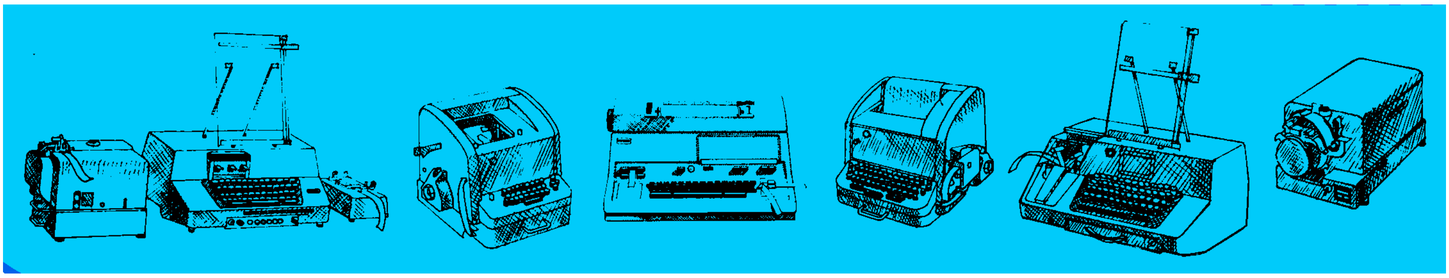

An introduction to Creed teleprinters and punched paper tape equipment

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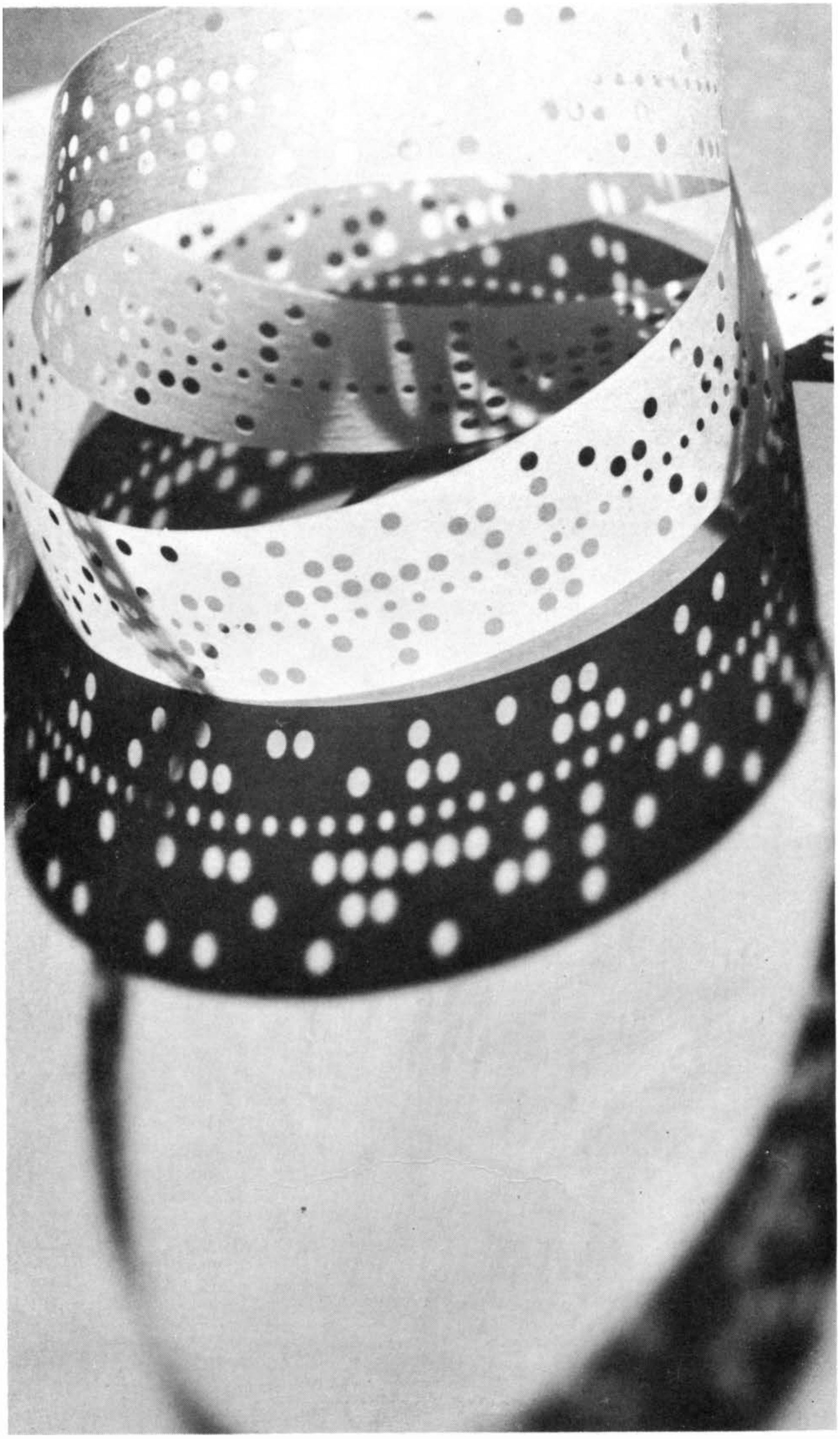


CONTENTS

INTRODUCTION

Creed teleprinters and punched paper tape equipment were originally developed for use in the telegraph communication field and they have been increasingly used ever since in telegraph systems all over the world.

During recent years, however, their use has been extended beyond this traditional field to a rapidly growing number of non-telegraphic applications such as the provision of input and output facilities for digital computers and the automation of existing systems such as punched card accounting and mechanised addressing.

As a result of this sudden increase in the number of applications that are being found for teleprinters and punched tape, considerable interest has been shown in this equipment by engineers and others who wish to discover whether it can be applied to their own special problems.

This bulletin has been written principally for such readers and others who need to know of the basic principles used in teleprinter communications systems. It contains a brief, non-technical introduction to the general principles underlying the operation of Creed teleprinters and punched tape equipment, and includes a brief description of each of the various machines available.

It must be emphasised that this bulletin does not describe all the non-telegraphic applications that have been made to date of this equipment, nor does it contain any engineering details of circuits or machines.

Full technical details and free advice on how any Creed equipment can be used in telegraph or data processing systems is available on request.

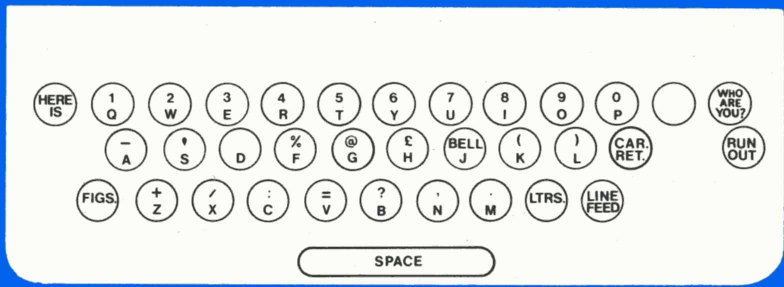


Fig. 1 A typical 3-row keyboard. Access to numerals, symbols and punctuation marks is by means of figure 'shift' key on left of bottom row

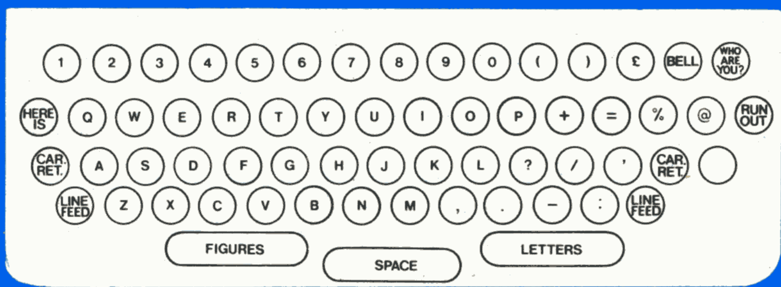


Fig. 2 A typical 4-row keyboard where operation of 'Figures' locks all 'letters' keys to prevent accidental operation while machine is in wrong shift condition

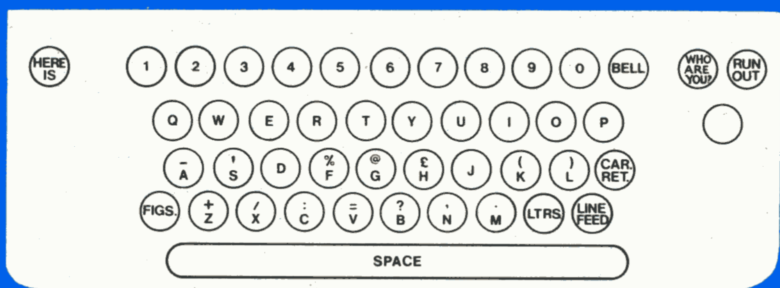
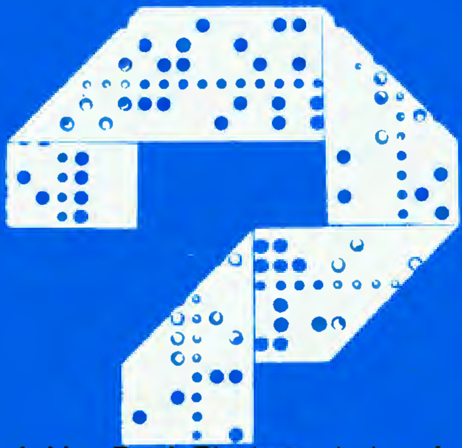


Fig. 3 A similar arrangement to fig. 2 but shift keys are in line with the arrangement of a 3-row keyboard

What is a Teleprinter



Any system for transmitting and receiving messages electrically over a distance in the form of coded signals is called a *telegraph system*.

If the messages are automatically printed by the receiving apparatus, the system is then referred to as a *printing telegraph system*.

The *teleprinter* is the basic piece of equipment of the Creed printing telegraph system. It consists of two parts: a keyboard transmitter and a receiver.

The *keyboard transmitter* consists of a *keyboard*, similar in appearance and layout to a typewriter keyboard, for originating the message, and a *transmitter* for converting the operator's key depressions into suitably coded electrical signals which it transmits to the line or other medium of transmission.

The *receiver* is a device for registering the coded signals that are received from the distant transmitter and converting them into a printed message on a page or tape.

The intelligence transmitted consists of characters, numerals, signs and functions. The most commonly used items of intelligence are shown in the three typical keyboard layouts illustrated in figs. 1 - 3.

The *characters* in all three layouts are the twenty-six letters of the English alphabet. While this is the most common arrangement, layouts for other alphabets with more or less than twenty-six letters are available.

Similarly, although the *numerals* in these layouts are confined to 0 and 1 - 9, these may be augmented by fractions.

Signs such as '%', '@' and '?', may also be varied to suit special requirements, such as data processing instructions or weather charts.

Seven *functions* are controlled from the keyboard. They are Line Feed, Carriage Return, Who-are-You?, Bell, Space, Letters and Figures. The purpose of these functions is as follows:

1. Line Feed. The transmission of this code causes the paper on the receiving teleprinter to be fed up to the next line. (If the received message is printed on tape, the 'Line Feed' function is not, of course, used).

2. Carriage Return. This function causes the carriage on the receiving teleprinter to return to the beginning of its travel so that the printing starts again at the beginning of a line. (Again, with tape printing, this is not used).

