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Department 539
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August 8, 1958

FILE MEMO

SUBJECT: Paper Tape Input

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The numerous special characters which are desired for programming the Stretch machine present a problem of input. The punched card keyboard is not extensive enough.

One suggestion, as an aid to a solution of the problem, is the use of the IBM electric typewriter, both upper and lower cases. Essentially, such a scheme would double the usable character set now available for the standard punched card input.

Unfortunately, the standard Hollerith code will not permit such an increase in the symbol table. Furthermore, it would be convenient to employ an eight channel code in which a maximum of seven bits are present per character, the same code employed by the inquiry station typewriter. It is possible to revise the 024 card punch to accept typewriter impulses to punch the desired code into cards; however, the metal parts of the 024 are not made to punch more than four holes at a time without bending (expensive to adjust) and, thus, each character punched would require two complete machine cycles, making the 024 too slow to be practical with normal typewriter speeds.

The simplicity, speed, and cost of punched paper tape equipment might provide us with an answer to the difficulties. This memo will discuss this question.

The following device has been suggested as one means of paper tape input: An electric typewriter (possibly that of an inquiry station) sends impulses to a paper tape punch which punches as rapidly as symbols can be stroked. All lower and upper case symbols will have individual codes as well as backspace, space, carriage return, line feed, tabulation, black, red, the same as those employed by the inquiry station. The tape will be supplied to the punch by a reel of unpunched tape. The punched tape will continue unbroken to a tape reader via a slack bin into which the tape may fall. This allows punching an entire record of information before reading begins, and after punching has ceased, reading at faster rates than typewriter stroking. The paper tape

