical functions where control is synchronized by a pulse train derived from print-wheel rotation. The crystal-controlled oscillator has a fundamental frequency of 200 kHz.

Discrete electronic components are used on the main board to provide interface amplifiers (for example, with the keyboard piezo-electric transducers), and drives to the various electromagnets on the printer and paper-tape units. Also included are the edge-connector sockets for the answerback, line isolator and under-line marker boards.

By assembling all the LSI and interface components on a

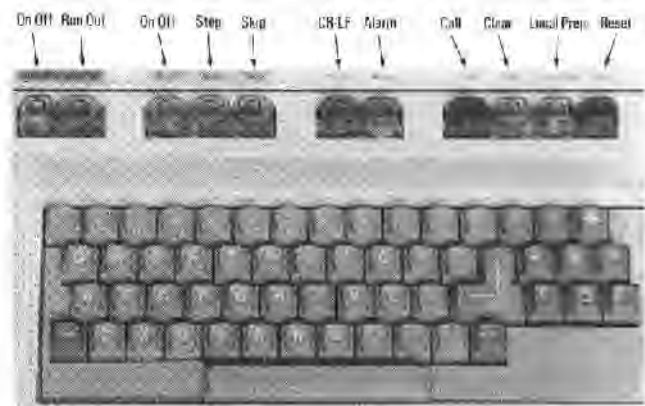


FIG. 5—Primary operator controls and keyboard



FIG. 6—Printed-wiring boards used in Teleprinter No. 23

TABLE 1
Push-Button Controls and Associated Lamp Indicators

| Position Left to Right | Designation | Function of Push-Button control | Colour | Condition for Lamp Operation |
|------------------------|---------------------|--|--------|--|
| 1 | ON OFF (Note 1) | Control of the paper-tape punch | Clear | Tape punch switched on |
| 2 | RUN OUT (Note 1) | When held operated, punches continuous letters (ITA2 Combination No. 29) into tape for start and finish identification | Clear | No lamp fitted |
| 3 | ON OFF (Note 2) | Control of the paper-tape reader when terminal is in <i>off-line</i> or <i>on-line</i> modes | Clear | (i) Reader switched on with tape present (ii) Each time STEP control is operated |
| 4 | STEP (Note 2) | Steps tape one character through reader each time it is operated | Clear | No lamp fitted |
| 5 | SKIP (Note 2) | Steps tape one character through reader, without transmission or printing, each time it is operated | Clear | No lamp fitted |
| 6 | CR—LF | Gives one CR—LF action on printer when pressed and released; gives continuous LFs when operated for more than 1 s | Red | Printing positions 55–69 for <i>end-of-line</i> indication |
| 7 | ALARM | To draw operator's attention to terminal | Amber | (i) When the paper tape low, tape tight, and tape out sensors are operated (Note 3) (ii) Incoming call while in <i>local prep</i> mode (iii) J/Bell received from line (iv) Incoming call alarm (optional) (Note 4) |
| 8 | CALL | Initiates call establishment | Green | (i) <i>Proceed-to-select</i> received from exchange (ii) Incoming call (iii) Call established following interruption of <i>local prep</i> mode |
| 9 | CLEAR | Disengages terminal from line | Clear | No lamp fitted |
| 10 | LOCAL PREP | Allows off-line use for practice and tape preparation | Clear | In <i>local prep</i> mode |
| 11 | RESET | Resets terminal to <i>stand-by</i> from <i>local-prep</i> mode; cancels (optional) incoming call and J/Bell alarms | Blue | Incoming call while in <i>Local Prep</i> mode Incoming signal while in <i>tape prep</i> mode |

- Notes: 1. The label has a blue background corresponding with a marker on the paper-tape punch
 2. The label has a yellow background corresponding with a marker on the paper-tape reader
 3. The lamp glows steadily and the terminal emits an audible interrupted tone; these conditions remain until the cause of the alarm condition is removed
 4. The lamp flashes in synchronism with an audible tone alarm

single board, the use of cable forms, with their inherent liability to pick-up unwanted signals, is avoided. Three socket connectors are located at the front of the main board for the ribbon cable plugs associated with the tape punch, tape reader and keyboard units.

(b) Answerback and Option Board

This board carries the 20-character answer-back information and the facility option matrix. Selection is effected by cutting out diodes to give the required answer-back format and terminal configuration.

(c) Line Isolator Board

This carries all the circuits that interface the external transmission and control lines with the terminal's electronic control system. Isolation from high external voltages is provided. The external connexions are through a PWB-mounted D-type connector.