3. Who-are-You? This function causes the distant teleprinter keyboard transmitter to send back automatically to the calling teleprinter, where it is printed, a series of characters and/or numerals informing the calling operator of the identity of the distant station. This assures the calling operator:

a) that he is connected to the right station;

b) that the called teleprinter is operating even if unattended; and

c) if operated at the end of a message, that the whole message has been received.

4. Bell. The transmission of this function causes a bell to ring (or produces some other warning indication) at the called station to attract the operator's attention.

5. Space. This is similar to the normal spacing function on a typewriter. Its transmission results in the carriage on the receiving teleprinter feeding along one space without printing.

6. Letters and

7. Figures. These functions have a purpose which will be explained in the next section.

In the keyboard layouts in Figs. 1 - 3, two keys ('Run Out' and 'Here is') have not so far been referred to, since they are not strictly speaking items of intelligence, i.e. no code signal is allocated to them. Their purpose is as follows:

1. Run-Out Key. The depression of this key results in the last signal sent being repeatedly transmitted for as long as the key remains depressed.

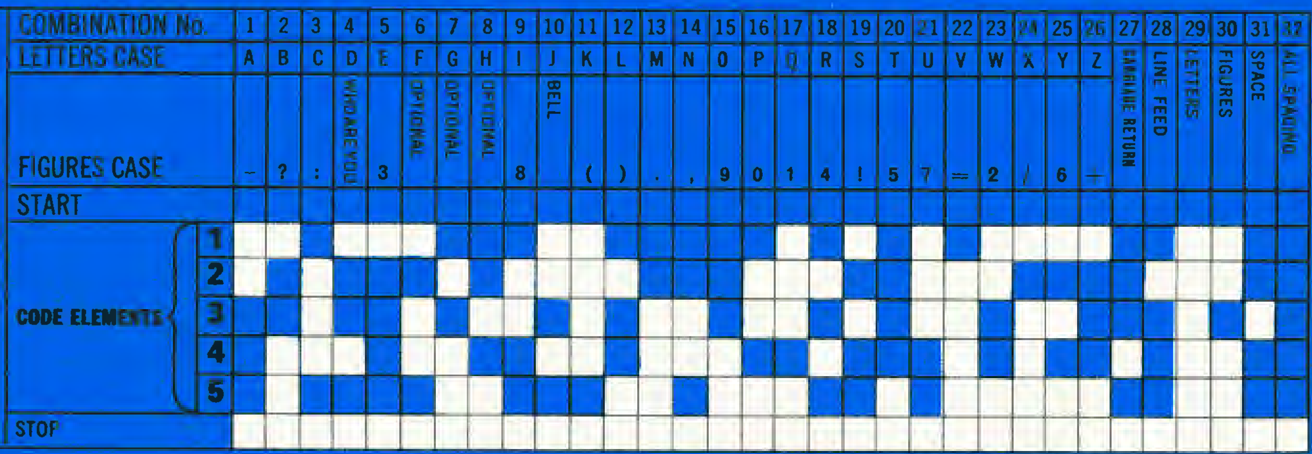
2. 'Here is' Key. The depression of this key causes the keyboard transmitter to send automatically the calling station's identification code signal to the called station.

THE TELEPRINTER CODE

The code used for the transmission of intelligence from one teleprinter to another is a 5-unit, 2-element (binary) code which allows a total of 2^5, i.e. thirty-two combinations. The method of allocating these combinations to the various items of intelligence has been the subject of various conferences held by the CCITT (International Telegraph and Telephone Consultative Committee), a body which represents most of the main telegraph interests in the world and exists to promote, among other things, the growth of common practices in telegraphy. The method of code allocation indicated in Fig. 4 is the CCITT International Code No. 2, which is the one at present in general use.

It will be noticed that the two kinds of elements of the code are called 'mark' and 'space' elements. These terms were derived from telegraph systems employing the Morse Code, where the dots and dashes were referred to as 'marks' and the spaces between the dots and dashes simply as 'spaces'. In connection with the 5-unit code these meanings are, of course, irrelevant, but the terms have been adopted as convenient labels for distinguishing between the two kinds of elements of the code. A 'mark' element may be defined, therefore, in terms of the International Code as any element of the code represented by a solid dot in Fig. 3; similarly, a 'space' element is

FIG 4
START-STOP
CODE



any element of the code represented by blank code position.

It will also be noticed that there are more items of intelligence in the International Code than there are 5-unit code combinations. It might seem at first sight that this would preclude the use of a 5-unit code, as the simplest and most natural method of coding is to allocate one combination to each item of intelligence. In fact, however, the intelligence carrying-capacity of the 5-unit code can be nearly doubled by allocating *two* combinations to each item of intelligence.

This is achieved by the use of a 'shift' system—each of the two 'cases' being selected by the operation of a Letters or Figures key. The letters case contains all letters and the figures case all numerals, punctuation marks and special symbols. Functions, such as carriage return, line feed and space can be operated while the teleprinter is in either shift condition.

The teleprinter receiver is designed so that the 'Letters' and 'Figures' combinations have to be transmitted *only when a change of case occurs*. For example, if a 'Letters' combination is transmitted, the receiver translates all combinations received after this and before the reception of the next 'Figures' combination, into the 'Letters' case.

The 'Letters' and 'Figures' combinations, because they possess this case-changing function, are usually referred to as 'case-change' or 'case-shift' combinations, and the corresponding keys are similarly referred to as 'case-shift' keys.

It has been mentioned that the Carriage Return, Line Feed and Space functions are in both cases. The depression of the keys corresponding to these functions results in the receiver performing the functions irrespective of the case to which it is pre-set. The object of this is to keep the number of depressions of the 'Letters' and 'Figures' keys to a minimum.

START-STOP PRINCIPLE

Each of the coded combinations in the International Code (see Fig. 4) is preceded by a spacing element and succeeded by a marking element. These are known as the 'Start' element and 'Stop' element respectively.

A fundamental problem in the design of telegraph apparatus is that of ensuring that the transmitter and receiver remain in synchronism. This problem has been solved in a number of different ways, in the Baudot system for example, by the use of special correcting pulses. The method used in the teleprinter, which is the simplest and most widely used, is to transmit special 'Start' and 'Stop' signals at the beginning and end of each code transmission. The receiving apparatus is thus started and stopped by the sending apparatus for each character transmission. Any difference in phase between the two machines caused by a slight difference in the speed of their motors is thereby prevented from accumulating and synchronism within the required degree of accuracy is, accordingly, maintained.

The advantage of this method of achieving synchronism is that the transmitter and receiver motors may differ slightly in speed without interfering in any way with transmission. This means that a simple mechanical motor governor is all that is required to maintain synchronism.

The Start-Stop principle of synchronisation is so fundamental to the design of telegraph apparatus that printing telegraph machines employing this principle are generally referred to as 'Start-Stop' Printing Telegraph machines.

TELEGRAPH SIGNALS

A result of using the Start-Stop principle is that the time required for the transmission of the seven elements for each code combination must be longer than the time for one cycle of operations for the receiving apparatus.

On the standard Creed teleprinter, this is done by making the time for a complete seven-element code transmission equal to $7\frac{1}{2}$ units in length (a 'unit' being the time of transmission for the shortest signal) and the cycle of operation of the receiver equal to $6\frac{1}{2}$ units. This allows a one-unit rest for the receiving apparatus between the reception of each code combination.

The $7\frac{1}{2}$ units for each seven-element code transmission are shared out between the seven elements by allocating one unit to the 'Start' element, one unit to each of the five code elements and $1\frac{1}{2}$ units to the 'Stop' element.

The use of $7\frac{1}{2}$-unit transmission with $6\frac{1}{2}$ unit reception instead of, say, 7-unit transmission with $6\frac{1}{2}$-unit reception or $7\frac{1}{2}$-unit transmission with 7-unit reception is, to a large extent, arbitrary. As a result, there has been some variation in the systems adopted by different countries at different times.

Recently, the CCITT recommended that not less than 7.4 units shall be used for transmission. Receivers must be able to work either to 7-unit or $7\frac{1}{2}$-unit transmission. All Creed teleprinters meet these requirements.

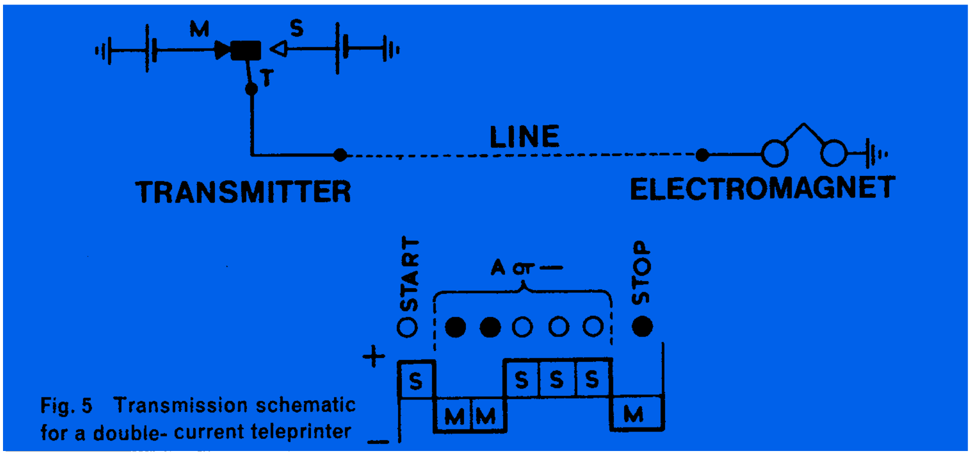


Fig. 5 Transmission schematic for a double-current teleprinter

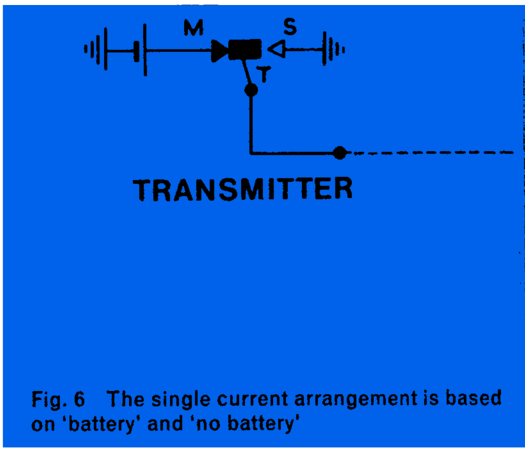


Fig. 6 The single current arrangement is based on 'battery' and 'no battery'

TELEGRAPH SPEED

The unit of telegraph speed is called the 'baud', after the famous French telegraph inventor Baudot. It is equal to the number of shortest telegraph signals, i.e. units, per second.

The present international standard is 50 bauds, which makes the unit equal to 20 milliseconds. With $7\frac{1}{2}$-unit transmission, the 'Start' signal and the five code signals are, therefore, each 20 milliseconds in length while the 'Stop' signal is 30 milliseconds, and the transmission time for a complete $7\frac{1}{2}$-unit transmission is 150 milliseconds, equal to 6·6 characters per second.

Another way of measuring telegraph speed, which is very useful, is in words per minute. In order to obtain a word-measure, five letters and a space are taken to be the average length of a word in English, i.e. six code transmissions. A telegraph speed of 50 bauds, using $7\frac{1}{2}$-unit transmission, is thus equivalent to

$\frac{1000}{150} \times \frac{60}{6} = 66\text{-}\frac{2}{3}$ words/min.

