

IBM

Printer

TYPE

719-720-730

**with Type 760 Control
and Storage Unit**

MANUAL OF OPERATION: PRELIMINARY EDITION

MINOR REVISION (April, 1956)

This edition, Form 22-6665-1, is a minor revision of the preceding edition but does not obsolete Form 22-6665-0. Principal changes in this edition are:

PAGE	SUBJECT
Throughout	Control instructions 0006, 0007, 0008 and 0009 changed to 0026, 0027, 0028, and 0029, respectively.
7, 11	Carriage skip channels changed from 1, 2, 3, 4 to 1, 2, 4, 8.
11	Form length switch changed to L, M, and S.
12	Grouped records section changed.
16	Read instruction differs for 702 and 705.

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IBM PRINTER
Type 719

TYPE 719 - 720 - 730 PRINTERS

OUTSTANDING in the field of high-speed printing are the IBM Printers, Types 719, 720 and 730. Designed for use with the Types 705 and 702 Electronic Data-Processing Machines, the printers provide a new means of high-speed visual output.

The Type 719 Printer operates at a maximum speed of 1,000 lines per minute, each line having 60 printing positions.

The Type 720 Printer operates at a maximum speed of 500 lines per minute, each line having 120 printing positions.

The Type 730 Printer operates at a maximum speed of 1000 lines per minute, each line having 120 printing positions.

The printing positions on all three printers are horizontally spaced at 10 per inch. Each position can print any of the 47 standard characters.

An automatic tape-controlled carriage is provided as an integral part of the printers. Positive form feeding is accomplished by two sets of forms tractors, one above and one below the printing line.

Each printer is equipped with a Type 760 Control and Storage Unit which provides the power supply and control circuitry. The same control unit may be used with a Type 719, 720 or 730 printer. Each printer and its control unit may be used with the Type 727 Tape Unit for independent tape to printer operations. They are also used as a direct output for the 705 and 702 systems. Data are printed in the same sequence as entered into the printer control unit.

The premium notices shown in Figure 3 were prepared on the Type 719. Note the clear, legible letter style achieved through wire printing. The multiple carbon form illustrates the clarity and legibility of the carbons. An original and up to seven legible carbons can be prepared at one time.

PRINTING

THE PRINTING of each character is accomplished by 35 wires that are located in a rectangle 5 wires wide by 7 wires high (Figure 1).

By selecting and extending a pattern of these wires, each of the 47 characters now in use can be printed in any of the printing positions. Each matrix of 5

wires by 7 wires is called a printing head. The Type 719 and 720 have 30 printing heads and the Type 730 has 60 printing heads.

On the 719 and 730, the printing heads are located in alternate positions; that is, there are five printing heads to the inch (Figure 2). To print an entire line of 60 positions on the 719, the 30 print heads first print in the odd-numbered printing positions. The entire 30-position print unit then shifts to the right one-tenth of an inch and prints in the even-numbered positions. This completes that line of printing. Printing of the next line occurs in the reverse order, the even-numbered positions, a shift to the left, and the odd-numbered positions. Printing may start with either the odd or even printing positions, depending upon where the print unit was last stopped. The operation is the same for the Type 730 except that 120 positions are printed with 60 print heads. Each line of printing on the Type 719 or 730 is composed of two sub-cycles, one for each operation of the print heads.

On the Type 720, which prints at the maximum rate of 500 lines per minute, the print heads are located every fourth position; that is, there are five heads to each two inches of a printing line (Figure 4). To print an entire line of 120 positions, the 30 print heads must be used four times. Between each operation of the print heads the entire unit shifts to the