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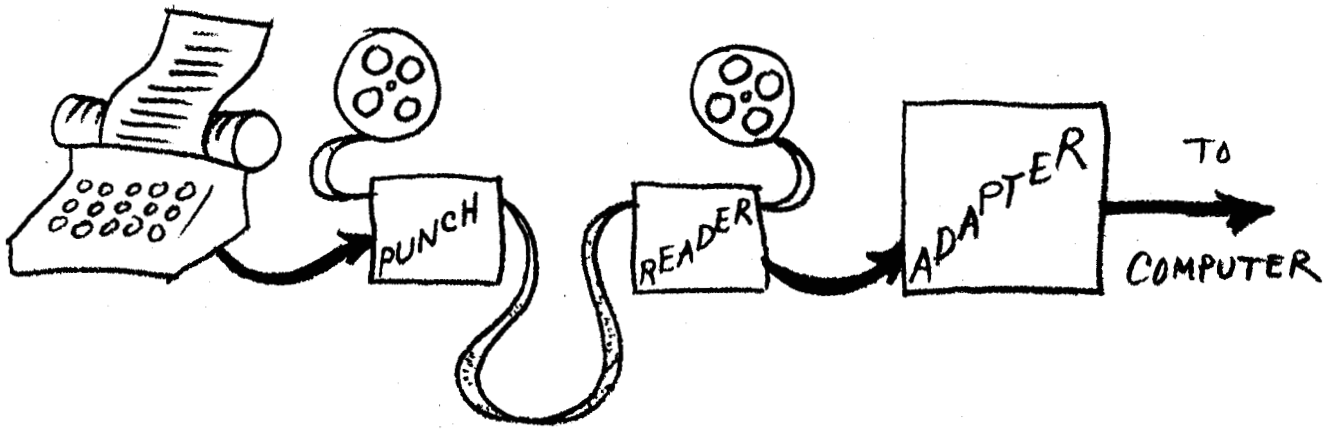
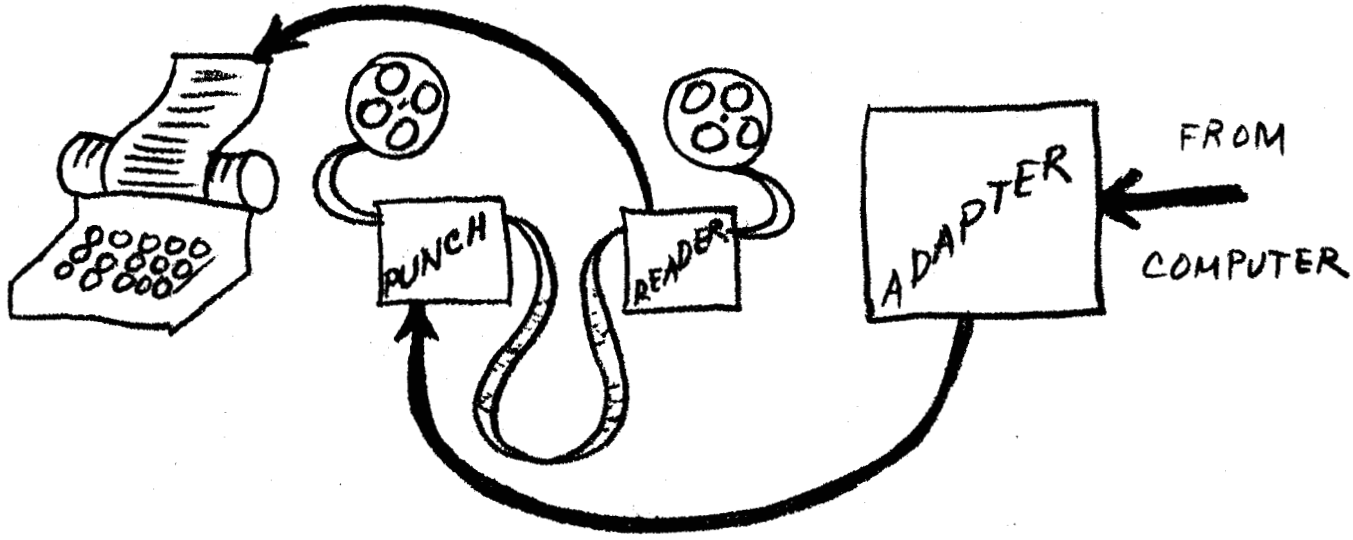
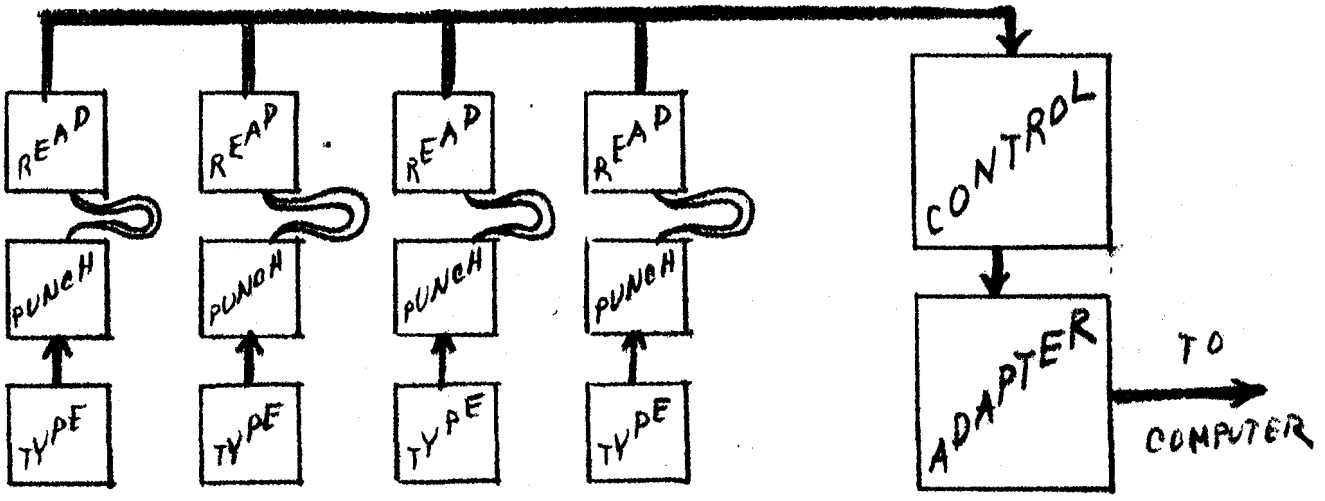
is wound onto a reel after it passes through the reader, and will probably never be used again, although it can be if necessary. The reader impulses an adapter (possibly that of an inquiry station) which, in turn, properly delivers the message to the computer memory via the exchange. See figure below:



There will probably be occasion when it is desired to type short messages from the computer rather than use the line printer because of the extended symbol table used. This can be handled by driving the punch by the adapter at speeds faster than the electric typewriter can stroke; and, then, afterwards, having the reader drive the typewriter at maximum typewriter speeds. See figure below:



By use of a control unit, it is possible to engage several typewriter-punch-readers with a single adapter and I/O channel. See figure below:



Several programmers can be typing and punching while the computer is reading in a single tape to memory. Of course, the computer can deliver output to only one typewriter per channel at a time.

Paper tape has not been popular for earlier computers because of certain problems which were not shared by the punched card method of I/O. The possible problems of punched paper tape use are as follows:

1. Ease of sorting data.
2. Ease of collating data.
3. Tapes longer than practical for the slack bin between the punch and reader.
4. Ease of error correction.

Concerning 1 and 2, numerical data will involve no special symbols and hence may be punched into IBM cards, sorted, collated, and fed to computer via standard card reader or magnetic tape. Interpretation to machine language can be easily handled by programming. Input via paper tape will be largely newly written programs which need no sorting or collating. Hence, it will be unusual to face 1 and 2 as problems.

When the paper tape becomes too long to be practical for the slack bin, case 3, the tape may be wound directly onto a special reel from the punch station. The special reel has one removable side. This allows the paper tape to be fed to the punch from the center of the roll with no rewinding required.

Error correction is not obviously easy, so some discussion of 4 is necessary.