OUTLINE DESCRIPTION OF A TELEPRINTER

The basic elements of a simple point-to-point teleprinter system are represented in Fig. 5.

The transmitter consists essentially of a metal tongue T which, when a key is depressed, is caused to move between two contacts M (mark) and S (space) in a manner determined by the code combination of the key depressed. Voltages of opposite polarity are connected to the two contacts and the tongue is connected to the line.

The basic element of the receiver consists merely of an electromagnet, one side of which is connected to line and the other side to earth.

Thus, when a key is depressed, a sequence of square-wave pulses (ignoring distortions caused by the line constants and the electromagnet inductance) is transmitted to the electromagnet, the armature of which is caused to reproduce the movements of the transmitter tongue. The remainder of the receiver translates the code combinations to produce the desired functions.

The method of transmission represented in Fig. 5, in which the pulses of transmitted voltage are of opposite polarity, is called 'double-current' operation. Although in the figure the marking voltages are negative and the spacing positive, there is no rule that is universally followed. The G.P.O., for example, adopt the convention in Fig. 5, whereas America and the continental countries adopt the reverse convention.

Fig. 6 illustrates the 'single-current' method of operation, in which voltage is applied only to one contact. In this system, a spring is used to return the electromagnet armature when there is no current flowing through the electromagnet. Once again, no set rule is followed in deciding whether the voltage should be applied to the marking or spacing contact or whether this should be positive or negative.

STAGES OF TRANSMISSION

There are a number of well-defined stages and processes between the depression of a key and the impression of the selected character on the paper in the distant printer. These are shown schematically in Fig. 7 which, for clarity, represents the stages for the transmission of a particular letter —A, for a double-current teleprinter. These general principles apply to all conventional teleprinters now in production, but the means of achieving the same end result vary quite considerably from model to model.

For this reason it is not possible to describe here in detail the sequence of operations between the depression of a key and the printing of a character on the distant teleprinter. The following stages, however, apply to all current models whether the printing unit is a moving type-bobbin (Model Seventy-five), a moving type-basket (Model 444) or a stationary typewheel with a moving carriage (Models 7, 8 and 54).

1 Key is depressed.

2 Code is set up on keyboard coding unit.

3 Transmitter unit 'reads' off code set up on coding unit.

4 Tongue of transmitter is moved between two contacts (positive and negative battery) in accordance with the code for the character to be transmitted.

5 Transmitter automatically inserts *Start* signal followed by a combination of five marks or spaces (negative or positive battery) and a *Stop* signal to line.

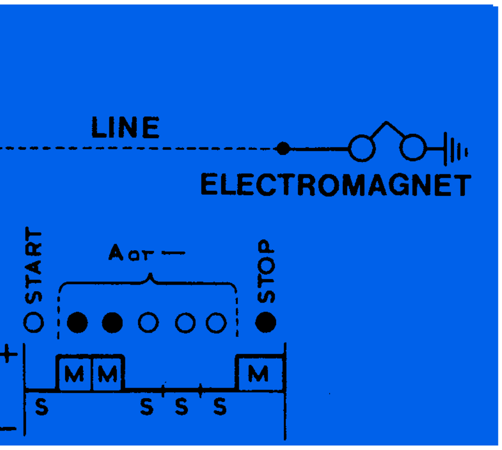
6 Signal is received, and fed to electromagnet of distant teleprinter.

7 Electromagnet armature moves back and forth in accordance with code of character being transmitted.

8 Code is transferred to mechanical store.

9 Receive mechanism reads off code and positions appropriate type against printing point.

10 Character is printed.



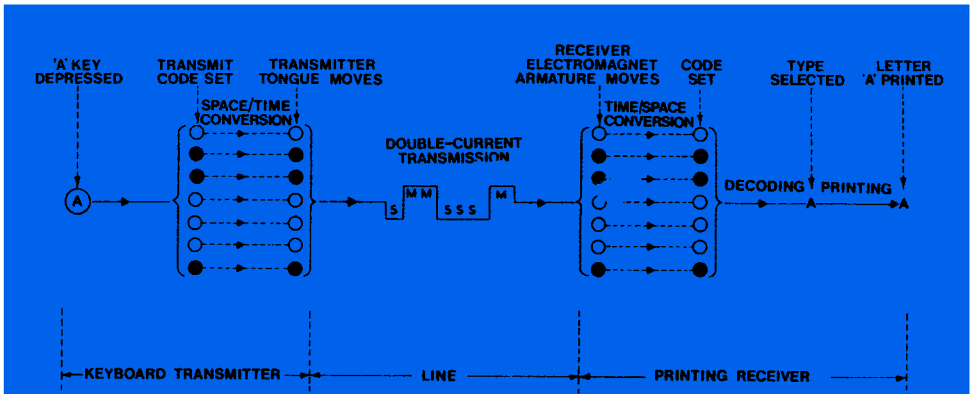


Fig. 7 Schematic diagram showing the sequence of operations which follows the depression of a key on the teleprinter keyboard

KEYBOARD

The teleprinter keyboard consists of the following parts:

1 An assembly of *keys* (see Figs. 1 - 3).

2 A number of *combination bars* running under the keys. Five of these are used to set up the code corresponding to the key depressed in the manner described above. A sixth bar is used to trip the transmitter camshaft when moved by the depression of a key.

3 A *transmitting mechanism* for automatically 'reading' the code combinations set up on the five code combination bars and converting this into the movement of the transmitter tongue between the marking and spacing contacts.

4 A *trip mechanism*, operated by the trip bar when any key is depressed, for releasing the transmitter at the beginning of a code transmission and arresting it at the end.

5 An *answer-back unit* (optional facility) which is operated by the receiver when a 'Who-are-You?' signal is received by it. It first locks the keyboard against manual operation and then automatically takes control of the code and trip combination bars, transmitting through them the station identification code signal which is stored in the unit on a number of metal or plastic wards.

6 An *'End-of-Line Indicator' unit* (optional facility). This is a counting device which records the number of key depressions after each operation of the Carriage-Return key. When some fifty-five key depressions have been recorded, the device closes a pair of contacts and lights a warning lamp on the front of the teleprinter. The ensuing operation of the Carriage-Return key resets the mechanism. It is used when transmitting without a local record to a page teleprinter to provide a visual warning to the sending operator that the page attachment on the distant teleprinter is now approaching the end of a line and he must therefore depress his Carriage-Return key.

7 An *automatic Send-Receive switch*. This switch usually consists of a metal tongue operating between two metal contacts. When the keyboard is at rest, it is held against the Receive contact. Immediately after the transmitting mechanism is released, i.e. before any intelligence is transmitted, it is moved automatically by a cam on the transmitter shaft to the 'Send' contact. At the end of each cycle of operations, it is returned to the 'Receive' contact once more.

RECEIVER

The receiver consists of the following main components:

1 A *motor* which provides power for the keyboard transmitter as well as the receiver.

2 A receiving *electromagnet* to reproduce the movements of the keyboard transmitting tongue.

3 A *cam unit*, the mechanism of which is released and arrested by the 'Start' and 'Stop' signals respectively. When released it 'reads' the electromagnet armature movements corresponding to the incoming code combination and stores the combination in a 5-unit mechanical store. It also controls the operation of all other units (see below).

4 A *decoding unit* which accepts the incoming serial code unit-by-unit and feeds a complete 5-unit code in parallel to

5 A *printing unit* which refers to the incoming 5-unit code, positions the appropriate type against the printing point and prints the character.

6 A *page or tape unit.* A page attachment unit consists of a paper carriage for mounting a roll of paper, and a number of mechanisms, powered by the cam unit for performing the following functions:

(a) *'Letter feeding'*,—feeding the carriage along past the printing point on receipt of any combination other than a functional combination.

(b) *'Line feeding'*,—feeding the paper up one or two lines (this may be predetermined by a manual setting) on receipt of a 'Line feed' combination.

(c) *'Carriage-Return'*,—returning the carriage to the beginning of a line on receipt of a 'Carriage-Return' combination.

(d) *Ringing a bell* as the carriage nears the end of a line (or can be arranged to light warning lamp).

7 A *ribbon feed mechanism* for automatically feeding and reversing the feed of the ink ribbon. A ribbon jumper is provided to lower the ribbon from in front of the printing between operations of the typehammer so that the operator can see what has been printed.

8 An *answer-back trip mechanism*. This mechanism is controlled by the 'Who-are-You?' code transmitted from the distant machine or by operation of the local 'Here is' key, which causes it to transmit the station identification code signal to the distant teleprinter.

9 An *orientation device*. This device is connected between the receiving electromagnet armature and the cam unit and provides a means of adjusting the phase of the cycle of operations of the receiving mechanism to that of the incoming code signals, thereby optimising the tolerance of the receiver to distortion in these signals.

10 *A 'period of operation' counter* (optional facility). This mechanism records the number of operating hours performed by the receiving mechanism and provides an indication of when to service the teleprinter.

Numerous additional facilities are available and these are listed in detail in separate publications covering individual models.

Punched Tape

EQUI

Creed punched tape equipment was originally designed, and is still mainly used, as an important means of increasing the efficiency of telegraph transmission systems. Automatic tape transmission has been used for many years to give fuller utilisation of line or channel time and over the past few years Creed tape relay systems have been installed in many parts of the world.

Today, however, this equipment has found a wide variety of applications in non-telegraphic fields such as data recording, process control and the provision of input and output facilities for digital computers. What was once a method of automatically transmitting messages has now become a comprehensive technique for automatically recording, storing and processing information of all kinds.

The punched tape system is obviously analogous to punched card systems, but it has important advantages over the latter in providing a continuous record of information in place of the discrete record produced by a punched card and, by the ease with which it may be used for automatic data recording, in eliminating the necessity for transcribing written information into punched card form.

Knowledge of the punched tape technique and the somewhat specialised machines used in conjunction with it has hitherto been largely confined to telegraph engineers. The principal purpose of the following sections is to give a brief, non-technical description both of the technique and the machines used with it, for those who are not telegraph specialists but wish to discover whether punched tape can solve their information-handling problems.

The following sections are necessarily neither detailed nor complete, but full technical specifications are available on request from Creed & Company Limited.

PUNCHED TAPE TECHNIQUE

KINDS OF PUNCHED TAPE

Two kinds of punched tape are in common use: the 'punched tape' illustrated in Fig. 8 and the 'punched and printed tape' shown in Fig. 10.

The *punched tape* used in Creed equipment is $\frac{11}{16}$in., $\frac{7}{8}$in. or 1in. wide (17·5, 22·2 and 25·4mm) and is supplied in reels of 340 yards (311m) The $\frac{11}{16}$in. wide tape carries five levels or tracks of information, $\frac{7}{8}$in. wide six or seven tracks, and 1in. wide eight tracks. The code is punched across the tape, 'marks' being represented by punched holes and 'spaces' by unperforated positions. Between the second and third code holes, on $\frac{11}{16}$in. wide tape a smaller feed hole is punched to enable the tape to be drawn through the equipment by a sprocket wheel. These feed holes are in line with the centre of the code holes.

The *'punched and printed'* tape illustrated in Fig. 10 embodies a method of combining printed with perforated information on the same tape. The printing is placed between the feed hole perforations. Because the punching and printing are achieved simultaneously at different positions on the tape, the punched code and the printed interpretation are $8\frac{1}{2}$ pitches out of phase.

In both of the types of tape described above, it is important to ensure that the spacing between successive sets of punched holes is uniform and equals $\frac{1}{10}$in. with an accuracy of $\pm\frac{1}{2}$ feed hole pitch in ten inches of tape.