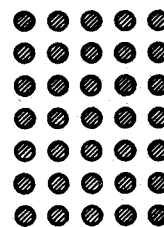


FIGURE 1

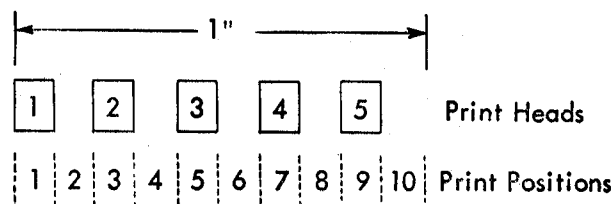


FIGURE 2

ACCOUNTING STUB

NOTICE ISSUED _____
LETTER ISSUED _____

TELEPHONE NO. _____
TELEPHONE CALL _____

POLICY OR BOND NUMBER 4270
DATE DUE MO. 4 DAY 1 YEAR 54
PREM FOR 6 MONTHS

DESCRIPTION AMOUNT
PREMIUM \$ 195.23
DIVIDEND \$ 25.11
AMT. DUE \$ 170.12

Second Carbon

ROBERT G. BALLY

NOTICE OF PAYMENT DUE ON YOUR POLICY AS DESCRIBED BELOW

POLICY OR BOND NUMBER 4270
DATE DUE MO. 4 DAY 1 YEAR 54
PREM FOR 6 MONTHS
DESCRIPTION AMOUNT
PREMIUM \$ 195.23
DIVIDEND \$ 25.11
AMT. DUE \$ 170.12

First Carbon

ROBERT G. BALLY

REPRESENTATIVE LIFE INSURANCE COMPANY

RECEIPT

POLICY OR BOND NUMBER 4270
DATE DUE MO. 4 DAY 1 YEAR 54
PREM FOR 6 MONTHS
DESCRIPTION AMOUNT
PREMIUM \$ 195.23
DIVIDEND \$ 25.11
AMT. DUE \$ 170.12

ROBERT G. BALLY
7 PROSPECT RD.
PEORIA 9, ILL.

Original

THANK YOU FOR PAYMENT OF THE AMOUNT INDICATED

John Smith
SECRETARY

CASHIER OR AGENT

DATED

FIGURE 3

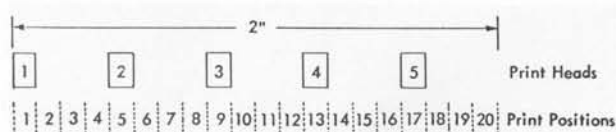


FIGURE 4

right one-tenth of an inch. This enables print head number 1 to print position 1, shift right to print position 2, shift right to print position 3, and shift right to print position 4. The next line of printing occurs in the reverse order. Printing may start at the left or right depending upon where the print unit was last stopped. Each line of printing on the Type 720 is composed of four sub-cycles, one for each operation of the print heads.

The method of printing consecutive lines in the reverse order (left to right followed by right to left) on these printers permits maximum utilization of the print unit movement. The information coming into the printer does not have to be reversed for every other line by the program of the EDPM. This is controlled automatically from the printer.

Manual suppression of groups of printing positions is provided by print suppression levers located at the top of the print unit (Figure 5).

CHECKING

As a CHARACTER enters the printer from the Type 760 Control Unit, the check code for that character is stored. When this character is set up in the print mechanism, a check code is set up. These two check codes are then compared to determine whether the printer has set up to print the correct character. If the two check codes agree, printing continues in the normal manner. When an error is detected, the print check light glows and the machine stops if the printer is operating from a tape unit. When operation is under the control of the EDPM, a signal is returned to the EDPM for interrogation. For a more complete discussion of error detection operation see "Print Check."

CARRIAGE

A TAPE-CONTROLLED carriage is provided as an integral part of the printers. Paper used in this carriage must be continuous form stock and marginally

punched for pin feeding. Maximum form dimensions are:

Width — $16\frac{3}{4}$ inches overall, using standard marginal punching

Length — 22 inches

To insert forms in this carriage, open lever A (Figure 6). The entire carriage may then be moved to the left on extension rods. The paper line is now easily available for form insertion. The forms are threaded on the forms tractors above and below the printing line (Figure 7). Slide the carriage back into engagement with the printer and lock in place with lever A.

The form may now be manually advanced through the carriage, a full line space at a time, with knob B. For adjustments less than one line space, vernier knob C is used. To vary the space between the print heads and the paper for multiple carbon forms, the thickness adjusting knob D is provided.

Normal single spacing (six lines per inch) or double spacing (three lines per inch) can be performed with no loss of printing time.

Channels 1, 2, 4 and 8 of the carriage tape are provided for skipping. Skips $3\frac{1}{2}$ inches or less require two sub-cycles. Skips greater than $3\frac{1}{2}$ inches require additional sub-cycles.

Channel 12 of the carriage tape is provided to control overflow operations. The operations performed as a result of sensing a 12 will vary with the setting of the program switch. For these particulars, see "Program Switch."

