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The Teleprinter No. 11

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This article gives an account of the development, features and use of the Teleprinter No. 11. Amongst other features, this machine incorporates new designs for the keyboard and typehead, an "orientation" facility on the receiving cam unit to facilitate maintenance, and an "end of line" warning mechanism. The Teleprinter No. 11 is replacing the existing Teleprinter No. 3 as the changeover from manual to automatic switching of teleprinter circuits proceeds.

Introduction.

WHEN teleprinter working was introduced into the inland public telegraph service of the British Post Office in 1928, the machine adopted was the Creed Teleprinter No. 3. This was a tape printing machine with a revolving type wheel, the type being inked by means of ink rollers which rub on the faces of the type. The keyboard layout and signalling code were almost identical to that already in use on the Murray Multiplex system; in this there is no separate "space" key, the "space" function being obtained by the depression of the "letter space" or "figure space" keys, and so inversion is always accompanied by spacing of the tape. In addition, as the machine was only intended for tape printing, no provision was made for "carriage return" or "line feed" signals. The keyboard was motor driven, the depression of a key merely serving to trip the transmitting mechanism and determine the 5-unit code combination to be transmitted, the remaining functions of setting up the code and transmitting the signals being carried out automatically. The signalling speed was 49 bauds, i.e., each unit element had a duration of 20·4 mS.

When international agreement was reached on the signalling code and speed for start-stop telegraphy, a code suitable for page printing was adopted, the "letters" and "figures" functions were divorced from the "space" function and the signalling speed was fixed at 50 bauds. By this time however, the Post Office had some two thousand Teleprinters No. 3 in service, and it was decided to retain this machine for use on the inland public network, on which it has continued to give efficient and reliable service.

The Teleprinter No. 7 was introduced in 1932 for use on Telex and private wires. This was basically a page printing machine, although it could be fitted with a tape printing attachment, and conformed to the C.C.I.T. (International Telegraph Consultative Committee) requirements referred to above. Thus, although it could not interwork with the Teleprinter No. 3, it could operate to machines constructed to the same standards by European manufacturers, and private wire and Telex subscriber working to the Continent became possible.

The Teleprinter No. 7 was similar in operation to the Teleprinter No. 3 except for such modifications as were necessary to provide page printing. There were, however, considerable changes in detail to improve reliability and facilitate maintenance. The mechanical design of the machine was based on unit construction principles which facilitated manufacture and assembly and ensured interchangeability of units for maintenance purposes. An ink ribbon replaced the ink rollers, giving cleaner operation and more legible printing.

The Teleprinter No. 7 is still the standard machine which the Post Office supplies to private renters and Telex subscribers, although a number of changes have been, and are still being, introduced to improve its performance. One of the most important of these was the introduction in 1939 of the "striker" transmitter, which ensures much more accurate timing of the output signals than could be obtained with the "link" transmitter which was used on the No. 3 and the earlier No. 7 teleprinters.

The question of reconstructing the public telegraph network on an automatic switching basis was under very active consideration in the years preceding the war and field trial equipment had been designed and tested. At that time it was intended to employ Teleprinters No. 3 as the operating instruments. All work on the project had to be abandoned during the war years, but the matter was immediately reopened on the cessation of hostilities in 1945. In the following year it was decided that the teleprinters to be used on the network should conform to C.C.I.T. standards, so that there would be no restriction on future extension of the system to private or international switching networks. Certain additional features, not available on the Teleprinter No. 3 without extensive modification, were required to enable the machine to operate over an automatically switched system, and it was decided to adopt a new teleprinter which was under development by Creeds at the time, and on which the additional features could be incorporated. This was the Creed Model 47, which became the Post Office Teleprinter No. 11.

The first prototype machine was inspected at various stages of its construction and towards the end of 1947 a sample model became available for tests by the Post Office. This machine did not embody all the features required for automatic switching, but a limited number was purchased and installed on point-to-point circuits so that field experience of the new machine could be obtained at an early stage. These machines were known as the Teleprinter No. 11A.

Meanwhile development of the additional facilities went on, and some 250 machines embodying all the required features were brought into service when the first automatic switching centres were opened at London North and Birmingham in October, 1950. These machines were designated Teleprinters No. 11B. A further 2,000 machines have since been purchased in preparation for the expansion

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of the automatic switching scheme during 1953-1954.