Mention should be made here of the fact that tapes are available in a variety of colours. Colour coding of tapes is widely used to distinguish their different functions, where there is any danger of mistakes occurring.

METHODS OF CODING INFORMATION ON PUNCHED TAPE

Telegraph intelligence is coded in punched tape according to the International 5-Unit Telegraph Code No. 2, given in Fig. 4. This follows from the fact that telegraph signals are used for communication. The 'Start' and 'Stop' signals are not perforated in the tape as these are inserted automatically by the transmitter.

Non-telegraphic information may be coded in many different ways. There are no standard methods except in certain specialised fields, e.g. meteorology, and the method adopted will depend on the particular application for which it is required. The three main kinds of non-telegraphic application are the provision of computer input facilities, the automatic recording of data for subsequent analysis by a computer and the automatic control by punched tape of a sequence of operations or processes. As the same principles of coding are employed in the last two applications, the following brief discussion will be confined to computer codes and automatic data recording codes, the latter being dealt with first.

In the discussion of telegraph theory given earlier, the unit of intelligence was called an 'item' of intelligence and the usual method of allocating a 5-unit combination to each item of intelligence was described. In discussing the wider field of data recording, the more general term 'information' will be used in place of 'intelligence' and the unit of information will be called an 'item' of information. An item of information may be any state or condition of a process under investigation, a meter reading, a specific lapse of time, a distance or any definite value of a variable quantity.

In telegraphy, the coding of intelligence is relatively simple because the items of intelligence comprising the message are transmitted and received

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serially, i.e. no two items of intelligence are required to be transmitted or received simultaneously. In punched tape recording of non-telegraphic information this is not always the case. Whereas the coding of the movement of an instrument pointer approximates to the telegraph case, since the pointer cannot point to two divisions of the scale at the same time, the coding of a number of different states of a process, some of which may occur at the same time, is more complicated.

It will simplify the discussion to introduce the following technical terms:

Disjunctive information: this consists of items of information *no two* of which can occur at the same time.

Conjunctive information: This is made up of items of information *any* of which may occur at the same time.

Mixed information: this consists of both disjunctive and conjunctive items of information.

(It follows from these definitions that telegraph intelligence is of the disjunctive kind).

To take first the coding of *disjunctive information*. As there are thirty-two combinations available with the 5-unit code, thirty-two distinct items of information can be coded if one item of information is allocated to each code combination. Thus, the scale of an instrument could be divided into thirty-two parts and each division of the scale represented by one combination. If greater accuracy is required, two successive combinations can be allocated to each item of information and one combination reserved to discriminate between the combination pairs (e.g. the 'all-spacing' combination). This would give 31^2 or 961 divisions.

The capacity of the 5-unit code for coding *conjunctive information* is more restricted. Using the most straightforward method of coding, only five conjunctive items of information can be coded. This is effected by repre-

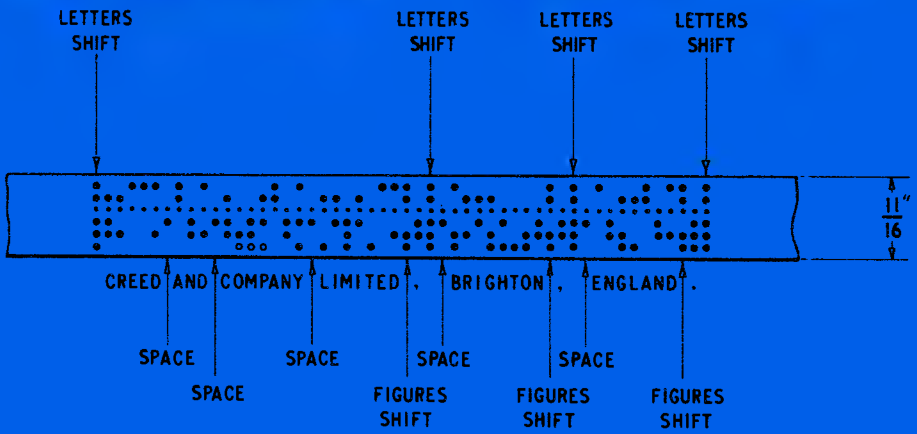


Fig. 8 Interpretation of coding on standard 5-unit punched tape

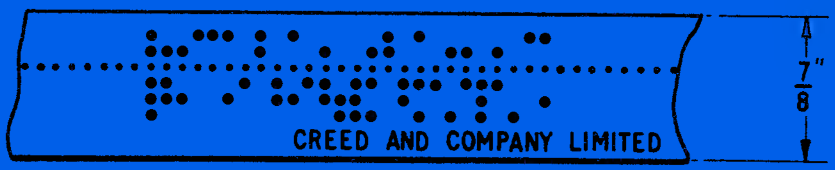


Fig. 9 Punched tape with interpretation printed on extra width of tape at bottom edge

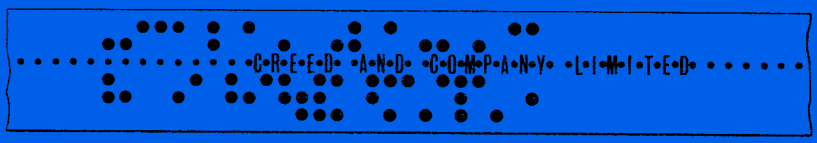


Fig. 10 Interpretation printed on standard 11/16in (17.5mm) wide tape utilising spaces between feed holes

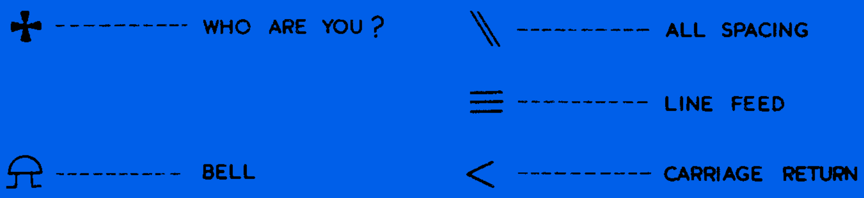
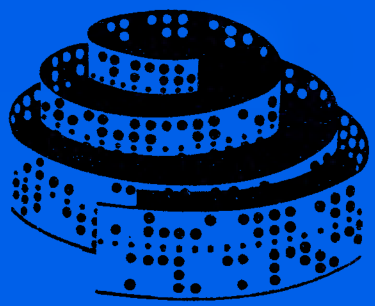


Fig. 11 The signs printed on tape to indicate a functional code



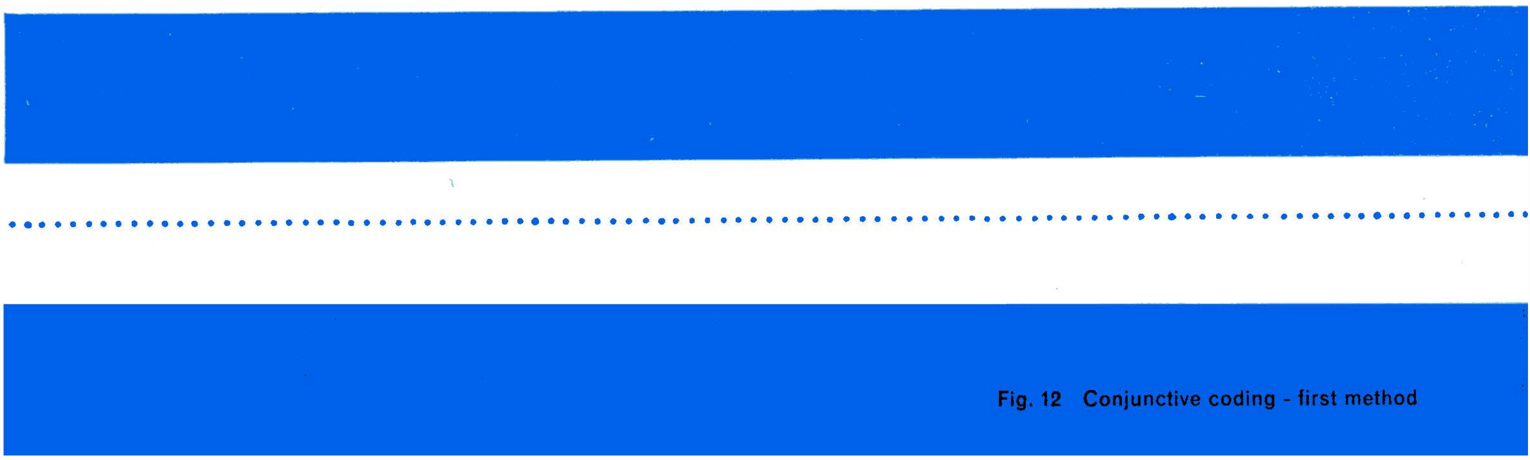


Fig. 12 Conjunctive coding - first method

senting each item of information by a series of punched holes in one of the five code tracks (see Fig. 12). A sixth item of information, if this is a continually repeated item such as a fixed lapse of time or a fixed distance, can be represented by using the feed holes for the purpose. Various methods may be employed to increase the number of conjunctive items of information that may be coded. For example, nine sources of information may be coded by using four of the code tracks for eight items of information, the items being punched in two successive groups of four, and the feed holes used to represent time or distance as before. The fifth track is reserved for discriminating between the first and second group (see Fig. 13). This method of coding may be extended to code 13, 17, etc. items of information, with a corresponding reduction in the speed of recording as the number of items increases.

To code *mixed information,* the most straightforward method is to separate the information into its disjunctive and conjunctive parts and use a mixture of the coding procedures already described for these kinds of information. Thus, the first two tracks could be utilised for coding three disjunctive items of information using a 2-unit code, and the remaining three tracks utilised for three conjunctive items of information. The feed holes could be used, as before, to represent time or distance (see Fig. 14).

In the foregoing discussion only a small selection of the possible methods of coding information for automatic data recording systems has been given, and these have all been based on the use of 5-unit tape. Considerably more information may be coded by the use of 6-, 7- and 8-unit equipment. The principles of coding on such equipment, however, are the same as those given above.

Computer codes, like the ordinary teleprinter code, follow the principle of disjunctive coding, but the items of information are allocated to the different code combinations in such a way as to simplify the detection of errors and to satisfy other operating requirements.

A detailed discussion of this subject cannot be given here, but the main requirements for a good computer code can be seen from a study of Fig. 15, which gives the code employed by a leading computer manufacturer.

It will be noticed in the first place that the combinations are listed in order of their equivalent numerical values, 'holes' being taken to represent the 1's and 'no-holes' the 0's of binary numbers. The convention is adopted that the first teleprinter element of each code combination corresponds to the least significant digit of the associated binary number. Thus, the combination MSMMS corresponds to the binary number 01101.

The letters case contains the alphabet, full-stop, question mark, pounds sign and erase sign. The figures case contains the decimal digits, a number of arithmetical symbols, a range of programming symbols, the full-stop—which is used for the decimal point—the erase sign and space. The figures and letters case-shift functions appear in both cases as with the International Alphabet No. 2 (see Fig. 4) and for the same reasons.

