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# The "MITE" Teleprinter

New, small telegraph page printers now under development by the Teleprinter Corporation weigh only 12 pounds and are entirely compatible with existing teleprinter apparatus. They embody radical innovations in design and are said to be the first practical teleprinters of their weight and size. Companion equipment will include a miniaturized transmitter-distributor and a reperforator.

A NUMBER of new "data read-out" devices have been developed in recent years to keep pace with the requirements of automatic digital computers. The outputs have taken the forms of cathode-ray indicators, magnetic tape, punched cards and tape, smoke printing, magnetic printing and electrostatic printing, as well as alphanumeric page printers.[1] Page and tape printers have been used for many years in communication circuits and have been made to operate in response to as many as eleven types of Morse, synchronous printer and start-stop printer codes.[2] Many of the new types of equipment, however, have required special input signals, operate at high speed, or are otherwise not compatible with existing communication equipment.

Civilian and military users have indicated that, although they anticipate a need for higher speeds in their communication circuits, they will probably use printers operating from the telegraph start-stop code for some time to come.[3,4] The armed forces find it increasingly desirable to add electronic aids to their mobile and airborne units but are naturally reluctant to increase the size of vehicles and aircraft. Civilian users are increasingly aware of the desirability of printed communications and of a print-out device compatible with those systems most generally in use. In both these connections the characteristics of reduced weight and cube, lower power consumption, and lower initial costs and maintenance become increasingly important.


Figure 1. MITE with keyboard in operating position

## General Characteristics

It was with these facts in mind that the Miniaturized Integrated Telegraph Equipment (MITE) was developed. The initial machines were designed with a view toward both commercial and military

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specifications. It is believed that this small, lightweight printer has a place both in communication services and in certain computer applications. It is not intended to compete with high-speed units such as a recently announced digital printer which prints 10,800 lines (the equivalent of an average book) in one minute. The MITE is a page printer which weighs only 9 pounds when receiving only and 12 pounds when fitted with a keyboard, for sending as well as for receiving. The printer unit is 3½ by 8 by 12 inches. The keyboard unit is 1½ by 8 by 12 inches. The carrying case is 5 by 11 by 12½ inches. The carrying case weighs approximately 4 pounds so the whole equipment weighs 16 pounds when packed up and ready to move. Figure 1 shows the MITE with the keyboard in the operating position. The keyboard can be pushed back under the printer, or it can be removed altogether as shown in Figure 2.

The machine operates up to 100 words per minute with the standard 7.42-unit Baudot code but future models are expected to operate up to 200 words per minute if the code pulses are fed to the machine simultaneously. The machine is completely compatible with 7.42-unit code machines and can be converted in a matter of minutes to 60, 66, 75 or 100 words per minute operation by changing one externally mounted gear. Actually there is nothing inherent in the design of the machine which limits it to this type of code and special machines are being built to operate with other codes. Both the keyboard and type cylinder can be changed to accommodate weather symbols or, in fact, to any desired selection of characters or functions up to a maximum of 64. (Two of these are shift from lower to upper case and the reverse shift from upper to lower.)

## A New Approach to Character Positioning

One of the design objectives was to produce a machine capable of high-speed operation wth a minimum of high-speed mechanical motions. This demanded a radically new approach to the method of deriving 64 mechanical positions from the five intelligence pulses in the start-stop code.

One of the basic principles used in the MITE is illustrated in Figure 3. This uses a unique application of one of the six "simple machines"—the pulley. It will be seen that if one end of the string is fixed and the other end is attached to a weight,