During the development of the Teleprinter Automatic Switching System it became apparent that it would be an advantage if the teleprinters installed on the engineering test positions, which were necessarily Teleprinters No. 11B in order to provide the required terminating facilities for automatic speaker circuits, could also inter-operate with Teleprinters No. 7 on private wires which could be routed through the same engineering control board. It was also desired to use Teleprinters No. 11 on the switchboard positions on the Inland and Continental Telex systems, because the visibility of the printing was much better than that of the Teleprinter No. 7 with tape attachment, and to extend their use to the manual switchboards used with various private wire networks. The keyboard layout and signalling code already conformed to that of the Teleprinter No. 7, so that all that was necessary was the addition of an "end of line" mechanism and warning lamp. Machines with this facility are known as Teleprinters No. 11C, and 450 have now been purchased by the Post Office. Fig. 1 shows one of

FIG. 1.—TELEPRINTER NO. 11 WITH COVER ON.

the machines with its cover in position and carrying a message tray with two compartments.

General Design Features.

The Teleprinter No. 11 is largely of orthodox design and makes use of many of the mechanisms and principles of operation employed in the Teleprinter No. 7, and in fact a large proportion of the parts are common to the two machines. Fig. 2 indicates the principal units included in the new machine.

The keyboard, described in more detail later, is a departure from previous designs, being of the "saw tooth" type in which the operation of depressing a key, in addition to releasing the transmitting mechanism, positions the combination bars which determine the code to be transmitted. The merit of this arrangement lies largely in the "touch" and in the fact that the keyboard is automatically locked against the depression of a second key without the need for a separate locking bar.

The transmitter is of the "striker" type similar to that used on the Teleprinter No. 7, but with the components rearranged to operate from the saw-tooth keyboard.

On the receiving side some improvements in the design of the electromagnet have been introduced, increasing the stability and facilitating adjustment. The selecting mechanism embodies an orientation device which provides a means of checking and centralising the receiving margin. An improved typehead clutch has also been introduced.

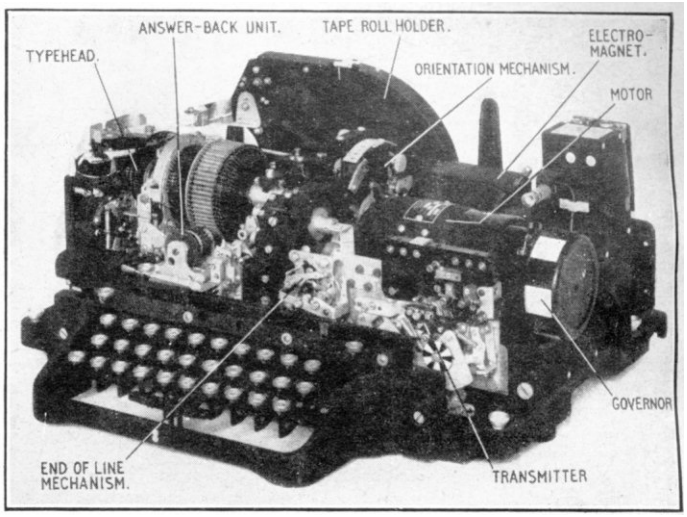

FIG. 2.—FRONT VIEW OF TELEPRINTER NO. 11; COVER REMOVED.

Of general interest is the widespread use of new materials and manufacturing techniques. Great use has been made of zinc alloy (Mazak) die castings for smaller parts. This process permits the manufacture of large numbers of parts to extremely close dimensional tolerances. In contrast to the Teleprinter No. 7, ball bearings are used for only four of the main bearings, oil impregnated sintered bronze bushes being used for the remainder and also for many of the minor pivots.

The Keyboard.

The principle of operation of the saw-tooth keyboard is illustrated in Fig. 3 from which it is seen that a particular keybar when depressed engages with the sloping edges of triangular projections on each of the five combination bars and a trip bar. The combination bars are thus moved to the right or left as required for the particular code sequence to be transmitted, while the trip bar is moved to the left to release the transmitter mechanism. The layout of the keys finally adopted conforms to that used on the Teleprinter No. 7 except that the "WRU" signal, which is the secondary case of letter D, is provided on a separate key, and a shift lock bar operated by the "figures" and "letters" keys ensures that the D key cannot be depressed following a figure shift, which, of course, would result in the sending of a WRU signal. This feature, and the placing of the WRU key at the rear out of the normal key field, guards against the accidental sending of a WRU signal and the consequent release of the distant answer-back during operating. Two additional keys have, however, been added, namely a "Here is" key and a "Run out" key. The depression of the "Here is" key releases the answer back unit so that the answer back code may be transmitted at will to the distant end of the circuit. The "Run out" key provides continuous transmission of any chosen character from the transmitter, the character sent corresponding to the last character key depressed. This is possible because the combination bars on the saw-tooth keyboard are not restored to one side at the end of each character transmission, as in the motor driven keyboards used by the Post Office on Teleprinters Nos. 3 and 7, but remain in the position corresponding to the last character sent. The operation of the "Run out" key releases the transmitting cam and consequently causes the continuous transmission of this character until the key is released.