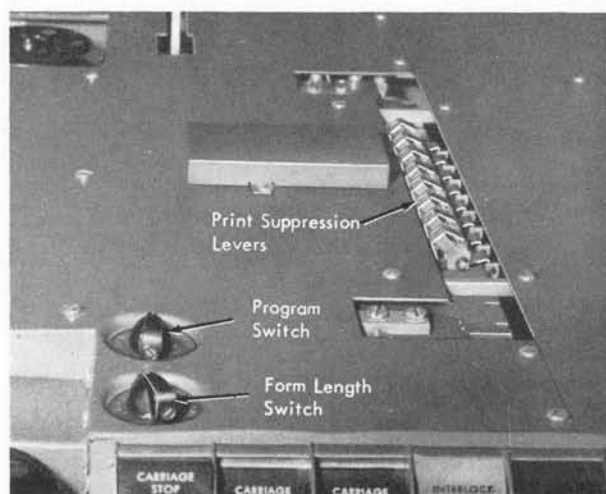


FIGURE 5. PRINT-SUPPRESSION LEVER, FORM-LENGTH SWITCH, AND PROGRAM SWITCH

OPERATING SPEEDS

THE MAXIMUM operating speed of the Types 719 and 730 Printers is 1,000 lines per minute; of the Type 720, 500 lines per minute. In actual practice, however, the operating speeds achieved will vary with these factors:

1. The length of the skips.
2. The number of characters being loaded into the control unit.

All spacing is performed while the printers are operating at maximum speeds. Any skip $3\frac{1}{2}$ inches or less requires two sub-cycles of printer time. Where a skip is greater than $3\frac{1}{2}$ inches, an additional sub-cycle is required for every additional two inches of skipping. For example, if the skip to be performed is five inches, the machine would require a total of three sub-cycles.

The characters being loaded into the control unit affect printing speed in two ways:

1. Information coming from the central processing unit is at a faster rate than information from a tape unit in independent tape to printer operations.