The allocation of code combinations to these 61 characters and functions is carried out in the following way:

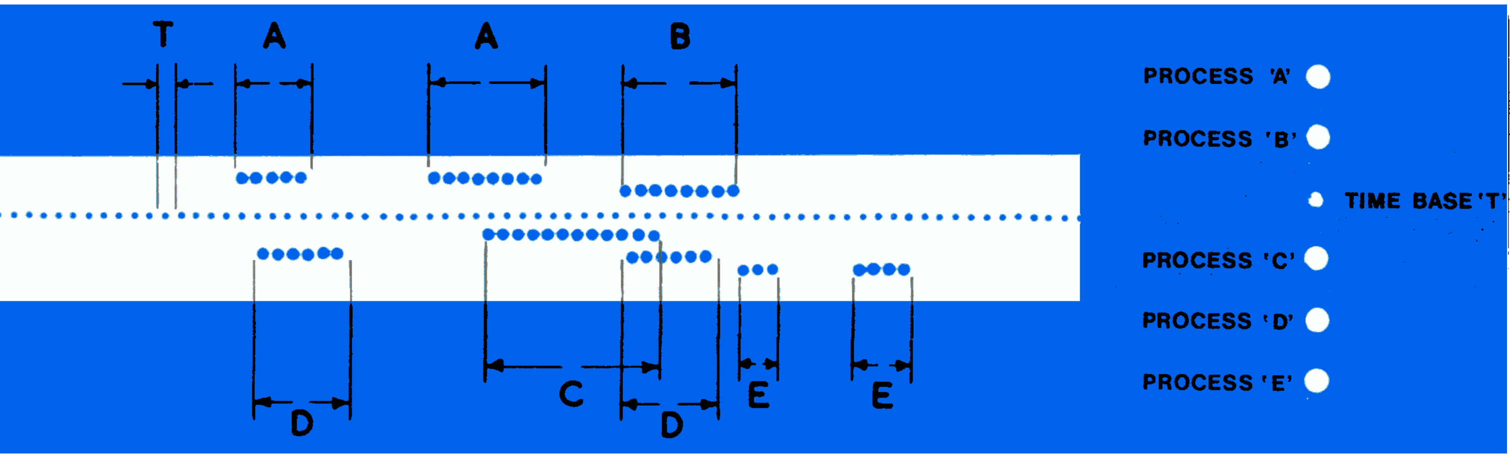
1. The twenty-six letters of the alphabet are coded by assigning to them the combinations whose numerical equivalents correspond to their positions in the alphabet. Thus, 'V' which is the twenty-second letter of the alphabet, is coded by 10110 (i.e. SMMSM), the binary equivalent of 22. The object of this is to simplify alphabetical sorting.

2. The decimal digits, together with the most important arithmetical symbols and teleprinter functions, are coded by combinations having an odd number of holes. This provides a very useful safeguard against the most common teleprinter faults, viz. the substitution of a mark for a space ('extra') and of a space for a mark ('failure'). When either of these faults occurs in a combination having an odd number of holes, it always turns into one with an even number. Hence, the items of information whose combinations have an odd number of holes cannot be changed into other items of the group, but only into some other more easily detected items.

This odd-parity condition leaves scope for imposing a further condition on the allocation of code combinations to the decimal digits. Since there are only ten decimal digits, they may be coded by the first four significant digits of the corresponding binary numbers, the fifth significant digit being disregarded. Thus '0' is coded by '10000', '1' by '00001', '2' by '00010', '3' by '10011' and so on. When such combinations pass into the computer, they are first checked for odd-parity and then the fifth significant digit is ignored.

3. Erase is coded by five holes, i.e. the all-marking combination. Punching errors are eradicated by overpunching with the erase combination. When this combination is fed into the computer, it is ignored.

4. The figure-shift signal is coded by blank tape, i.e. by an all-spacing combination, so that on input the blank tape before the perforations automatically sets the computer into an assigned condition.



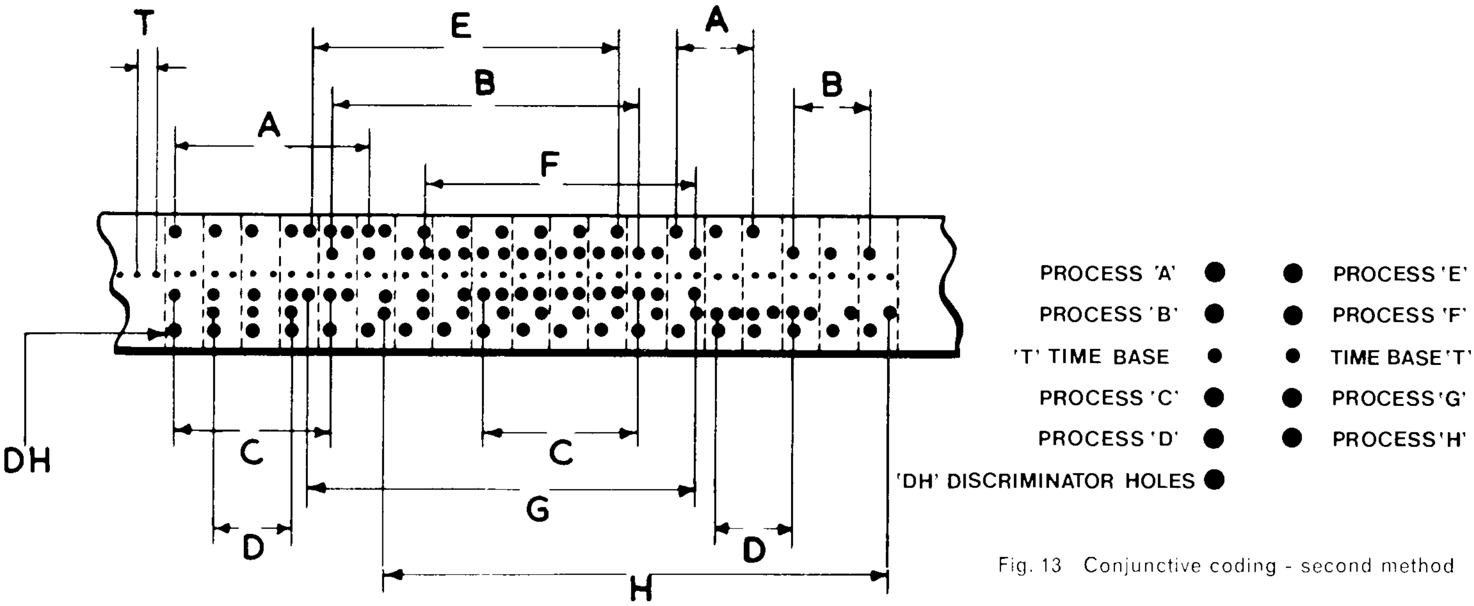


Fig. 13 Conjunctive coding - second method

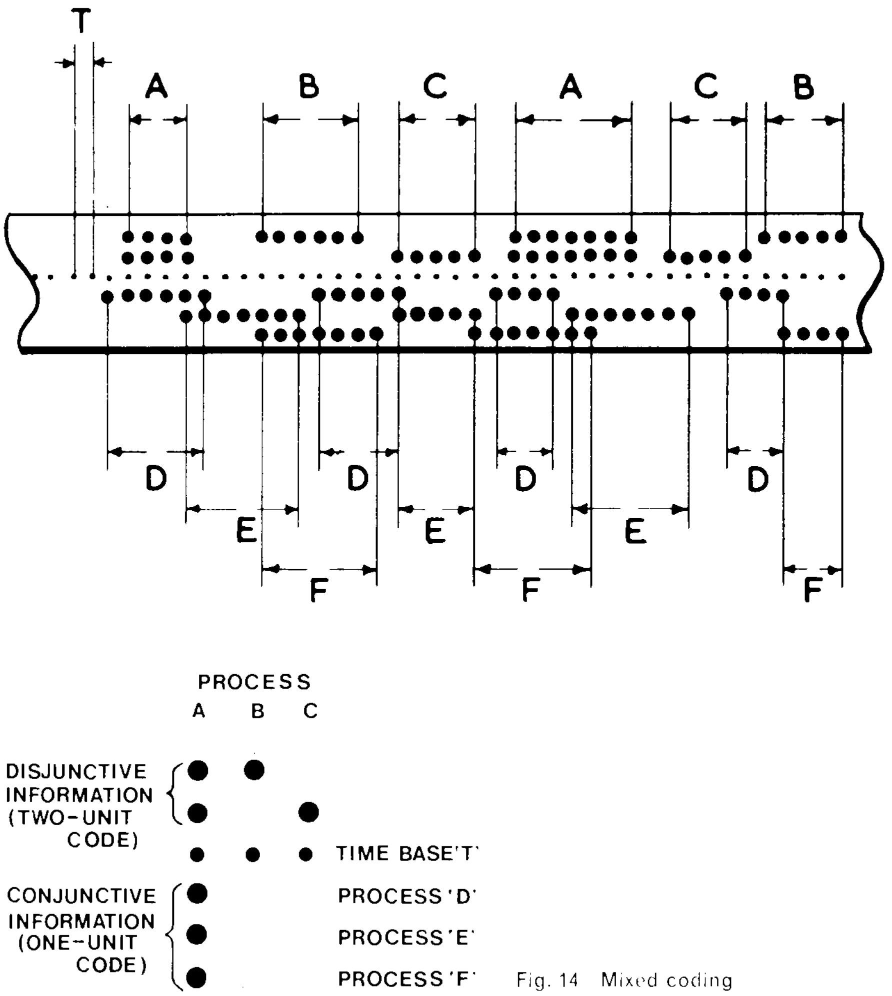


Fig. 14 Mixed coding

FIGURES CASE	LETTERS CASE	TAPE					BINARY VALUE	DECIMAL VALUE
		5	4	3	2	1		
FIGURES SHIFT							0	0
1	A					●	1	1
2	B				●		10	2
✳	C				●	●	11	3
4	D			●			100	4
(	E			●		●	101	5
)	F			●	●		110	6
7	G			●	●	●	111	7
8	H		●				1000	8
≠	I		●			●	1001	9
=	J		●		●		1010	10
−	K		●		●	●	1011	11
Ʊ	L		●	●			1100	12
L.F	M		●	●		●	1101	13
S.P	N		●	●	●		1110	14
,	O		●	●	●	●	1111	15
0	P	●					10000	16
>	Q	●				●	10001	17
≥	R	●			●		10010	18
3	S	●			●	●	10011	19
→	T	●		●			10100	20
5	U	●		●		●	10101	21
6	V	●		●	●		10110	22
/	W	●		●	●	●	10111	23
X	X	●	●				11000	24
9	Y	●	●			●	11001	25
+	Z	●	●		●		11010	26
LETTERS SHIFT		●	●		●	●	11011	27
•	•	●	●	●			11100	28
∩	?	●	●	●		●	11101	29
C.R	£	●	●	●	●		11110	30
ERASE	ERASE	●	●	●	●	●	11111	31

Fig. 15 A typical computer input-output code

Applications to digital com

During recent years there has been a growing realisation that punched tape affords a valuable method of transmitting, recording and storing digital information of all kinds, and that its usefulness is not confined merely to the telegraph field.

Undoubtedly an important factor in bringing about this realisation has been the rapid development of digital computers in recent years. A computer requires auxiliary apparatus for:

(1) converting written programmes into coded information, e.g. on a punched or magnetic tape, and checking the accuracy of this conversion;

(2) feeding the coded information automatically, at high speed, into the computer;

(3) recording the computer output in coded form; and

(4) converting this coded output into printed characters.

Computer engineers discovered in the commercially available and well-tried punched tape and teleprinter techniques, not only a method of satisfying their most important input and output requirements, but also a very flexible means of providing a variety of auxiliary, computer information handling facilities.