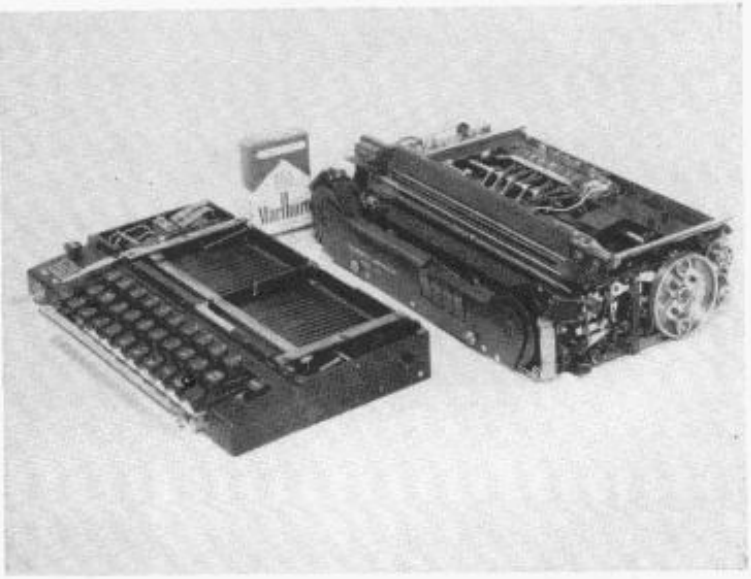

Figure 2. MITE with keyboard removed

a ½-inch movement of any pulley in a vertical direction will move the weight one inch. Next, suppose that each pulley is moved a different distance. Then the weight can be moved to any one of five different positions, depending on which pulley is moved. Finally, consider the possibility that each pulley is moved from its resting position twice the distance that the previous pulley travels and consider, also, that from one to five pulleys are moved at the same time. It can now be seen that there are 32 evenly spaced positions of the weight for all of the possible

combinations of pulleys moved or not moved.

If a strip of type were substituted for the weight, then an elementary character

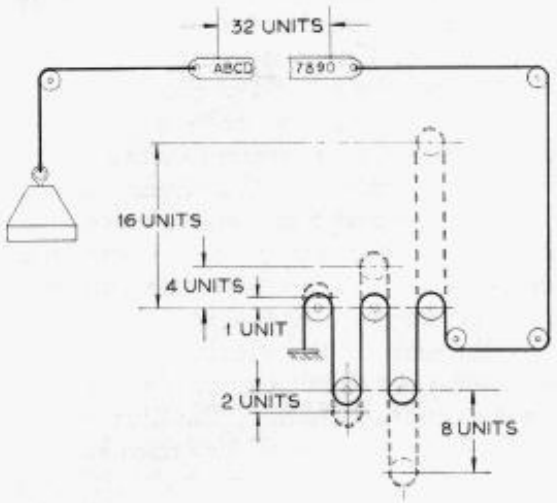


**Figure 3. Schematic of a simplified print positioning device**

positioning device will have been provided. The 32-character length of the strip would, however, require a rapid motion of the type strip if the first and last letters on the strip were called for sequentially.

The space and motion requirement could be reduced by arranging the letters in the form of a rectangle 8 characters long and 4 characters high and employing 2 coordinate motions. The space and motion requirement could be still further reduced by folding the rectangle into a half cylinder 8 characters long and with 4 faces, and converting the linear coordinate motion used to choose one of the four up and down positions of the rectangle to rotary motions up to 180 degrees. This has been done in the MITE with an 8-sided type cylinder which is 8 characters long. (See Figure 4.)

The 32-position half cylinder derived from the 5-pulley system is represented by 4 faces of the 8-sided cylinder and 8 lateral positions along those faces. The opposite 4 faces of the cylinder and the 8 lateral positions along those faces represent the "upper case" of the 32 basic positions so that the cylinder is rotated 180 degrees by the selection of "letters" or "figures" (lower or upper case), and the selection within that 180-degree segment is achieved by the basic 5-pulley system. Since a space is designated on the cylinder for every character or function

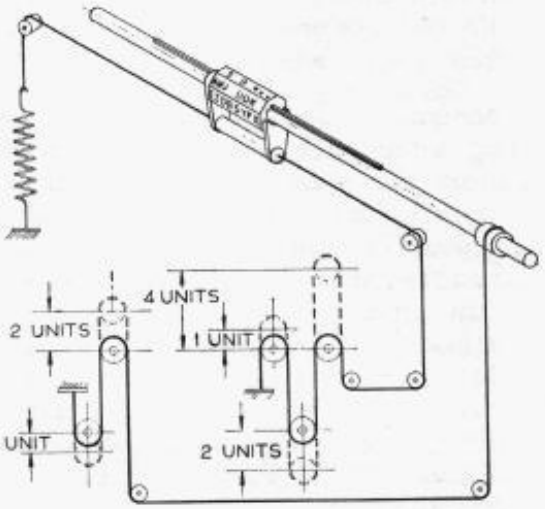


**Figure 4. Schematic of print cylinder positioning method used in the MITE**

that can be selected, the cylinder provides for 64 possible characters and functions, two of which are "letters" and "figures." In this way a small cylinder can accommodate 64 characters of standard teleprinter type. In operation the first two of the five intelligence code pulses control the rotary selection motions of the type cylinder while the last three pulses control the lateral motions.

## The Selector

The problem of arranging for the proper pulley to respond to the appropriate signal pulse is met by the selector in conjunction with motor-driven camshafts.