The keyboard used by the Post Office employs three rows of keys, and each key, with a few exceptions, is used to transmit two characters, the primary being a letter and the secondary a figure, punctuation sign, etc. The change of case at the receiving machine is controlled by the operation of the "letters" or "figures" key, and failure to perform

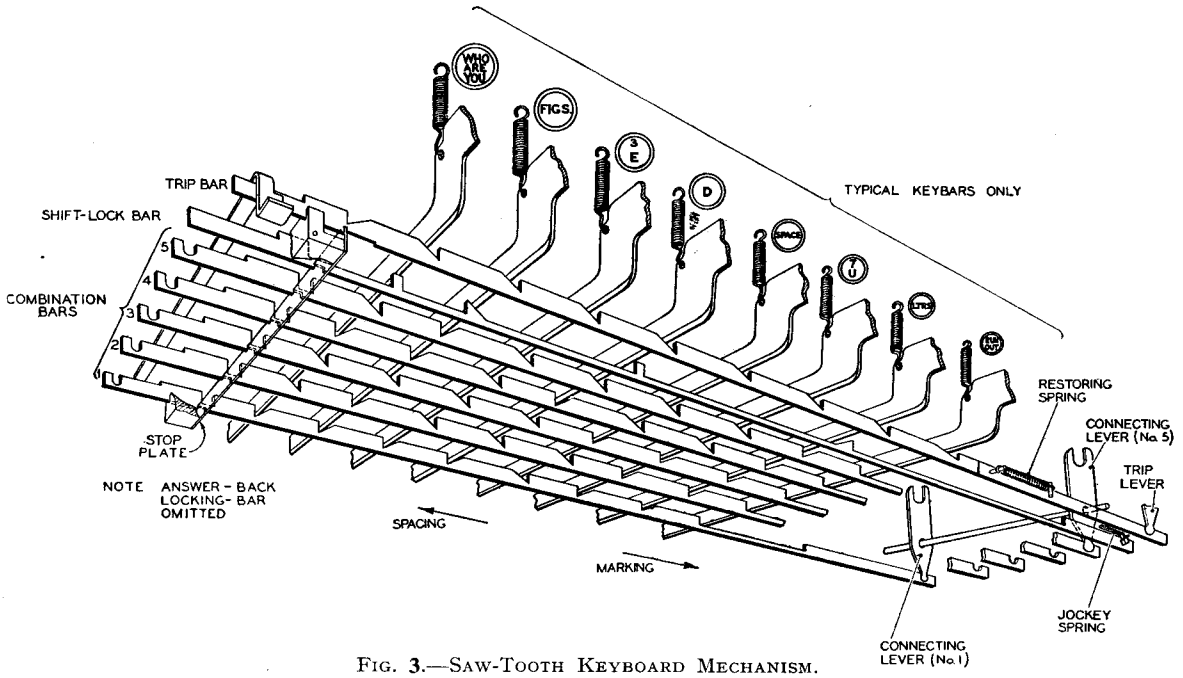

FIG. 3.—SAW-TOOTH KEYBOARD MECHANISM.

this operation will result in incorrect reception. It may be of interest to mention that a keyboard has been designed by Creeds which eliminates this cause of error but at the expense of an increase in size and complexity. In this keyboard, which uses four rows of keys, the first three rows are used for letters only, the keys in the fourth row being used for figures in the primary condition and punctuation signs, etc., in the secondary condition. When the "letters" key is depressed the keys in the fourth row are locked against operation, and when the "figures" key is depressed the keys in the first three rows are locked. In order to transmit the secondary character of a key in the fourth row a separate manual shift key must be held depressed.

Another interesting variant of the saw-tooth keyboard, which may also be fitted to the Teleprinter No. 11, has been produced by Creeds, principally for alphabets with more than 26 letters. When such alphabets are employed with the standard start-stop 5-unit code, it is necessary to place one or more letters in the "figures" case. To avoid the necessity of memorising these letters, a specially designed transmitter can be supplied which automatically inserts the correct case-shift signals whenever the operator changes case.