INPUT PREPARATION

In the punched tape method of preparing coded information for transmission to a computer, the information is punched into a tape either *manually*, by using a keyboard tape punch or other equivalent instrument, or *automatically* by arranging for the processes requiring analysis (if the information is of this kind) to control a tape punch, thereby recording the data for analysis directly on the tape without manual transcription.
In the former case, where the tape is manually prepared, the risk of error is introduced, and means must be provided for rapidly checking the accuracy of the tape. This function is fulfilled by the various types of *tape editing equipment.*

MANUAL TAPE PREPARATION

There are three methods available for preparing punched tape, two of which are described later. Their main features will be repeated here, however, for easy reference:

(1) A Model 7P/N Series II Keyboard Tape Punch, producing $\frac{11}{16}$in., $\frac{7}{8}$in. or 1in. perforated tape under the control of a 4-row teleprinter pattern keyboard. No print-out is provided. The maximum speed obtainable is 14 characters per second, i.e. 140 words per minute.

(2) A Model 7, 54, 75 or 444 Page Teleprinter equipped with a tape punching attachment, producing 5-unit, $\frac{11}{16}$in. wide, fully-perforated tape under the control of the teleprinter keyboard. The maximum speed obtainable is 10 characters per second, i.e. 100 words per minute. As this method does provide a print-out, it may be used by a relatively unskilled operator.

(3) A Model Seventy-five Printing Reperforator, producing 5-unit $\frac{11}{16}$in. wide, punched tape under the control of a 3-row or 4-row teleprinter pattern keyboard. There is a printed local record of the punched information on the tape itself but this is not visible from the keyboard and there is no other printed local record. A maximum speed of 100 words per minute is obtainable.

Of the three methods given above the teleprinter method is the most widely used. Although it is less economical than the first method for preparing tape, it is easier to use and the teleprinter and tape punching attachment may be employed for other purposes.

TAPE EDITING

It is very important to prevent errors made during the preparation of tape from reaching the computer. A well-known firm of computer manufacturers using tape input equipment has estimated that in manually-prepared unchecked tape one error may be expected to occur in every 300 to 2000 characters.

Some errors are noticed immediately after they are made: for these the tape is back-spaced until the first incorrect character is over the punches. It is then over-punched with the 'erase', i.e. all-marking character. Most computers using a punched tape input are so designed that they ignore the 'erase' character.

To detect and eliminate other errors, two methods are in common use, both of them employing tape editing equipment manufactured by Creed & Company:

(1) The proof-reading method requires a tape reader, and a teleprinter fitted with a keyboard, a tape punch attachment and a two-colour printing facility. A control unit with an 'inching' key, i.e. a key for releasing the tape reader a character at a time, is also required. The print-out of the tape to be checked is first proof-read by the programmer, who marks the errors on it. The tape is then placed by the operator in the tape reader and punched and printed copies of the tape are obtained on the teleprinter. The operator watches the process and when an error on the initial print-out is neared, he stops the tape reader, inches it forward a character at a time to the error, and then uses the keyboard to introduce the correct character in place of the error. This process is repeated for all the other errors. On the final print-out, uncorrected characters are printed in black, corrected characters in red.

(2) The Verifier method is similar to the perfect tape comparator method, in so far as it is based upon the principle of double typing with automatic comparison. It differs, however, in running together the second typing and the automatic comparison into one operation. It also differs in employing simpler and quite distinct apparatus. This consists of a Model 91, 5-Wire, Keyboard, a Model 92 Tape Reader and a Model 25 Tape Punch. The first tape is prepared from the programme by one of the methods described above or on the Verifier

PUTERS

keyboard. It is placed in the tape reader and a second operator types out the programme information once more. This keyboard, the tape reader and the high speed punch are connected together in such a way that if the combination for the depressed key corresponds to the combination sensed by the tape reader, this same combination is punched in the new tape in the tape punch. If, on the other hand, the depressed key combination and the sensed combination disagree, the key is locked down and the punch is inhibited.

The operator has now to determine whether the fault is hers or is in the control tape. To do this she first marks on the manuscript the character she is supposed to have typed, and then reads off the sensed character on the control tape by looking at the row of lights at the base of the machine. She next compares this with the combination of the character marked on the manuscript. If they are the same, the fault is hers so she depresses a special 'Cancel' key—which mechanically releases the locked key—and then depresses the correct key, which results in the correct combination being punched in the verified tape. If the combination on the lights and the combination of the manuscript are not the same, the fault is in the control tape. In this case she depresses one of three special keys which moves the control tape over the error and punches the correct character on the output tape in the punch. When the Model 25 has completed its punching, the depressed key is unlocked automatically.

The correction of tapes is perhaps the most important function of tape editing equipment, but it is not the only one. It is also required for copying tapes, for automatically checking the accuracy of such copied tapes, for making composite tapes, i.e. tapes containing information derived from two or more other tapes such as a library tape and provisional programme tape, and for obtaining a print-out of a tape.

OUTPUT RECORDING AND PRINTING

In the punched tape system of recording the output from a computer, the output is fed to a multi-wire, non-printing tape punch of the kind described on page 14. The fully-perforated tape is then fed into a single-head, single-wire automatic tape reader, the output of which is fed into a standard receiving-only teleprinter. This produces a printed copy, or multiple printed copies, of the information.

It has been mentioned above that this print-out facility is provided in most types of tape editing equipment. There is, however, a demand for apparatus which has no other function than to provide a print out or, at the most, to provide tape-preparing facilities in addition. To cater for this demand, Creed & Company have developed a range of reproducer-terminal and interpreter sets. These are desk-mounted and are arranged in self-contained, packaged, units, suitable in appearance etc. for installing in a business office.

They are designed to meet a wide variety of application needs in both data processing and communications, and are outstanding for their versatility of operation. Facilities for on- or off-line working, page printing, tape editing, storage, tape preparation, transmission and reception are all provided for within these compact, high-performance sets designed to operate at speeds up to 100 words per minute. They utilize 5-track $\frac{11}{16}$in. (17.5 mm) wide paper tape.

The Reproducer/Terminal Set is available in two versions. They are virtually identical in appearance but differ in technical detail according to application needs. The Reproducer version is designed specifically for off-line tape editing operations in data processing systems, whilst the Terminal Set functions as a complete telegraph station for the interchange of messages and other data over communications circuits. If desired, the off-line facilities of the Reproducer can be combined with the on-line signal transmission and reception facilities of the Terminal Set to provide a single multi-function station offering exceptional versatility of operation.

MODEL SEVENTY-FIVE INTERPRETER SET

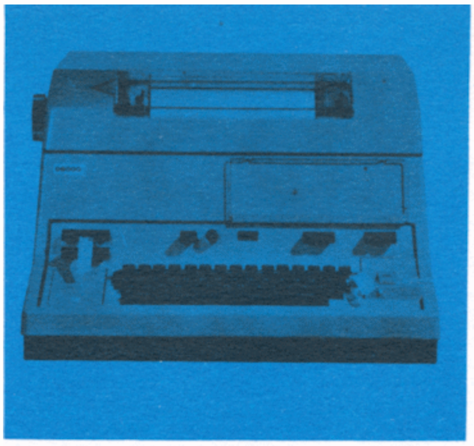
The Interpreter Set consists of a desk-mounted Model Seventy-five Receiver-only Teleprinter and a Model 6S/6-M Tape Reader. Tapes inserted in the reader are automatically interpreted by the printer in single- or multi-copy page form at speeds up to 100 w.p.m. If desired, the Model Seventy-five Receiver can be equipped with a tape punching attachment thereby enabling the Interpreter to be used for simple tape duplication.

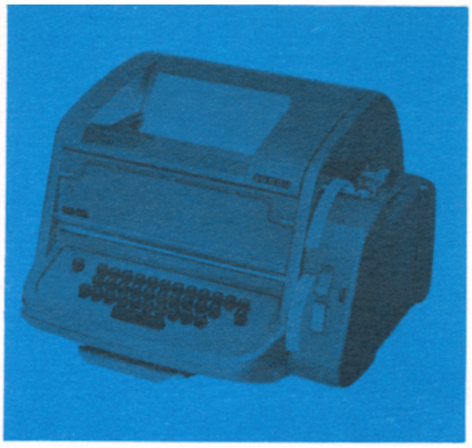
MODEL SEVENTY-FIVE 5-WIRE REPRODUCER SET

The 5-wire Reproducer Set consists of a desk-mounted Model Seventy-five 5-wire parallel input and output machine with tape punching attachment, associated with either a Model 35 or 92 Tape Reader.

The set is a dual-purpose piece of equipment which can be used for off-line tape preparation and editing, or in data processing applications where a parallel input and output printer can be used independently to record or transmit information in parallel form.

The equipment





The following are the main products in the current Creed range. Ancillary equipment which has not been covered in this brochure includes high speed tape winders, teleprinter desks and pedestals complete with power and signalling voltage supply and control units, a hand correction unit for paper tape, a range of signalling rectifiers, a teleprinter page winder and edge-punched card readers and punches. Creed also supply custom-built consoles and switching equipment to meet specific customer requirements.

TELEPRINTER MODEL 444

The Model 444 is a heavy duty page printing teleprinter which operates at up to 75 bauds, is compatible with all other current machines and is available with a full range of optional extras and special facilities. The 444 tape punching and reading units are fitted as an integral part of the keyboard and not attached to the side of the receiver. This brings increased operator convenience and makes possible faster tape handling.

Another innovation in the 444, which is the latest addition to the Creed range, is a Code Recognition Unit (stunt box). This permits a wide variety of remote control operations which can be used both within the machine for controlling the facilities of the 444 itself and externally for switching and other purposes. Thus it is possible to transmit a signal to a distant teleprinter which, when received, will cause the unit to switch the tape punch on ready to reperforate an incoming message. Similarly it can be arranged to switch on an ancillary piece of equipment (another teleprinter or tape punch) by the transmission of a special code.

This new teleprinter has all of the facilities of existing equipment and operates at any speed up to 100 words per minute without the usually attendant higher fault rate and maintenance requirement.

TELEPRINTER MODEL SEVENTY-FIVE

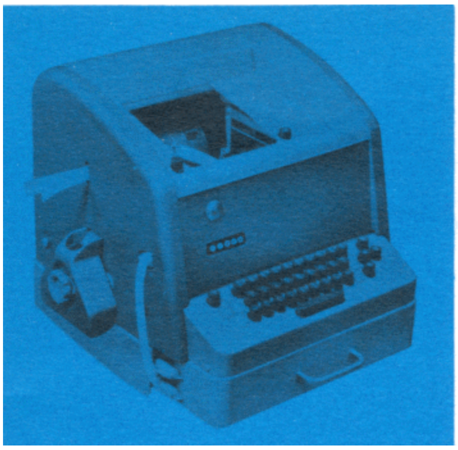
The Model Seventy-five is a high performance page printer for use in communications and data processing systems. It is capable of operating at up to 100 words per minute and is available as a transmitter/receiver or as a receiver-only.

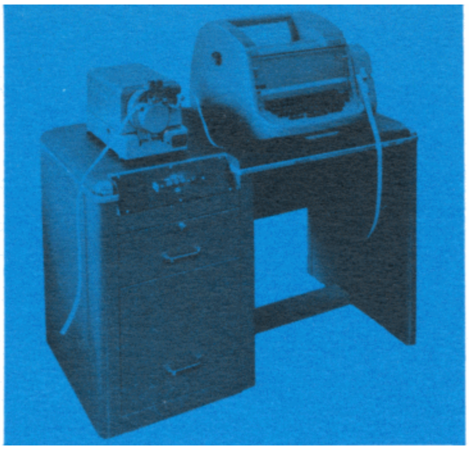
A feature of the machine is the stationery platen and moving typehead which traverses across the width of the paper. This method of printing means that the Seventy-five is unaffected by tilting, shock or vibration, and every character is visible as soon as printed.