*Synchronization.* Synchronization of the MITE printer with the transmitted signal, as with other 7.42-unit code printers, makes use of two pulses in addition to the five intelligence signal pulses. These are referred to as the "start" and "rest" or "stop" pulses. The start pulse effectively starts the rotation of the timing camshaft by releasing the start clutch. The rest pulse which is 1.42 units long occurs between the fifth signal pulse and the start of the next start pulse, and allows a margin of error to exist between the

motor speeds in the sending and receiving machines. The receiving camshaft rotates faster than the corresponding transmitting camshaft and comes to a stop during the stop pulse, while the transmitting camshaft will rotate continuously during a continuous automatic transmission such as from a tape transmitter.

*Reduction of Mechanical Speeds and Load.* In the MITE, the mechanism which controls the pulleys, and consequently the type cylinder, is arranged to reduce the speed of operation and mechanical load on the machine by gradually positioning the type cylinder while the signal pulses are being received, rather than by storing the pulses mechanically as they are received and beginning the positioning of the type after the receipt of the last intelligence pulse. For this reason, and because the type cylinder is located behind the printing medium, there is no need for a neutral position of the type cylinder; consequently, in the case of a repeated character, the pulleys and cylinder do not move.

*Selection.* Each of the five type-positioning pulleys described above is positioned by a cam follower passing through the pulley housing. The cams which move these followers are each coupled to a clutch. The five clutches and their cams are mounted on a continuously driving shaft on which the clutches freewheel when not engaged and to which they are capable of being sequentially coupled.

In response to its signal as received by the magnetic selector, each clutch will either engage the driving shaft for a 180-degree rotation or hold its position. The action of the clutch in each case depends on whether a mark or space signal is received and whether the clutch was left in mark or space position by the previous selection. If, for example, the No. 1 pulse for a given selection is a mark pulse, and if the No. 1 pulse of the preceding selection was a mark pulse, the No. 1 clutch will remain stationary. If a spacing pulse is received for No. 1 and the preceding No. 1 was a mark, the clutch will engage for a 180-degree rotation turning the cam affixed to the clutch correspondingly. The cam follower and the pulley controlled by it will go to the second of their two possible positions.

The actual release of each clutch is controlled by a pair of levers, one of which will engage the clutch and the other of which will stop it after 180 degrees. Each pair of levers is controlled by the selector and the instant of their release is determined by a sequence shaft which starts rotating upon receipt of the "start" pulse. The control of the clutch releases by the sharp drops in the sequence shaft cams is a feature which contributes markedly to accurate response and good range in the receiver.

At the end of the receiving cycle the sequence cam shaft rests while the main driving shaft on which the five pulley clutches now freewheel continues to turn. The rotation of the main shaft after the receipt of the fifth intelligence pulse releases the special function causing mechanism and either performs a mechanical function when one is selected or releases the print hammer to complete the character cycle.

*Range Adjustment.* The relative time at which the magnet armature position is sensed can be adjusted by moving the angular position of the timing camshaft with respect to the point at which the camshaft is released by the start clutch. This angular position of the start clutch release mechanism is connected to a calibrated dial which is marked in terms of percentage of one signal pulse. The variation in angular position which is possible without mutilation of a message is known as the "range" of a teleprinter. The MITE has regularly been observed operating with ranges in excess of 75 points at 60 wpm in the laboratory, and has tolerated signal distortions in excess of 35 points under the same conditions. This range adjustment permits the printer to operate correctly from distorted signals such as may be received over long telegraph lines.

### Keyboard

*General.* The mechanical and electrical connections between the keyboard and

the printer are very simple. The keyboard circuit is in series with the printer signal circuit and when it is removed from the printer or put in storage position, the contacts on the printer are automatically shorted. A spur gear couples the printer motor to the keyboard operating shaft. The keyboard can be operated separately as a unit remote from the printer by using a separate motor. It operates as follows: The striking of any key, or the space bar, releases a clutch which permits the motor-driven keyboard camshaft to make half a revolution. At the same time five code bars are set up in a particular sequence according to which key is struck. These code bars will permit or block the motion of a series of cam follower levers, which in turn will permit a series of five contacts to make contact or stay open and thus transmit the proper signal. The contacts are in series with the signal line and when no keyboard is pressed the contacts are closed.

*Regulation of Transmission.* In order to transmit the correct signal, these contacts must make and break at particular times, which would normally require a very accurate adjustment of each contact. This is avoided by providing a "master pulsing cam" on the keyboard camshaft. This operates a pair of contacts which accurately determine the timing of transmission while the five contacts affected by the code bars only determine whether or not each of the pulses is transmitted. The stop, two and four contacts are connected to one of the pulsing contacts and the number one, three and five contacts are connected to the other pulsing contact. In this way the adjustment of the five contacts is made noncritical and only the single pair of master pulsing contacts requires adjustment.