(d) Underline Marker Board

Discrimination between incoming and outgoing text is normally provided. If this facility is not required by the customer, removal of a link inhibits the operation. This board also carries components that electronically minimize the possibility of carriage bounce by delaying the resetting of the carriage feed pawl.

The main board is mounted horizontally beneath the print unit; the other three boards are mounted vertically under a removable cover at the rear of the print unit and cannot be interchanged because of offset connectors.

Distortion and Margin

As both the transmitted and received signals are processed electronically by using a crystal-controlled time-base, transmitter distortion and receiver margin are precisely determined and are not subject to change because of component wear, adjustment or lubrication state. The transmitter distortion is less than 1%, while the receiver margin is in excess of 45%.

Power-Supply Unit

This unit is self contained and totally enclosed, except for the ventilation apertures. Access to the electronics and connexion strips is through removeable covers. The equipment AC mains supply terminates within this unit and is distributed, via external connectors, to the elapsed time-meter (fitted as an aid to maintenance) and the induction motor; the latter is controlled through the internal motor-start relay contacts and the external start and run capacitor box.

A total of 8 stabilized, overload and over-voltage protected DC rail voltages are available from the power unit, though not all are used when the terminal is configured for ± 80 V double-current signalling. The rail voltages and uses are given in Table 2.

The terminal operates on an AC mains supply having a voltage in the range 210-240 V, 50 Hz, and power consumption in the quiescent mode is approximately 30 W. When operating, the power consumption is about 100 W.

TABLE 2
Power-Unit DC Rail Voltages and Use

| Voltage | Use |
|------------|---|
| +12 V | Positive rail for logic system, including LSI |
| -12 V | Negative rail for logic system, including LSI |
| +5 V | Supply for ICs |
| +30 V | Supply for keyboard resetting magnet |
| +32 V | Constant-current supply to charge print-hammer capacitor |
| ± 14 V | Supply for energizing function unit, tape punch, and tape-punch and tape-reader magnets |
| 15-0-15 V | Signalling supply for optional low-level output |

ANCILLARIES

Tape Reader

The paper-tape reader (see Fig. 7) is a completely self-contained unit, mounted to the left of the keyboard and in line with tape issuing from the punch; it incorporates spring-loaded taut-tape and tape-out sensors, and the character being read can be seen through slots in the tape gate. The tape hole/no-hole character code information is read mechanically through lightly sprung lever sensors, which directly activate single-pole twin contacts; the resulting 5-unit parallel output is fed to the electronic logic.

The mode of operation of the reader is read-before-feed, but the state of the code contacts is not transferred to the electronic logic until the feed electromagnet actually receives an energizing pulse: this allows the contacts maximum time to settle following tape movement. Operation of the electromagnet activates a feed pawl attached to the armature, which engages with a ratchet wheel on the same shaft as the tape feedwheel. Each operation of the armature advances the tape by one hole pitch (2.54 mm).

Paper-Tape Punch

The paper-tape punch unit is a separate entity which is attached to the left-hand side of the page printer (see Fig. 7), and is operated independently of the printer except for using the same motive system and source of control signals. Drive from the printer motor is through toothed belt reduction gear trains, which cycle the punch continuously at the character rate, in synchronism with the print wheel.

Rotary-to-linear motion for punching and stepping the 17.46 mm wide paper tape is obtained from an eccentric on the drive shaft. Punching and stepping occur at different points of the cycle to give a punch-before-feed action sequence, which allows viewing of the last character punched.

Six electromagnets control the punching of the 5 code holes and the smaller feed hole. A cam on the eccentric presents the electromagnet armatures to the pole-faces on each cycle; therefore, only a small holding current is required to maintain



FIG. 7—Paper-tape reader and punch units

the magnet(s) operated and effect punching action. Tape advance is by means of a friction drive, which impels the tape against the punch reference edge, and is linked to the action of the feed hole punch so that no movement occurs without a feed hole.

Forward movement of the central bar lever parts the feed rollers so that a new tape can be passed unimpeded through the punch from the tape reel. Operation of a second lever at the rear moves the tape backwards, one character pitch at a time, to provide for tape correction by overpunching. Paper cuttings from the punch are collected in a see-through plastics box, which can be readily removed for emptying.

LINE TERMINATING UNIT

For double-current signalling to the UK Telex network, an external terminating unit must be associated with the Teleprinter No. 23; the unit is compact and is connected to the teleprinter line isolator PWB by a signal cord. Its 80.0-80 V signalling supply is electronically stabilized and protected against overload by fuses and a resistor bulb (barretter). The transmitted signal passes to the SEND wire through a standard BPO low-pass T filter.