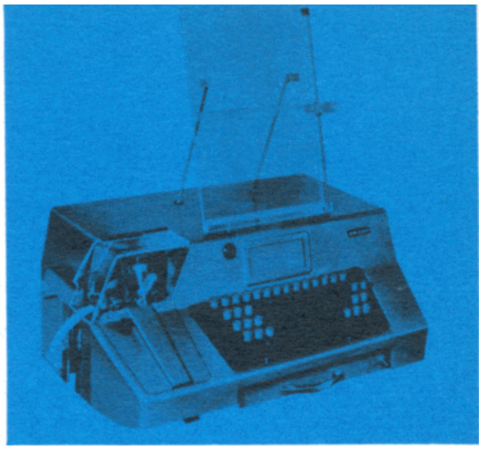
Important optional extras include attachments for tape punching and/or reading 5-unit tape. The punch which operates simultaneously with normal page printing can be switched in to punch tape from incoming signals or from manual operation of the local keyboard. The tape reading attachment permits the automatic transmission of pre-punched message tape at up to three times the speed averaged in manual operation.

Other optional extras include: two-colour printing, operation counter, combined carriage-return/line-feed key, automatic carriage-return and line-feed action at end of line, 20-character answer-back for keyboard and receiver-only models, dual-speed gear box, dual purpose friction/sprocket feed platen.

Specials include machines for automatic regeneration of received signals; sequential to parallel, parallel to sequential conversion, $11\frac{1}{2}$ ch/sec. print out from parallel input, edge punched card printing-punching version, solenoid-operated case-shift (inversion), two-colour printing, keyboard inhibition, reperforator inhibition and tape reader trip, combined sequential/parallel output for combination recognition and switching, half-width platens for paper economy, high-speed form throw facility and command keys generating set sequence of signals from one key depression.







PRINTING REPERFORATOR MODEL SEVENTY-FIVE PR

A development of the basic Model Seventy-five Teleprinter, the Creed Printing Reperforator is designed for the automatic recording of telegraph messages and other data, both as coded perforations and corresponding printed characters, on standard 5-track $\frac{11}{16}$in. (17.5 mm) wide paper tape.

Like the parent Model Seventy-five Teleprinter from which it is derived, and with which it shares a high percentage of common components, this machine is outstandingly smaller and lighter than the equipment it is designed to replace, whilst having the ability to operate reliably at speeds up to 100 w.p.m., with reduced maintenance.

A feature of the Model Seventy-five Printing Reperforator is the positioning of the printing between the punched sprocket-feed holes on the tape. With this arrangement a legible printed record is obtained on fully punched tape of standard width which may be handled by photoelectric readers as well as conventional telegraph transmitters. Printing on the tape occurs $8\frac{1}{2}$ feed hole pitches behind the corresponding code perforations. If desired, a second tape may be punched (but not printed) simultaneously with the punching and printing of the original.

The Model Seventy-five Printing Reperforator is designed primarily for on-line reception of telegraph signals, but is available optionally with either a 3- or 4-row keyboard for direct on-line manual signal transmission or off-line origination of code punched and printed tape.

Where application needs do not demand a printed record on the tape, the machine may be supplied without its printing component for service as a simple 5-track, non-printing tape punch, operating at speeds up to 100 w.p.m.

REPRODUCER TERMINAL SET

The Creed Model Seventy-five Reproducer/Terminal Set is a composite, multi-purpose equipment, comprising:

1. Model Seventy-five Teleprinter with tape punch;
2. Model 6S/6-M Tape Reader (auto-transmitter);
3. Equipped Desk with built-in push-button control unit.

Designed to meet a wide variety of application needs in both data processing and communications, the Reproducer/Terminal Set is outstanding for its versatility of operation. Facilities for on- or off-line working, page printing, tape editing, transmission and reception, all are provided within this compact, high-performance set designed to operate at speeds up to 100 words per minute.

The Reproducer/Terminal Set is available in two versions. These are virtually identical in appearance but differ in technical detail according to application needs. The Reproducer version is designed specifically for off-line tape editing operations in data processing systems, whilst the Terminal Set functions as a complete telegraph station for the interchange of messages and other data over communications circuits. If desired, the off-line facilities of the Reproducer can be combined with the on-line signal transmission and reception facilities of the Terminal Set to provide a single multi-function station offering exceptional versatility of operation. A 5-wire Reproducer Set which has parallel input-output is also available.

KEYBOARD TAPE PUNCH MODEL 7P/N SERIES 2

The Creed Model 7P/N Series 2 Keyboard Tape Punch is widely used in the communications and data processing fields as the basic machine for transcribing source data into 5-track punched paper tape.

Moderate cost, small-size, rugged construction and high speed of operation are features which have contributed to its appeal.

The machine is designed to cater for the expanded codes that are finding increasing application in data processing systems, and three distinct versions are available.

1. a narrow-tape version which punches five code tracks in $\frac{11}{16}$in. (17.5 mm) wide paper tape;
2. a medium-tape version which punches six or seven tracks in $\frac{7}{8}$in. (22.2 mm) wide paper tape;
3. a wide-tape version which punches eight code tracks in 1in. (25.4 mm) wide paper tape.

Also introduced is a new all-metal overall machine cover for improved appearance and utility. The punching mechanism is now fully enclosed for protection against damage or dust while remaining instantly accessible via a hinged cover section incorporating a window for viewing the punching operations.

The tape supply reel is relocated in a space-saving under-base drawer and a larger copy holder provides greater convenience for operators encoding lengthy data such as computer programming instructions.

TAPE READER MODEL 6S/6-M

The Model 6S/6-M Tape Reader affords efficiency, economy and flexibility in handling volume communications traffic by automatically transmitting at maximum circuit speed messages and other data previously coded into 5-track punched paper tape.

This machine also finds extensive application as an input device in data processing and automation systems operating on a punched tape basis.

The standard model is designed for either single- or double-current operation at 50 bauds on a $7\frac{1}{2}$- or 7-unit basis as required (66 or 72 words per minute respectively), but gearing and governing can be provided optionally for 45.52 bauds operation with $7\frac{1}{2}$-unit transmission (60 words per minute).

Also available, at extra cost, is a high speed version of this reader for operation at 75 bauds with $7\frac{1}{2}$-unit transmission (100 words per minute), where circuits permit.

TAPE PUNCH MODEL 25

The Model 25 Multi-wire Tape Punch is designed for general applications that involve the conversion of parallel-wire (simultaneous) electrical impulses into punched paper tape. Versions are available for punching 5-, 6-, 7- or 8-track codes at any speed up to 33 characters per second.

One of the most widely used of all Creed data processing machines, the Model 25 has thousands of hours of proven reliability behind it in service as an output punch with large- and small-scale electronic computer installations.

Its small size, simplicity and moderate cost also make it an attractive output device for a variety of other automatic data-recording requirements based on the punched tape 'common language' concept. The Model 25 is a completely self-contained machine that requires only motor power and external signal supplies.

TAPE READER MODEL 92

The Creed Model 92 Tape Reader meets the need for an inexpensive, medium-speed input device for use in a variety of punched tape controlled data processing and automation systems.

Designed to operate at speeds up to 20 characters per second (200 w.p.m.), it can be supplied for reading 5-, 6-, 7- or 8-track paper tape, and gives a coded signal output on a multi-wire, parallel (simultaneous) basis, using changeover contacts for each track.

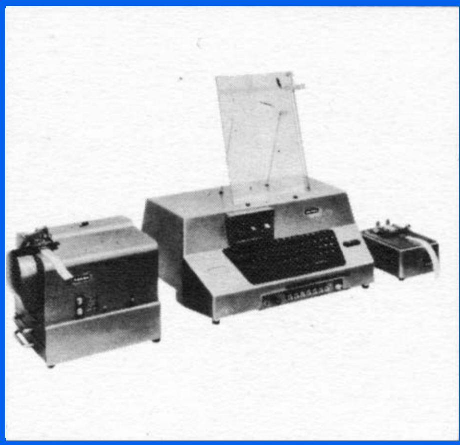
Electromagnetically operated, the Model 92 Tape Reader is simple, robust and reliable, whilst its small size and low weight are features of practical appeal, whether required for service as a self-contained unit or as a systems component for integration with other equipment.

TAPE READER MODEL 35

The Creed Model 35 Tape Reader is capable of reading 5-, 6-, 7- or 8-track fully punched tapes in either direction at up to 40 characters per second.

The fastest tape reader in the Creed range, the Model 35 operates in a parallel mode and is suitable for applications in a wide field, including data processing, data transmission and automation systems. It will operate step-by-step at speeds up to 35 characters per second or synchronously at 40 characters per second, and will stop within one character pitch at these speeds.

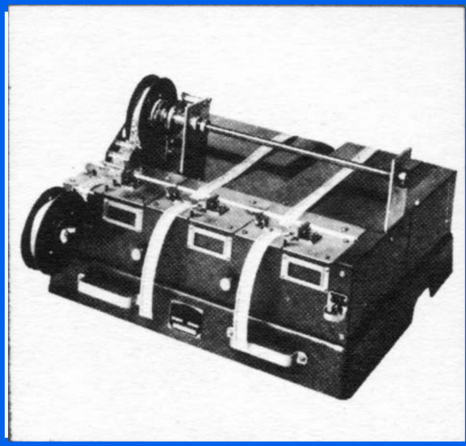
The Model 35 Tape Reader is available in two basic versions, the first suitable for 5-track operation and $\frac{11}{16}$in. (17.5 mm) wide tape. The second is an 8-track version taking 1in. (25.4 mm) wide tape and adaptable for 6- and 7-track operation by adjusting the tape guides to accept $\frac{7}{8}$in. (22.2 mm) wide tape. Both the 5-track and 6- to 8-track versions can be adjusted to take 3in. (7.6 cm) and $3\frac{1}{2}$in. (8.9 cm) wide edge-punched cards. Also available with easy load facility for reading edge punched cards.



TAPE VERIFIER MODEL 90

The Model 90 Tape Verifier is a versatile unit of Creed tape editing equipment, designed to provide a positive check on the accuracy of punched paper tape used as the input medium in data processing and automation systems. Comprising a multi-wire keyboard, tape reader, tape punch and power-pack—all electrically interconnected—the Verifier caters for the examination of a 5-, 6-, 7- or 8-track tape, according to model used, and the preparation of a second tape containing none of the errors detected in the original. Operator errors due to incorrect keying, either in original tape preparation or subsequent verification, are automatically and positively indicated, including the presence of unwanted data or the absence of data from the tape. The machine also functions as a normal keyboard tape punch for the origination of 5-, 6-, 7- or 8-track tapes, according to model used, at speeds up to 15 characters per second.

Like most other Creed data processing units, the Verifier features an extremely flexible specification, enabling the basic machine to be tailored to a variety of individual application needs. This versatility is exemplified in the new Verifier-Reproducer combination having a page printing capability allied to normal tape verification and preparation facilities.