### Motors

The rotational inertia of the motor serves to integrate the pulses of mechanical power required for the printing cylinder positioning operations over the full character cycle. The total power required by the machine is 25 watts including the power for operation of the magnets, so it can be seen that quite a small motor is used. When the power source is alternating current, the motor operates at 3600 rpm for 60 cps and 12,000 rpm for 400 cps. These motors are synchronous with the line frequency and no speed adjustment is possible. When the power source is direct current, a 10,000-rpm motor is employed and an adjustment governor is used for speed adjustment. A 101.69-cps tuning fork is used for speed adjustment purposes. The motor speed is the same for all operational speeds, a single gear being changed for the various sending and receiving speeds. (The 25-watt figure given was observed with the d-c power source and the a-c figure may be somewhat higher.)

### Printing Out

*Paper-Type Relation.* The type cylinder prints from behind the paper and the print hammer presses the inking ribbon against the front of the paper. This unusual arrangement maintains the type face clean at all times and also has the advantage of reducing mechanical wear on the inking ribbon which is struck by the smooth, regular hammer face rather than a sharp, irregular type face. The main advantage is that the operator has greater visibility of the printing as it is being received. A standard typewriter inking ribbon is used. The ribbon tilts back and downwards after each operation of the print hammer so that the last letter printed can be read. The placement of the type does not affect the ability of the printer to make carbon copies.

*Carriage Return.* Unlike in an ordinary typewriter, the paper does not move laterally but only the type cylinder moves. However, the term "carriage return" is still used. Since the type cylinder is quite light (about ½ ounce), fast return action is possible. This is important to ensure that the first character at the beginning of the new line is to be clear when only one character space is allowed for the carriage return operation. The MITE is fitted with automatic carriage return and line feed which are triggered when the end of a line is reached without receipt of carriage

return and line feed signals. The MITE prints 72 characters per line on standard 8½-inch rolls.

### Nonprinting Functions and Special Outputs

The nonprinting functions of the machine include all standard communication printer functions such as carriage return, line feed, shift, signal bell, repeat key and the break key. Four of these functions can be directly controlled mechanically from front panel buttons. These buttons will not put a signal on the line but can cause the following operations: carriage return, line feed, figures and letters. In addition, auxiliary outputs can be provided for special functions.

In series with the two pulley-controlled cables which position the type cylinder rotatively and laterally are two slotted plates which slide laterally parallel to one another. The arrangement of the slots in these plates is such that the selection of a nonprinting function will align a certain pair of slots in the two plates. A series of function clutch release levers attempts to sense the alignment of any two slots during each character cycle. When the slots are not in alignment, the levers are deflected. When a nonprinting function signal is received, the appropriate lever is not deflected, but passes through the aligned pair of slots releasing its clutch. These slotted plates can easily be adapted with added slots and function clutch release levers and clutches, so that additional nonprinting functions can be provided. There is a position on the type cylinder for each of these functions. Normally, in these positions there is no character on the type cylinder and the print and character advance functions are suppressed. A character could, however, be printed simultaneously with the introduction of a special function if so desired.

In addition, there are about 30 points in the MITE at which contactors, mechanically actuated by the machine, can be installed. These contactors can be used to set up electrical circuits in combinations determined by the characters or groups of characters selected by the MITE.

### Design and Construction

*Design.* Certain basic design principles were adhered to in designing and developing this equipment. While miniaturization of the over-all machine was a basic goal, the utilization of full size components was considered a necessity. The miniaturization of the machine is, therefore, a result of its simplified design and of new approaches to certain problems which permitted that simplification.

Reduction of mechanical speeds within the equipment was considered paramount as was reduction of distances travelled by moving parts. Reliance on rotating components was considered preferable to reciprocating components and the weight of moving parts has been kept at a minimum.