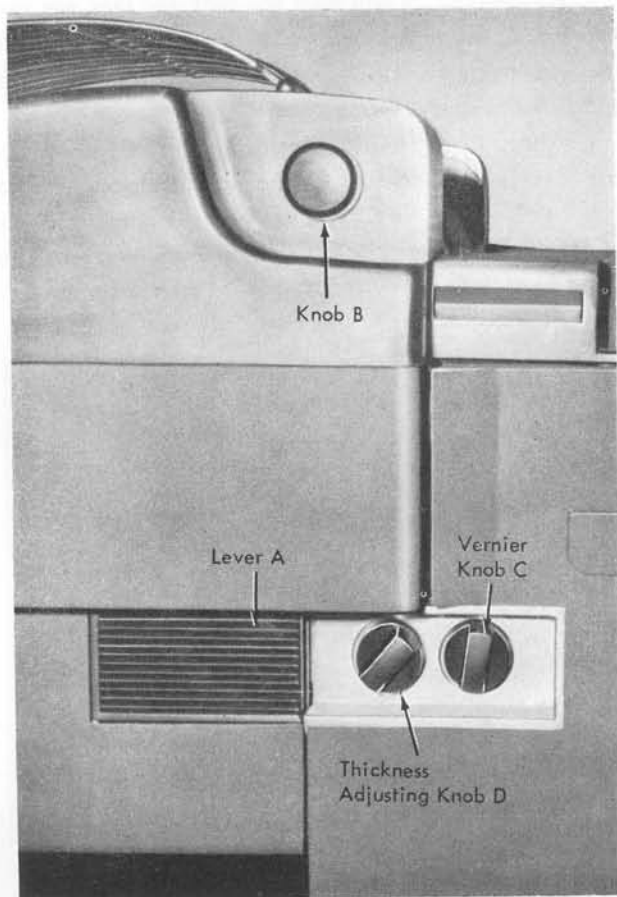


FIGURE 6

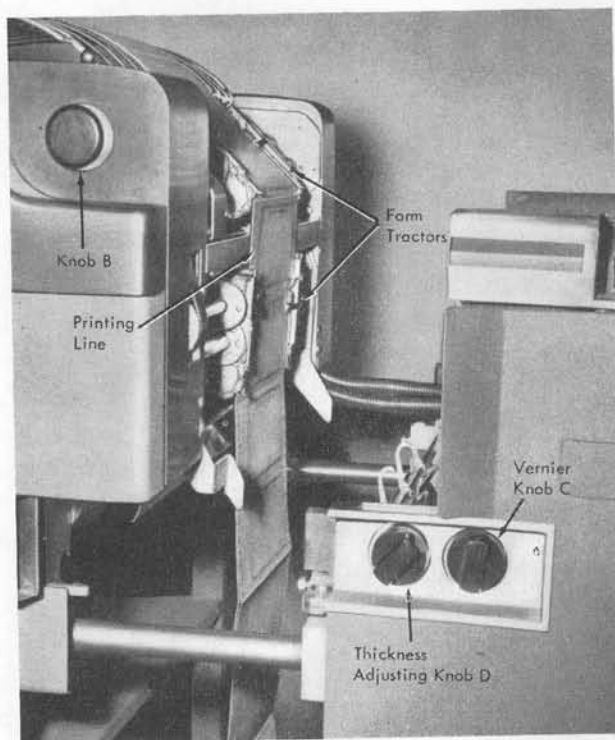


FIGURE 7

2. The number of characters in a grouped record vary the time required to load the control unit. For example, a long group may need one or more additional sub-cycles to load the control unit completely.

For example: a central processing unit to Type 719 Printer (single record) operation will produce 1,000 lines per minute when no skipping is required. One line utilizes two sub-cycles; two lines use four sub-cycles, etc. Grouped records may or may not reduce this operating speed depending upon the character length of the group.

When skipping is to be performed, the effective printing speed is determined by combining the time required for skipping with the time required for loading the control unit and printing the information. For example, assuming the information is coming from the central processing unit and the form is being prepared on the Type 719 Printer, the effective printing speed for the form shown in Figure 3 is determined as follows:

- | | |
|---|----|
| 1. Sub-cycles required to load Type 760 with 7 records (52 characters each) and print 7 lines | 14 |
| 2. Sub-cycles required to skip (overflow) within $3\frac{1}{2}$ inches | 2 |
| Total sub-cycles to load Type 760, print 7 lines, and perform 1 skip | 16 |

		TYPE 719 60 characters per line			TYPE 720 120 characters per line				TYPE 730 120 characters per line				
Characters per group	Read from CPU	0-600	-	-	0-600	601-1000	-	-	0-600	601-1000	-	-	
	Read from Tape	0-120	121-320	321-600	0-120	121-320	321-767	768-1000	0-120	121-320	321-767	768-1000	
Records per group		LPM	LPM	LPM	LPM	LPM	LPM	LPM	LPM	LPM	LPM	LPM	
1		1000			500				1000				Group by 5 or 10. Maximum record length 120 or 98 characters.
2		1000	800		500	444			1000	800			
3		1000	857		500	461	428		1000	857	750		
4		1000	889	800	500	471	444		1000	889	800		
5		1000	909	833	500	476	454		1000	909	833		
6		1000	923	857	500	480	461		1000	923	857		Group by 10. Maximum record length 100 characters.
7		1000	933	875	500	482	467		1000	933	875		
8		1000	942	889	500	485	471	457	1000	942	889	842	
9		1000	948	900	500	487	474	461	1000	948	900	857	
10		1000	952	909	500	488	476	465	1000	952	909	869	

Enter column corresponding to characters per group and row corresponding to records per group. Read speed at intersection.

With the Type 720 or 730, if there are more than 100 characters per record, only the upper portion of the table may be used.

FIGURE 8. PRINTER SPEED

Since there are 2,000 sub-cycles per minute, the effective printing speed in lines per minute for this form of 7 lines is:

$$\frac{2000}{16} \times 7 = 875 \text{ lines per minute}$$

Figure 8 is a table of operating speeds. The printing is at a maximum speed of 500 or 1000 lines per minute when the 760 is loaded with 0-120 characters from tape or 0-600 characters from memory. When additional characters are loaded into the 760, an additional sub-cycle is required. For example, loading the 760 with 305 characters from tape will require an additional sub-cycle. Assuming that there are five records in a group, it will require 11 sub-cycles to load the 760 and print five lines. Therefore, it is possible to print $(2000 \div 11) \times 5 = 909$ lines per minute.

OPERATING CONTROLS

Print Drive Switch

Located at the right end of the printer, this switch provides power to the print drive mechanism.

Operating Keys and Lights

The key and light unit has been designed with all the stop and off keys raised for easy access and to facilitate operation. A description of the keys and lights follows.

Carriage Stop

This key turns off the READY light and stops the printer at the end of the line being printed. The car-

riage motor is also turned off with this key. The EDPM will continue to operate until the printer is again selected. At this time operations will stop, waiting for the printer to again be made ready. To restart the printer, the CARRIAGE MOTOR START key must be depressed to restart the carriage motor (Figure 9). Following this, the START key must be depressed to make the printer ready to operate.