MULTIPLE TRANSMITTER MODELS 71, 72 & 74

Comprising three independent message transmitting heads, 'packaged' on a single base and driven by a common motor, the Creed Model 71 Three-Gang Multiple Transmitter affords space-saving, heavy-duty tape transmission facilities for teleprinter tape relay operations. The machine reads standard $\frac{11}{16}$in. wide (17.5 mm) 5-track fully-punched paper tape. Standard telegraph model operates at 50 bauds, 7.5 unit transmission, (400 characters per minute) on a single-wire sequential (serial) basis. For data processing and automation applications, the machine can be supplied for operation on a multi-wire parallel (simultaneous) basis at a speed of 800 characters per minute. Multi-wire reading heads can be supplied separately for incorporation in other equipment and are available optionally with an external control tape reversing facility.

The Model 72 Multiple Transmitter is generally similar in design but incorporates three number transmitting heads for the provision of automatic message identification facilities in association with the Model 71.

The facilities of these two machines are combined in the Model 74 Transmitter which has one number and two message transmitting heads.

A series of control relay units is available for use in conjunction with these machines, permitting maximum flexibility of operation under a wide variety of conditions.

FREE ADVICE AND SYSTEM PLANNING AVAILABLE

It has been our aim in this brochure to provide potential users of teleprinters and punched tape equipment with basic information on the Creed range. It has not been possible in a publication of this nature to give full technical specifications or lists of operating facilities but separate publications covering each machine are available on request.

Creed also offer a free advisory service on all aspects of printing telegraph and punched paper tape handling. This service includes the provision of Systems Engineers to analyse your communications or tape handling problem and advise on the most economical and efficient solution. For free advice (without obligation, of course) contact Creed & Company Limited, Hollingbury, Brighton, England. Telephone Brighton 507111, Telex 87169.

A British subsidiary of ITT.

GLOSSARY OF TERMS

Abbreviation: (BS) – British Standard

Answer-Back A device which, when released by the receiving mechanism in response to an appropriate signal from the distant end, controls the transmitter and causes it to send back automatically the identity of the called station. This facility assures the calling operator:

(1) that he is connected to the station desired,

(2) that the called teleprinter is operating, even if it is unattended, and

(3) if operated at the end of a message, that the whole message has been received.

Back Space Key A control fitted to keyboard perforators and reperforating attachments to feed punched tape backwards—usually so that mistyped character can be erased by over-punching the all-mark (letters) combination.

Baud The unit of telegraph speed. Telegraph signals are characterised by intervals of time of duration equal to or greater than the shortest or elementary interval. Telegraph speed is, therefore, expressed as the inverse of the value of the elementary interval in seconds. A speed of one elementary interval per second is termed one baud (BS).

The elementary interval for teleprinter transmission is 20 milliseconds i.e. 1/50th of a second. Therefore, the telegraph speed is 50 bauds (see Telegraph Speed).

Cadence Speed For teleprinters this is the telegraph speed in words per minute. Two teleprinters having the same telegraph baud speed do not necessarily have the same cadence speed:

For a telegraph baud speed of 50 bauds, using 7-unit transmission, the cadence speed is 71.4 words per minute.

For a baud speed of 50 bauds, using $7\frac{1}{2}$ unit transmission, the cadence speed is 66.6 words per minute.

Case In telegraphy this term is often used synonymously with shift.

CCITT No. 2 Code The internationally agreed 5-unit telegraph code.

Character A printed symbol. Characters may be letters, figures, punctuation marks or signs. Signs may be sub-divided into operation signs (e.g. +./.=), abbreviation signs (e.g. @.£), and functional signs (e.g. ≡ for Line Feed).

Combination A particular arrangement of code elements.

Double-Current System A telegraph system in which signals are transmitted by reversing a current that is normally on the line during transmission (BS).

Duplex System A multiple-way system in which the circuit is arranged for simultaneous operation in opposite directions, over a single circuit (BS).

End-of-Line Indicator A mechanism attached to the transmitter of a teleprinter, to provide a visual or aural indication when a specific number of keys have been depressed after the Carriage Return key. This device is used as a warning to depress the Carriage Return key in cases where there is no local record or only a tape record at the transmitting end and the receiving machine is a page machine.

Figure Shift One of the shifts into which the characters and functions of the five-unit code are grouped.

Five-Unit Code The CCITT No. 2 Telegraph code.

Function A teleprinter operation other than printing or perforating which requires the transmission of a particular code combination (e.g. Line Feed).

'Here-Is' Key Control for operation of local 'Answer-Back Unit' to transmit identifying code name to distant station.

Keyboard Perforator Machine which produces punched paper tape (without printed interpretation) from keyboard operation.

Letter Shift One of the shifts into which the characters and functions of the five-unit code are grouped.

Local Record A printed copy at transmitting station of message sent to line manually or automatically.

Margin The maximum distortion which, when occurring on any or all of the signals applied to a telegraph receiver, is compatible with correct registration of all the symbols for which the receiver is designed (BS).

Mark One of the two kinds of elements in the international binary start-stop code, e.g. the first two elements in the combination for 'A' in the code are marks.

Off-line Term used to indicate that a teleprinter or set of equipment is not connected to a signalling circuit or line.

Orientation Device An integral unit in most teleprinters to adjust the machine's operation so that the least distorted portion of each incoming unit (or baud) signal is sampled and fed to the decoding unit. This adjustment ensures that slight line distortion does not result in mis-selections.

Parallel Working Mode of operation where input and output is on a multi-wire simultaneous basis, e.g. where signals are applied to five or more lines simultaneously.

Reperforator An instrument which converts incoming electrical impulses of the five-unit code into equivalent perforations of a paper tape.

Run-out Key Operation of this control, which is fitted to certain teleprinters and reperforators causes the high speed repetition of the character associated with any other key held down at the same time.

Send-Receive Switch A switch used in simplex systems for changing over from the sending to the receiving condition, and vice versa. On the teleprinter this switch is operated automatically, the tongue moving over to the send contact before the transmission of each character signal. The return to the receive contact may take place either directly after the transmission of the character signal, or be delayed.

Simplex System A telegraph system in which the circuit is arranged for operation in one direction at one time (BS).

Slip Term used to describe punched tape.

Space One of the two kinds of elements in the international binary start-stop code, e.g. the last three elements of the combination for 'A' in the code are spaces.

Start Space Usually positive battery or no-current signal which precedes every five-unit code combination. This signal releases the receive-cam in the local and distant teleprinters to ensure that both machines are in synchronism.

Stop Mark Usually negative battery signal which arrests the receive-cam of local and distant teleprinter which then remain stationary to await the start space of the next character code.

Tape Low Alarm A visual alarm system fitted to many punched-tape machines to give warning that the supply of unpunched tape is running low.

Tape Reader Also known as automatic transmitter, this machine is designed to translate the coded perforations in punched paper tape into electrical signals at a steady, fixed speed.

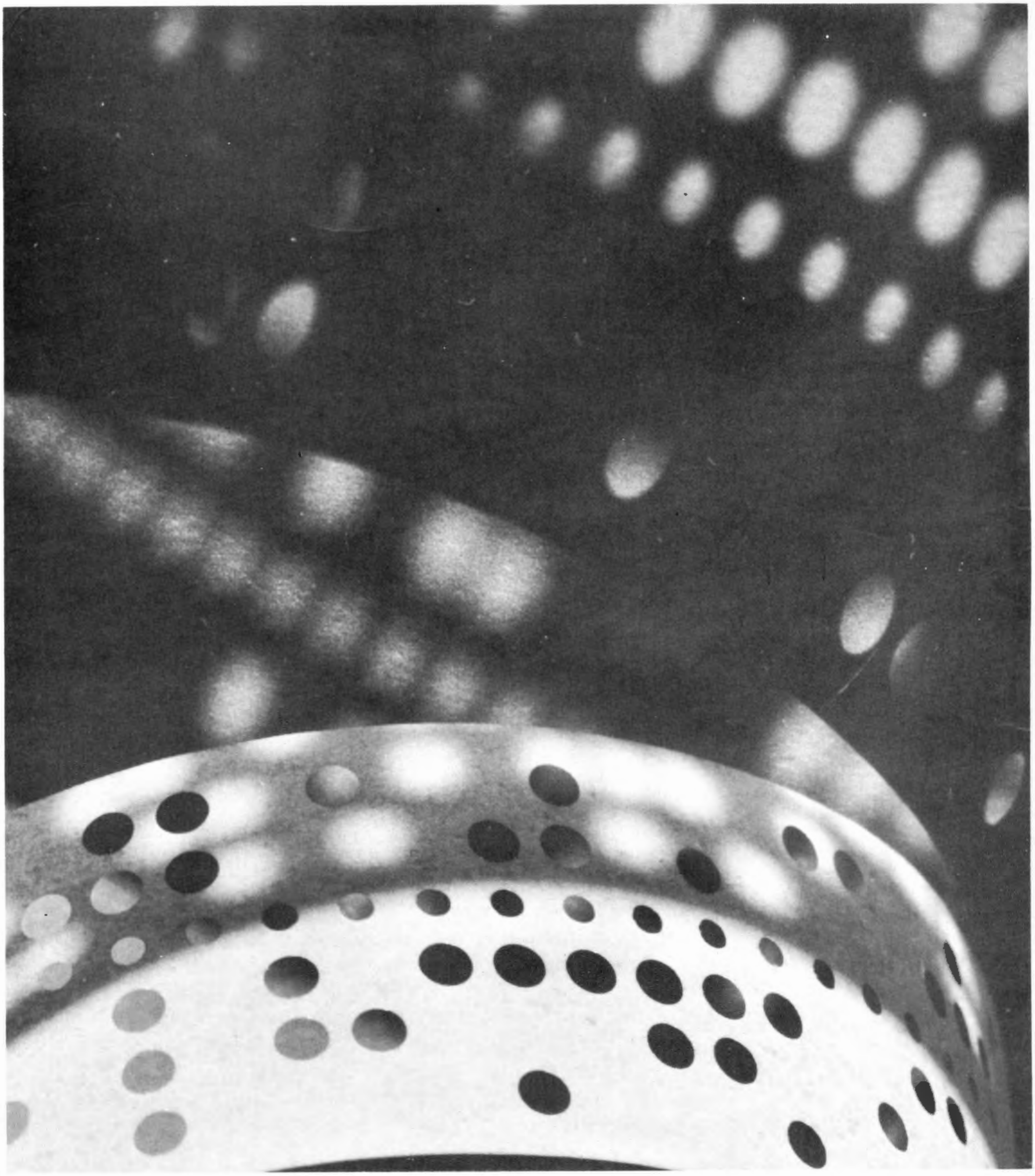
Telegraph Distortion In telegraph systems in which the signals at their origin are characterised by modulation at specific instants, the degree of distortion of the modulations when reproduced at the receiver is the ratio of the difference in delay or reproduction of the instants to the duration of the shortest modulation interval applicable to the particular system under consideration (BS).

Telegraph Speed The rate of transmission, either in characters or words per minute, or in bauds. For the purpose of calculation, a word is accepted as consisting of 5 letters and a space, or 6 characters (BS).

Telex The public teleprinter service operated by the GPO and Post & Telegraph authorities in most countries of the world.

Torn Tape Relay A system of message routing based on the removal of a punched tape from a reperforator at a communications centre and feeding into an automatic transmitter connected to another circuit. This system makes possible considerable operating economies since it is necessary for every station in a network to be connected only to the communications centre and not to all other stations.

'Who Are You' Signal The code which when transmitted to a distant teleprinter causes the answer-back unit to automatically transmit back a station identification word or phrase usually known as the Answer-Back Code.



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