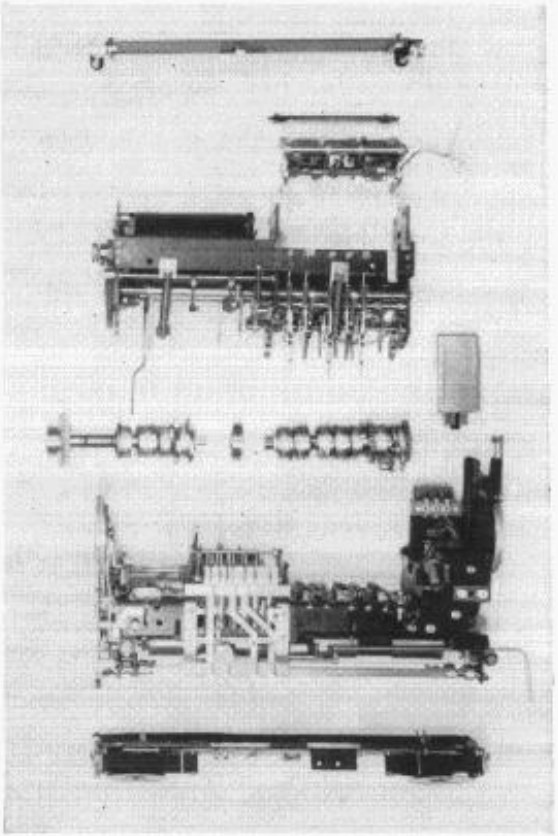

**Figure 5. The printer is shown separated into its major subassemblies**

The MITE has been designed so that gravity restoration is avoided permitting operation of the machine in any attitude including upside down. While the standard carrying case accommodates the

printer and keyboard, a standard full size roll of paper, spare parts and field service tools, other special cases are being worked on. The standard roll is 8½ inches wide and 4½ inches in diameter. The machine lends itself quite readily to rack mounting either while still in the carrying case or after removal from it.

Unitized construction was adopted to permit complete replacement of whole sections. Figure 5 shows the machine broken down into its main subassemblies. These are, from bottom to top, the ribbon magazine, the printer section, main shaft and the selector section. The breakdown into subassemblies is accomplished with the removal of eight screws and requires less than ten minutes. The reassembly requires less than 20 minutes. All parts are readily accessible for inspection, lubrication and servicing. It is estimated that personnel with previous experience in servicing teleprinter equipment can be taught to service this machine in about one week, while personnel experienced with typewriters and other business machines can be taught in two weeks. There is a total of approximately 70 mechanical adjustments on the machine, many of which are one-time factory adjustments to take up tolerances and which do not require readjustment in the field.

*Materials.* The selection of materials used in construction is in keeping largely with military requirements. Special attention was devoted to those parts where there was a possibility of wear and carboloy inserts were used where necessary. The main structural members are stamped aluminum. Precision castings were used where difficult machining operations could be reduced. Considerable effort was required to determine the most suitable material for the cable in the cable and pulley mechanism.

Many types of chain and metallic cable were tried before it was found that the best material was synthetic fiber cable. This was checked in a test jig for 3,000,000 operations using a test which caused stainless steel cable to fail after 3600 operations. After the 3,000,000 operations there was only minimum evidence of wear.

## Companion Devices

Other apparatus under development as companions to the MITE include a miniaturized transmitter-distributor and a reperforator. A "stunt box" which delivers electrical outputs upon certain signals or combinations of signals will also be built as a separate item, independent of the adaptations referred to above.

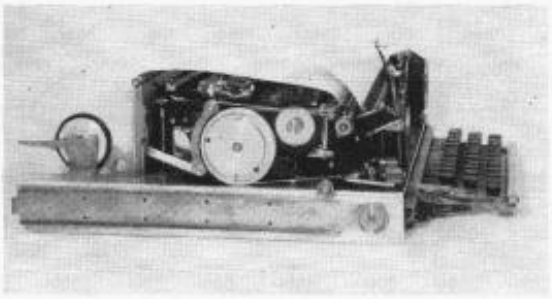

**Figure 6. The printer, keyboard and paper roll are shown mounted on a chassis**

The transmitter-distributor which automatically transmits signals when fed with standard five-hole perforated tape, will weigh less than two pounds including the motor. If the unit is to be used in conjunction with the printer, a common motor will be utilized and the printer motor will have adequate reserve power to drive the tape transmitter. This additional section will add about one inch to the width of the printer and seven ounces to the weight.

## References


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**Bernard Howard,** Vice President for Engineering of the Teleprinter Corporation, attended the University of Idaho and the New Mexico School of Mines. He has spent the past 15 years doing engineering design in the fields of aerial navigation, communication and wire recording, for such corporations as Bendix Aviation, Federal Telecommunications Laboratories, Fada Radio and Electric Company, and Air Associates. Mr. Howard holds many patents (in addition to those awarded in connection with his work with the Teleprinter Corporation and assigned to them), encompassing inventions in the fields of magnetic recording devices, preselector tuning mechanisms, aircraft instruments, and for several classified navigational and communications devices.


## NEW MICROWAVE TOWERS

Pictured on the cover of the Company's Annual Report for 1957 is one of Western Union's new microwave towers installed in 1957 near Cincinnati, Ohio. The Company's radio beam system, now linking New York, Philadelphia, Washington and Pittsburgh, is being extended to Cincinnati and Chicago.