The Orientation Facility.

An innovation of importance from the maintenance aspect is the provision of an orientation facility on the receiving cam unit. The actual cam is made identical, as regards cam tracks and period of revolution (130 mS), with that of the Teleprinter No. 7 but the rest position as determined by the retention pawl is advanced approximately 22 mS. A mechanical delay system (see Fig. 4) incorporating a clutch-driven cam and giving a delay adjustable between about 12-32 mS is introduced between the electromagnet armature and the receiving cam pawl abutment. With the delay mechanism in its mean position the receiving cam therefore starts to rotate some 22 mS after the commencement of the start signal and comes to rest again 130 mS later. This, of course, does not interfere with the normal start-stop operation of the teleprinter. The orientation device enables the selection periods of the receiving cam to be centralised with respect to the five code elements of the incoming signal so that the teleprinter can be adjusted to the optimum state for receiving signals over a

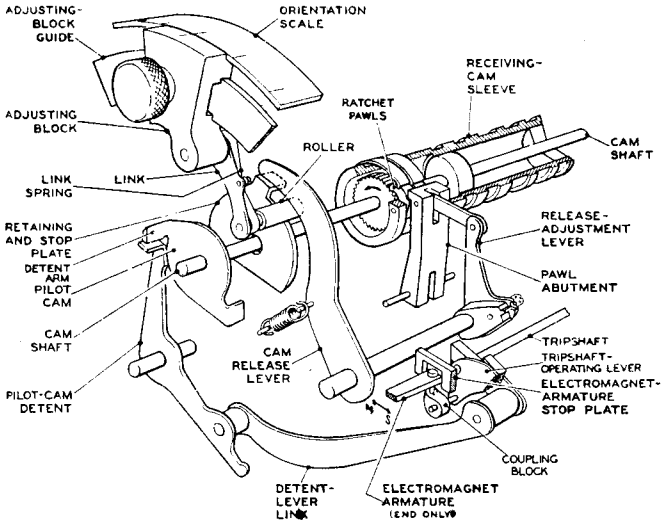

FIG. 4.—ORIENTATION MECHANISM.

particular line. In a switched system, in which a machine must receive signals equally well over any circuit, the use of the facility is of limited value but by connecting the teleprinter "in local" an approximate check of receiving margin can be made. On previous teleprinters there had been no ready means of checking margin in the field and the advantage of providing a margin testing feature for maintenance and also the desire to assist the manufacturers in standardising their production led to the adoption of the facility.

The Typehead.

The typehead of the Teleprinter No. 11 is a complete departure from previous design. The construction of the driving clutch and the latch mechanism is shown in the assembled and exploded views given in Figs. 5 and 6. The stop arm and the latch arm are assembled scissor fashion on the typehead spindle together with oilite friction washers, the whole being sandwiched together by the stout axial compression spring. Two shock absorbing springs are inserted between the cups mounted in the two arms. When released the typehead is driven by a clutch of the conventional drum type which slips when the typehead is latched to

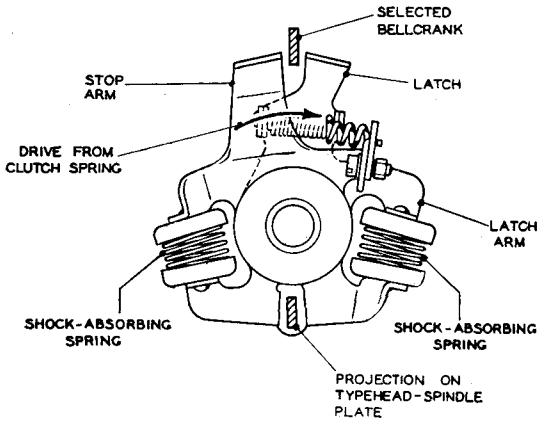

FIG. 5.—THE TYPEHEAD; ASSEMBLED.

a "fallen" bellcrank. In the latched position the bellcrank is gripped between the stop face of the stop arm and the latch on the latch arm while the rear ends of the two arms grip a projection on the typehead spindle and thus locate the type racks. The initial shock of the impact between the stop arm and the "fallen" bellcrank is absorbed by the two shock absorbing springs. After impact the two arms make two or three oscillations about their common axis before coming to rest gripping the bellcranks, during which interval the energy of rotation temporarily stored in the shock absorbing springs is dissipated in overcoming the mutual friction developed by the compression spring. In order to allow time for these oscillations to be damped, the speed of rotation of the typehead shaft has been made greater than on the Teleprinters No. 3 or 7.