Carriage Restore

This key causes a skip to channel 1. A depression of this key should always be a portion of the starting procedure of the printer. If no tape is in the carriage, a single space will occur if the brushes are on the contact roll, but if the brushes are not on the roll, the carriage will continue to feed paper until stopped by the CARRIAGE STOP key. This key is operative only if the READY light is off.

Carriage Space

This key causes a single space to occur regardless of the setting of the PROGRAM switch. This key is operative only if the READY light is off.

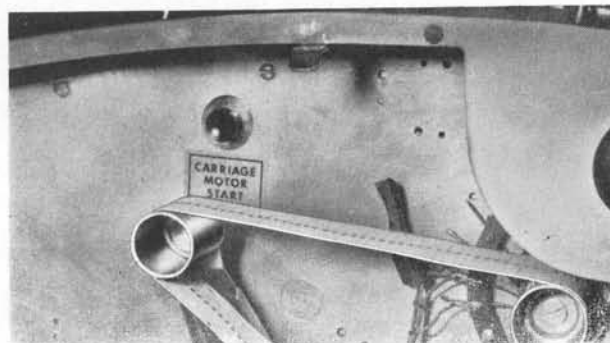


FIGURE 9

Interlock

When this light is on, it indicates that the carriage is in place ready to print and that the POWER ON key has been depressed, and the CARRIAGE MOTOR START key has been depressed. The machine is ready to function.

Fuse

This light indicates a defective fuse and will cause the printer to stop. The EDPM will continue to operate until the printer is again selected. At this time the EDPM will wait until the printer is again made ready by replacing the fuse and depressing the start key.

Print Check

When this light comes on, it indicates that a printing error has occurred. If the information is coming from the EDPM, a signal is returned to the central processing unit where it can be interrogated for action. If the information is coming from a tape unit, the printer stops after one additional line has been printed. The correction routine for this operation is described in the Type 702 and 705 Preliminary Manuals of Operation.

Power On

This light comes on to indicate that power is being supplied to the printer.

Ready

This light glows when the START key has been depressed. The interlock light must be on before the start key will turn on the ready light.

Read Check

This light works in conjunction with printing directly from a tape unit. When a code check error is detected in reading the tape, this light comes on and printing is prevented. The corrective routine for this can be found in the Type 702 and 705 Preliminary Manuals of Operation. To turn off the read-check light, depress both the reset and stop keys.

Select

When this light comes on, it indicates that the printer has been selected by the EDPM to operate. This does not necessarily mean that the printer is ready for operation.

Reset

When this key is depressed, the print check indicator is released. The start key may then be depressed.

Single Cycle

One depression of this key causes a single line to print if the printer has been selected to operate.

Form Stop

This light comes on when the carriage has run out of paper. Printing stops at the end of the line being printed.

Form Control

When the form stop light is turned on, the machine stops. This indicates the end of the paper forms. It is possible to print additional single lines by depressing the single-cycle key. For each depression a line is printed until a skip to 1 occurs. The skip to 1 occurs with no printing. Depressing the form control key causes a printing operation. It is possible to continue with single cycle operations for subsequent forms until another skip to 1 occurs.

Start

Depressing this key permits the printer to operate continuously if the READY light is on. It must be depressed at the beginning of the run or after any of the stops which may occur during an operation, such as form stop, read check, etc.

Stop

When depressed, this key releases the ready condition of the printer and stops printing at the end of that line.

Power Off

Depressing this key removes all power from the system.

Power On

Depressing this key turns on all power and the POWER ON light.

Back Space

When the printer is used with a tape unit, this key sends an impulse to the tape unit to back space the tape to the preceding record gap. It operates only when the read-check light is out.

Thermal Light

This light is turned on when excessive temperature in the chassis opens the thermal control contact. The opening of the thermal contact stops the machine. When the temperature drops, the machine may be restarted.

Program Switch

This switch is located on the top of the printer (Figure 5). The three settings of the switch are as follows:

1. The carriage will single space for every line of printing.
2. The carriage will double space for every line of printing.

On both of these settings a punch in channel 12 of the tape causes an overflow to channel 1.