Connexion of the terminal to AC mains power is through the mains lead of the terminating unit, from which the power supply is distributed to the teleprinter and card callmaker (where fitted) by separate cords.

The terminating unit provides a suitable point for terminating the SEND, RECEIVE and SIGNAL EARTH wires of the exchange line, and those wires used for remote control and signalling from the card callmaker. A test facility disconnects the terminal from line, at the same time it switches in a local loop test circuit for full service checks.

OPERATIONAL FEATURES OF TERMINAL

Keyboard Layout

There are clear operational advantages to be gained, particularly in terms of operator training and conversion times, from having the keyboards of typewriters and Telex terminals as alike as possible. When the Telex service commenced in the UK, the teleprinter used (Teleprinter No. 7) incorporated a 3-row keyboard, which had only a very basic similarity to the, then, generally accepted typewriter keyboard layout. Its successor (Teleprinter No. 15), introduced in 1968, conformed with the BPO policy of trying to achieve the highest degree of commonality between the keyboards of these 2 classes of office machine: the 4-row keyboard used assigned one character per key and no variations in the original layout have been introduced.

The Teleprinter No. 23 has a refined version of the earlier 4-row keyboard, in which the typewriter practice of assigning 2 characters to some keys is incorporated, the uppermost character being selected by coincident operation with the SHIFT key. The layout (see Fig. 5) corresponds closely with the British Standard¹ for typewriter keyboards, a notable exception being the location of the + (plus) key in the numerals row because of its use in Telex as an *end-of-selection* signal.

Keys having a control function that relates directly to the line signal are integrated into the keyboard, but are differentiated by colour. The symbols incorporated are those specified by CCITT² and represent a departure from the previous BPO practice of using abbreviations. Those characters that are inadmissible for international Telex communication—ITA2 Combination Nos. 6, 7 and 8 (corresponding to %, @ and £, respectively in the UK)—have their symbols coloured red. The distinctively-shaped NEW LINE key has the same effect as the corresponding key on an electric typewriter, but the generated character sequence to line is *carriage return, line-feed, carriage return*.

Facility Options

It is expected that the Teleprinter No. 23 will be primarily used on Telex by the BPO, but that some terminals will be used in-house and on private-circuit telegraphs. A range of options is catered for, so allowing the terminal to be configured to meet many system and customer needs.

Facilities are selected through the presence or absence of specified diodes in the answer-back and option PWB. To save time and the need for soldering operations, the answer-back section of new boards is fully equipped with diodes; it is therefore only necessary to cut out the appropriate ones to give the required answer-back sequence. The diode arrangement in the facility section is wired to suit terminals for UK Telex operation; alternative system requirements are met through appropriate rearrangement of the diode straps.

The transmission rate to and from line may be at 50, 75 or 100 bauds and printer speed can be varied by changing the motor gear. The printer operation in the *local* mode can be at a higher rate than that dictated by the line signal, thus permitting consistently faster operation of the keyboard and punch during message preparation. For example, when sending or receiving a message over a 50 baud circuit, the printer would operate at 6½ characters/s; in the *local* and *tape prep* modes, it could be made to operate at 10 characters/s.

Effect of Interrupting Calls

If an incoming call occurs while the terminal is being operated in the *local* mode, the keyboard is immediately locked to prevent any further characters from being keyed. The punch is also switched off (with the last character punched corresponding to the last character printed), and the paper is advanced by 4 lines to separate the existing local record from the record associated with the incoming call. This safeguards the paper tape under preparation against corruption, and enables the terminal to acknowledge the call and to send the *answer-back* signal on receipt of the *whenever-you* signal without delay.

Simultaneous Tape Preparation and Transmission

When a connexion has been established an existing message tape can be transmitted in the normal way by using the paper-tape reader. If the LOCAL PREP button is operated, the keyboard, printer and punch (switched on automatically) can be used to prepare another tape, without any interference with this transmission. This simultaneous operation in *on-line* and *local* modes is known as the *tape prep* mode, and is maintained for as long as the connexion remains established, or until the *local* mode operation is cancelled by operating the ERASE button. If an incoming signal is received from line, the blue alarm lamp is switched on, the reader and punch are stopped (without mutilation of characters), the keyboard is locked and the carriage returned, simultaneously with the paper being advanced by 4 lines.

Transferability of Answer-Back and Option PWB

If it becomes necessary to exchange Teleprinters No. 23 for any reason, the answer-back and option PWB can be transferred to the alternative equipment, to produce the same answer-back response and terminal configuration.