The performance of the new typehead clutch has been very satisfactory, the fault rate being about one eighth of that of the clutch previously used on the Teleprinter No. 7. As a matter of interest it may be mentioned that Teleprinters No. 7 are now fitted with a similar clutch.

Tape Feed Mechanism.

Experience with the Teleprinter No. 3 had shown that some changes in the tape feeding mechanism were desirable. In the Teleprinter No. 3 the roll of tape is housed inside the cover and the heat generated by the motor frequently causes cockling of the paper with a consequent liability for turns to come off the roll and become jammed in the tape roll holder. The tape roll holder of the Teleprinter No. 11 has, therefore, been mounted outside the cover; this has the additional advantage that a new roll of tape can be fitted without removing the teleprinter cover.

The inking of the types is effected by means of an ink ribbon, in place of the ink rollers used on the Teleprinter No. 3, which, although mechanically simpler, are not so satisfactory in use. The whole of the casting on the left-hand side of the machine, which houses the ink ribbon, platen and paper feed mechanism, is hinged at its base so that it may be swung outwards away from the typehead for maintenance operations.

Paper Failure Alarm Mechanism.

In order to effect operating economies it is an advantage to be able to rely on the reception of the answer back at the office of origin at the beginning and end of a transmission as a sufficient acknowledgment of receipt of the message at the office of destination, and thus to dispense with continuous attendance at the receiving machine. Under these conditions failure of the paper to feed correctly could cause message failure and a reliable paper failure alarm is essential. As it was further decided that the operation of the alarm should release the switched connection as an indication to the sending operator, it was also essential that the alarm should not be prone to false operation, otherwise artificial traffic in the form of repeat calls would be created.

In order to appreciate the problem fully it is necessary to define the fault conditions to which the alarm mechanism must respond. These are (*a*) breakage of the tape, (*b*) jamming of the tape not followed by breakage, (*c*) failure to feed the tape sufficiently so that overprinting of successive characters occurs. The device incorporated by Creeds in their original Model 47 prototype was designed with these

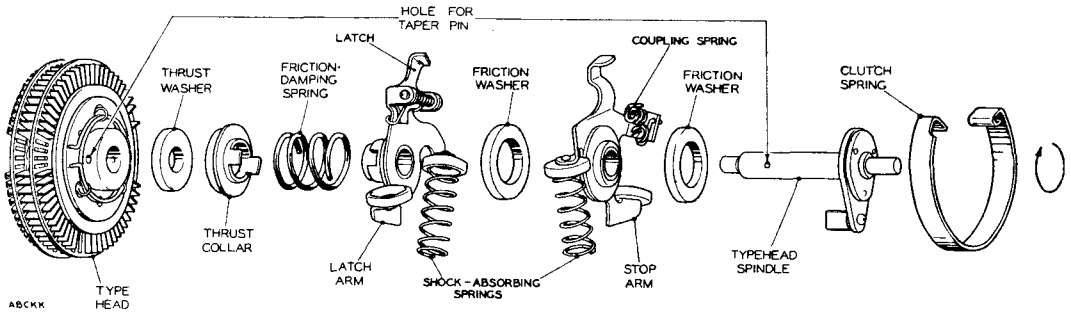

FIG. 6.—EXPLODED SKETCH OF TYPEHEAD.

requirements in mind but subsequent tests showed that it was liable to false operation either during or following manual feeding of the tape, whether by turning the tape feed knob or pulling the tape from the machine. Since a manual feed operation is the normal procedure in order to get the end of a message out, it followed that the first paper feed movement of the subsequent message was likely to be defective and the alarm operated. Another factor which contributed to indeterminate operation of the paper failure alarm was the presence of slack tape between the tape roll holder and the alarm mechanism. This was overcome by redesigning the roll holder with a simple brake mechanism controlled by the tape tension which may be seen in the top right-hand corner of Fig. 7.