There are several types of errors which can occur:

a. Typographical error - ommission of character.

b. Entry of symbols without definition.

c. Ommission of instructions.

d. Instructions in wrong order.

e. Error in program reasoning.

The problems created by error type e are many but should seldom create a problem worse for paper tape input than for cards.

Errors of type c and d are simple to handle by either directly typing at the inquiry station or punching paper tape, whichever applies better. If the corrections are entered in machine language, the punched card reader can be used.

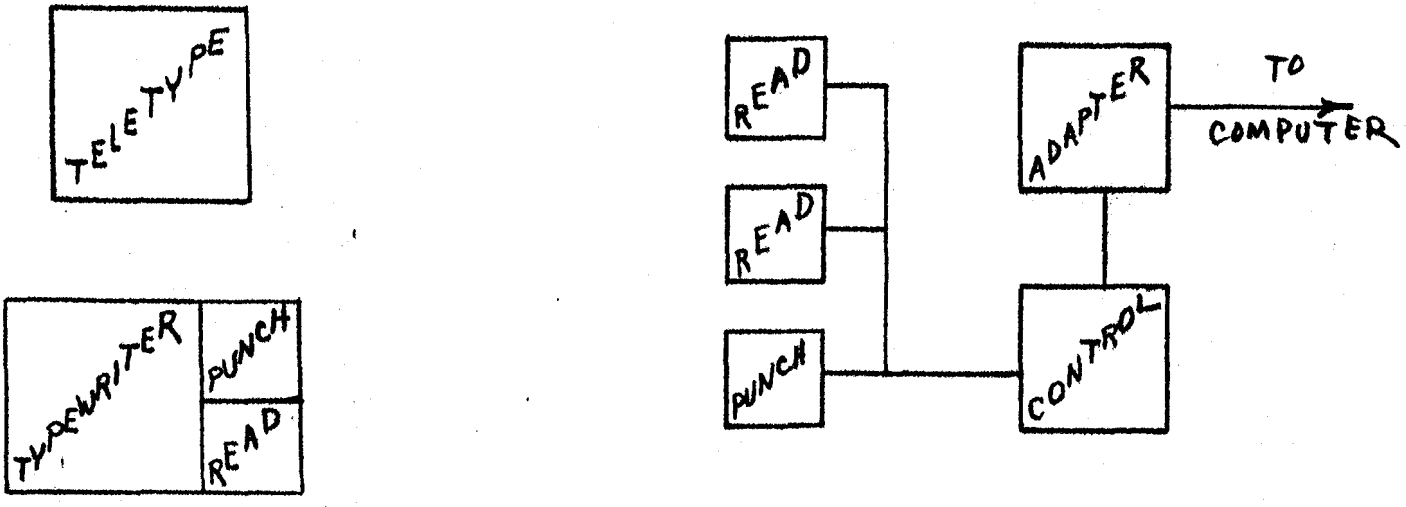
The only real problems of error correction which are generally more difficult for punched paper tape than for cards are those of types a and b. More specifically, in order to make paper tape a practical form of input there must be ways of overcoming the handicap of not being able to remove errors from a piece of tape without cutting and pasting. So, to reduce the trouble, all programs read by the computer which are to be assembled or compiled will enter memory in blocks of several instructions at a time. In this way, corrections can be made by the computer as signalled by coding from the tape before assembling or compiling begins for each block. For example, if the typist operating the paper tape punch notices that she has made an error in the line she is writing, she may signal the computer with a symbol (on tape) such as backspace, that an error has been made. Then, either by backspacing and using the erase key to correct the mistake, or by returning the carriage and typing a new line, the error can be completely wiped out in memory. If an error is found on a line above, the typist can, when the block is finished, signal the computer which line is in error (again by symbol and code number on tape immediately following the block), and retype the line. If the blocks are of a reasonable length each, no major problem will be created.

The computer itself will find errors which were not caught by the typist or by the programmer. Each of these errors will be indicated at an inquiry station. These errors can be corrected by an additional pass of paper tape.

It should be noted that some installations will place such a requirement on its inquiry stations that none can be afforded to punched paper tape I/O use. In these cases, an adapter which is independent of any inquiry station may be used with its own exchange channel to operate a reader and punch. Here, again, more readers than one can be employed when continuous input is desired per channel.

Punching or reading paper tape off-line at remote locations might be desirable at some installations. For this reason, the manufacture of a suitable typewriter punch-reader for eight channel paper tape is under consideration. All 88 of the keyboard symbols and the applicable typewriter functions will be included in the code repertoire. Furthermore, it might be the customer's wish to enter punched paper tape which has been written by a teletype device or by some competitor's machine such as Flexowriter. This can be done easily through the proposed on-line paper tape punch-reader and programming. Since the Flexowriter can also type from properly coded paper tape, such a device might be common for use off-line.

Below is a sketch showing a possible off-line paper tape installation and associated on-line equipment.



This memo is intended to promote interest, criticism, and suggestions since there are still a number decisions to make concerning the paper tape idea.

GHS/pkb