Safety

It has long been BPO policy to make its teleprinters as safe as is reasonably practicable, so that operators, maintenance staff and the network are not subject to avoidable risks. A heightened awareness of safety needs has been created by new legislation, notably the Health and Safety at Work Act; this, in conjunction with the new technology used in the Teleprinter No. 23, has resulted in the incorporation of safety

features not previously found in similar office equipment.

Although the electro-mechanical content of the terminal has been much reduced, a few hazards remain to catch the unwary; these have been guarded against by operational safeguards and by the careful use of warning labels. If an operator raises the lid without first having disconnected the AC mains as instructed, possibly to replace the paper roll, then the drive to the motor is cut before a finger-sized gap appears. If access is attempted while an established call is in progress, this also has the effect of clearing down the call and extending the *ABS* condition to the exchange, thereby preventing incoming calls. Normal terminal operation, in any mode, is possible only when the lid has been fully lowered.

Hazards to maintenance staff can never be entirely eliminated, but their training makes them aware of the nature and location of the likely danger points. However, to minimize inadvertent contact, internal covers are provided; these must be removed before access to potential hazard areas is possible.

In order that a terminal can be operated fully during a maintenance examination, it is necessary to have an over-ride for the interlock that prevents operator access. A special switch has been provided for this purpose; the switch is inaccessible to an operator and cannot be left operated by maintenance staff when the main equipment cover has been replaced. A guard against possible non-insertion of the cover plug associated with the lid interlock is provided by the switching on of the red lamp associated with the *CR-LR* control and disconnection of the dial; only when this plug is restored does the terminal present its normal operating state.

Electrical safety is achieved through close attention to inter-unit earth bonding, and careful specification and containment of those items carrying AC mains. Isolation from the lines and control leads is through transformers and opto-couplers. Motor damage from over-heating is prevented by means of a thermal cut-out in the stator winding.

TESTER

A special-purpose tester (Fig. 8) is available as an aid to the maintenance of the Teleprinter No. 23. Known as the *Electronic Maintenance Analyser* (EMA), it has the BPO designation Tester No. 266A. The EMA is substituted for the main board in the base of the teleprinter, and allows testing of the mechanical units (printer, punch, keyboard and tape reader), correct functioning being indicated by means of a meter and lamps. It can also be used to test the voltage and ripple levels of the DC supplies from the power unit, but does not permit the testing of the PWBs. Protection is provided against fault conditions or malfunctions, which might otherwise cause damage to a PWB.

The EMA is intended as an aid to servicing and maintenance of the Teleprinter No. 23 under workshop conditions. It assists in determining whether a fault is mechanical or electronic in nature, and can be used to check a unit statically and dynamically for correct functioning following adjustment or replacement. These tests can be made to a more onerous specification than that required for correct operation using the main board.

All the accessories necessary to enable the EMA to be used with the Teleprinter No. 23 are housed within the lid cover, which also carries the operating instructions.

CONCLUSION

A high proportion of the total UK annual capital investment in Telex is allocated to the customer terminal apparatus; the introduction of a new teleprinter is therefore a significant event in the evolution of the national Telex service. A new Telex terminal (Teleprinter No. 15) was last introduced in 1968 and is currently being replaced by the Teleprinter No. 23.

With the introduction of the Teleprinter No. 23, a number



FIG. 8—Electronic Maintenance Analyser (Tester No. 266A)

of benefits are expected to accrue to both the Business and its customers. In particular, the use of modern technology has permitted the cost-effective substitution of electronics for complex mechanisms except for those basic functions related to printing, paper movement and tape punching/reading. Consequential improvements in reliability and versatility, accompanied by reductions in size, weight, sound emission, routine maintenance and first cost, have followed.

The Teleprinter No. 23 is the first full-capability electronic teleprinter to be provided by the BPO for Telex customers' use. It is a first-generation electronic terminal giving some enhancement in features and facilities over the equipment it supersedes, but, at the same time, retaining the virtues of simplicity of operation and giving good-quality printing.

Because of the pace of technical advances in electronics, and marketing pressures arising from the development of office systems and new services that will compete with Telex, the Teleprinter No. 23 is unlikely to be in production for as long as its predecessors; however, it is expected to give good service for many years, and to be a most useful machine in making the transition from the electro-mechanical teleprinters predominant today to the advanced electronic technologies that will be used in future Telex terminals.

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To meet the particular requirements of the BPO, the Teleprinter No. 23 is a variant of proprietary equipment designed, developed and manufactured by ITT Creed Ltd. to a Company specification. The author wishes to acknowledge the assistance of colleagues and ITT Creed in the preparation of this article.

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