The elements of the alarm mechanism finally adopted are shown in Fig. 8. The tape is taken off the roll holder on the left (not shown) and is moved to the right by the tape feed

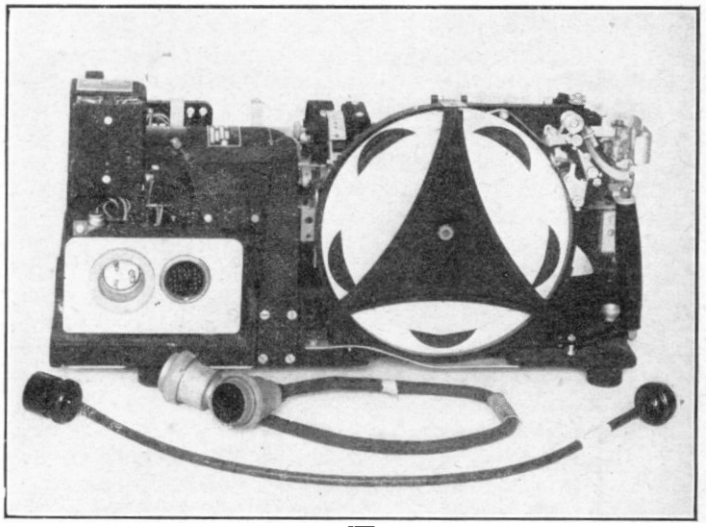

FIG. 7.—REAR VIEW OF TELEPRINTER NO. 11; COVER REMOVED.

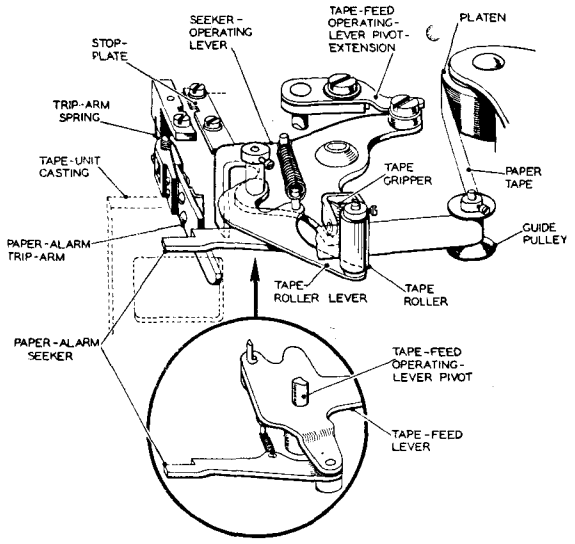

FIG. 8.—PAPER-FAILURE ALARM MECHANISM.

mechanism. The tape is lightly gripped, over its full width, by the spring-loaded jaws of a tape gripper mounted on a pivoted member known as the seeker operating lever. This lever is reset to the left-hand position against a stop plate at the end of each tape feeding operation and is moved by the tape during the subsequent tape feed, the movement being proportional to the tape feed. A projection on the seeker operating lever bears against the paper alarm seeker moving it forward. Simultaneously the seeker is withdrawn to the right during the forward movement of the tape feed ratchet pawl and is moved back to the left during the return motion. If the step at the end of the seeker has not moved sufficiently forward to clear the shoulder on the paper alarm trip arm the latter is displaced and in turn releases a spring-loaded contact operating lever. The forward movement of the seeker is determined by the actual movement of the tape and the design and the adjustments are such that the alarm contacts are operated when the paper movement is somewhat less than half of normal. This degree of overprinting may be tolerated as it represents the condition in which adjacent characters just touch. It should be mentioned that the tape feed ratchet pawl is adjusted so that in the normal rest position there is a lost motion equal to half a tooth pitch. This ensures that however the pawl may be left relative to the ratchet (e.g., by manual operation of the feed knob) the resultant feed cannot be less than one half normal unless a genuine paper fault condition exists.

When a paper alarm condition is set up it is cleared automatically, as far as the machine is concerned, when the next normal tape feed occurs although it is maintained by the position equipment until attended to and a reset key operated. This eliminates the need for any manual alarm resetting facility on the teleprinter itself.

The Motor.

In the automatic switching system as developed by the Post Office, the teleprinter is switched on at the beginning of each call and switched off at the end. In addition, the transmission of the answer back from the receiving machine at the beginning of a call is initiated automatically. It is therefore necessary for the machine to reach its full operating speed in a very short time, and the design features of the scheme imposed an upper limit of one second for a machine to reach its governed speed.

After a considerable amount of work had been done on the measurement of motor starting times and investigation of the possible causes of slow starting it was decided to redesign the motor windings, taking full advantage of the motor frame size to obtain a higher starting torque. The result was a more powerful motor which met the starting time requirement but, as experience has now shown, at the expense of some reduction in brush life. Further investigations are now being carried out to attempt to effect an improvement and some promising results have been obtained using brushes of a different grade of carbon.

The motor used by the British Post Office is a two-range D.C. motor wound for 160V and 200-250V. Motors for other voltages, both A.C. and D.C., are available, though they would not necessarily meet the requirement for a starting time of one second.

Check of Motor Speed.

The means available for measuring teleprinter speed had long been considered in need of improvement, and the introduction of a new teleprinter afforded the opportunity for adopting new methods. It was ultimately decided to provide a twofold check of speed, firstly by a speed test circuit in the switching centre transmitting reversals at a definite frequency, access to which could be obtained by dialling a specified number* and secondly by a tuning-fork-type stroboscope. The first was intended for routine checking of speed and accurate final adjustment of the governor; the second for use by a mechanic while adjusting a governor, to avoid holding the speed test circuit for an excessive period, and also for use where there was no access to the speed test number. Fundamental considerations led to different frequencies being chosen for the two methods, the band width of V.F. channels limiting the frequency of the speed test signal, and size and cost precluding a tuning fork of too low a frequency. Frequencies of 20 c/s and 150 c/s, respectively, were eventually chosen as most suitable from a variety of points of view including the available shaft speeds on the teleprinter, technical considerations in the production of tuning forks and the generation of signals by the signal generators at a switching centre. Two sets of stroboscopic markings were therefore provided on the teleprinter; six segment markings on the governor cover for use with the tuning fork and a six segment disc on the transmitter shaft for use with the speed test number. The latter can readily be made to revolve continuously by depressing the run-out key.

Connecting Cords.

The long cords generally fitted to teleprinters are inconvenient when the machine has to be moved or packed for transport. It was therefore decided that on Teleprinters No. 11 supplied to the Post Office the power and signalling connections should terminate on shrouded pin jacks on the machine and double-ended cords would be used for making the connection to the position equipment (see Fig. **7**). These cords remain on the position when the machine is removed.

"End of Line" Indicator.

An end of line mechanism and warning lamp were already available on Creed's standard machine. This indicator was therefore adopted after test, and its basic elements are illustrated in Fig. **9**; machines thus fitted are designated "Teleprinter No. 11C".

The mechanism counts each character transmitted, including the non-feed characters, lights a lamp after **55** characters have been sent and restores when the carriage return key is depressed. The end of line counter parts are mounted on the same base plate as the transmitter. A cam track on the transmitter moves link AR (Fig. **9**(*a*)) to the right once per revolution of the transmitter and in doing so causes a feed pawl, FP, to rotate ratchet wheel R one tooth.

* *P.O.E.E.J.*, Vol. 44, p. 107.

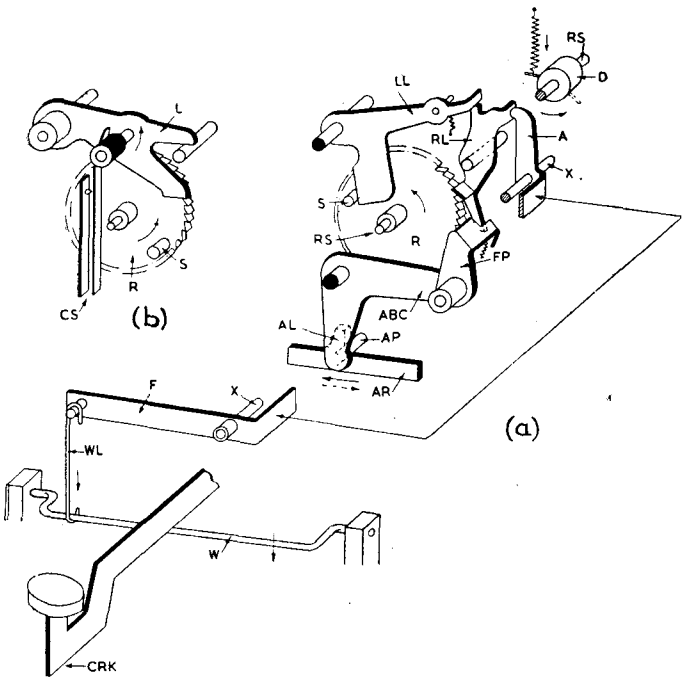

FIG. 9.—"END OF LINE" MECHANISM.

A retaining pawl, RL, prevents backward movement. As the ratchet wheel rotates a spring is elongated and partially wrapped round a drum, D. After 53 teeth have been fed stud S (Fig. **9**(*b*)) touches contact operating lever L, and after 55 teeth the contacts CS are fully operated. The periphery of the ratchet wheel is left blank after 55 teeth to prevent further rotation. When the carriage return key, CRK, is depressed (which of course may occur at any time) the cranked trip rod W is rotated and in turn causes the operation of the resetting lever (F and A). This in turn displaces RL which is held out by a latch, LL. The ratchet wheel is thus free to restore under the tension of the spring, and the lamp contacts are opened. At the end of the movement of the ratchet wheel, S strikes LL and releases RL. A damping buffer (not shown) is provided to absorb the shock of the return motion.

The end of line indicator lamp is mounted on a bracket above the governor and shines through a red faceted glass window in the front of the cover. It is sufficiently bright to attract the attention of the operator under the worst room lighting conditions. The choice of a suitable lamp caused some difficulty due to destruction of the filament by vibration and it was early found that a 160 V lamp had an exceedingly short life. Eventually a 6V, 0·3A filament lamp was selected as being the only standard item suitable.

Further Developments.

It will be appreciated that in a machine of the complexity of a teleprinter continual development work is proceeding to improve performance, facilitate maintenance and simplify manufacture. Such changes are introduced as soon as possible on new machines during manufacture, and may be applied to old machines during normal maintenance visits or overhaul if the cost is considered to be justified.

As already mentioned many parts are identical with Teleprinter No. 7 parts and some of the development work has been on parts common to both machines. A friction clamped speed adjusting screw, for example, has been introduced on the governor, with an access hole in the governor cover to facilitate maintenance. A more recent innovation has been the redesigned electromagnet unit the main features of which are the hardened steel stops on the armature, a stop plate rigidly mounted on the unit casting, oil impregnated bearings for the armature, a means of adjusting the polarising flux and the addition of a cover.

A further change, approved but not yet implemented, concerns the paper failure alarm parts which, as can be seen in Fig. **1**, overhang the left-hand side of the machine. This arrangement is somewhat unsightly and there is a certain risk of damage during handling. By careful redesign Creeds have been able to produce a more compact mechanism.

An important point on which development effort is now being concentrated is the abatement of noise. Although the Teleprinter No. 11 is not appreciably noisier than many other machines in the same class, the modern tendency is to demand a lower noise level in offices than has been accepted in the past. This is particularly important where the teleprinters are installed adjacent to phonogram positions. The problem has been tackled by the Post Office and Creeds with the object of reducing the noise at source, but although this focused attention, for example, on the advantage of obtaining a greater accuracy in the cutting of gears than had been required in the past, the best results have so far been obtained by standing the machine on a felt pad and lining the dust cover with hessian to damp its vibrations. Further development is now proceeding towards enclosing the machine completely in a new type of dust cover. The machine is resiliently mounted on a rigid sub-base on which the cover is also resiliently mounted, and the vibration of the machine is thus insulated both from the cover and from the table. Promising results have been obtained with the first sample, which possesses good sound reducing qualities but adds little to the overall dimensions or weight of the machine as compared with the present cover.

Conclusion.

The 250 Teleprinters No. 11B referred to in the introduction have now been in use for over two years. They have given very satisfactory service and show a fault liability somewhat lower than that of Teleprinters No. 7. As a result of experience on these machines and also on the Teleprinters No. 11A some modifications to design have been made on those parts which produced the larger proportion of the faults, and it is expected that machines from later production will show an improved performance.

Book Review

"Power Cables: Their Design and Installation." C. C. Barnes, A.M.I.E.E., A.I.I.A. Chapman & Hall. 272 pp. 68 ill. 35s.

This is the fourteenth volume of a series of monographs on electrical engineering.

It is a businesslike book of 272 pages and there are nearly 70 tables giving an impressive amount of technical detail of power cables. Much of the mathematics has been reserved to appendices and a good balance between theory and practice has been maintained. The book is very readable. There is a bibliography of 111 references. The chapter headings include:– Design Requirements, Core Identification and Assembly, Mechanical Protection, Power Cable Testing Requirements, Calculation of Permissible Current Rating, Intermittent Rating, The Effect of Short Time Peak Loads and Short Circuits on Cables already Loaded, Oil-filled and Gas Pressure Super-Voltage Cables, Overseas Super-Voltage Cable Development, Power Cable Manufacture, Installation, Effects of Grouping, Jointing and Terminating, Cable Faults, Modern Submarine Power Cables, High Voltage Direct Current Transmission, Care and Maintenance.

As so many people find that "one look is worth a thousand words" it is to be regretted that most of the photographic illustrations are too reminiscent in size and quality of the early cigarette pictures; otherwise this is a very good book for the engineer concerned with the distribution of electricity.

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