P. This setting of the switch puts the control of the carriage under the program of the EDPM. A single space will normally occur unless the carriage receives some other instruction from the EDPM to skip, double space, or suppress space. The character stored in the first position of each record in the printer control unit provides this instruction. The following list indicates the characters necessary to perform the various carriage operations:

Single Space	—	blank
Suppress Space	—	&
Double Space	—	0
Skip to Channel 1	—	1
Skip to Channel 2	—	2
Skip to Channel 4	—	4
Skip to Channel 8	—	8

When a hole in channel 12 occurs with this switch setting, a signal is sent to the EDPM and the program there decides the action to be taken by the carriage.

Form Length Switch

This switch is located next to the PROGRAM switch and must be set according to the length of the form being used. The three settings of this switch are:

L. This setting of the switch must be used if the form is over $3\frac{3}{4}$ inches long (22 spaces).

M. This setting of the switch must be used when the form is from 11 spaces through $3\frac{3}{4}$ inches long.

S. If the form length is 10 spaces or less, this setting of the switch must be used.

Two sub-cycles are required for any skip when the form length switch is set on M or S. With switch setting L, the number of sub-cycles required (minimum of 2) is dependent upon the length of the skip.

Record Grouping Switch

This switch is located on the top of the Type 720-730 printer near the program switch. The Type 719 printer does not require the switch. There are two settings for the switch, labeled 5 and 10.

5. This setting of the switch causes the 760 to be divided into five sections with 200 positions of storage in each. This occurs only when the machine recognizes a 4 in the units position of the address, as in SEL 0214. This setting would be used when the size of the record totals 100 or more characters. With this setting it is possible to load five grouped records into the 760 for printing.

10. This setting of the switch causes the 760 to be divided into ten sections with 100 positions of storage in each. This occurs only when the machine recognizes a 4 in the units position of the address. This setting would be used when the total size of the record is 99 characters or less. With this setting it is possible to load ten grouped records into the 760.

On the Type 719, the 760 is automatically divided into ten sections when the machine senses a 4 in the units position of the address. With a Type 719 it is possible to load the 760 with 99-character records, but print only the first 60 characters. Whenever the Type 719 is used, or when the record grouping switch is set to 10, the records loaded into the 760 should not exceed 99 characters. Included in the 99 characters are the carriage control character and the 760 control mark. To load records that exceed 99 characters is a programmer's error and causes a rearrangement of the record when printed. Although each section is divided into 100 positions, only 99 are usable.

When the record grouping switch is set to 5, the records loaded into the 760 should not exceed 122 characters. The 122 characters include the carriage control character and 760 control mark. If more than 122 characters are loaded, a machine failure occurs.

When records are written on tape, the 760 is not divided into sections but is loaded solidly from the beginning.

CONTROL AND STORAGE UNIT, TYPE 760

THE TYPE 760 Control and Storage Unit provided with the 719, 720 and 730 Printers contains 1,000 positions of record storage in addition to the control circuitry necessary for printer operation. This large storage capacity provides for the printing of group records, as well as single records. Group records can be printed from the central processing unit or from tape units on independent tape to printer operation.

The printer prints information in the same arrangement as it is received by the printer control unit; that is, spaces, punctuation, etc., are inserted before the information is placed in the printer control unit.

The printer and tape units can be connected to the 760 at the same time.

TAPE UNIT OPERATION

TAPE UNITS that are connected to the Type 760 Control Unit may be controlled to perform all the standard tape operations. These include backspacing, rewinding, rereading or rewriting records, writing a tape mark, and detecting end-of-file conditions. The tape unit used with the Type 760 is a standard Type 727. The control unit has been adapted to the tape unit with no change in speed or normal operations of the tape unit.

Tape Unit Selection

One or two input tape units may be connected to a single control unit. The tape units which are under program control are selected by the setting of the address selector switch on the tape unit. One of these tape units may be used to read the input data into the control unit while the other is loaded with the second reel and is in a stand-by condition ready to start operating when the first tape unit reaches its end-of-file condition. By the use of address modification within the program, it is possible to automatically switch tape units and save tape handling time.

The two tape units may also be connected to the control unit to operate as an input unit and an output unit. By program control either tape unit may be selected to read data into the control unit or write data on tape from the control unit. In this type of operation data move from one tape unit to the control unit and into the central processing unit. After

processing, the data are moved back into the control unit and then written on the other tape unit.

Early Start Feature

By programming it is possible to start a tape unit before the control unit is ready to receive or transmit data.

This feature allows the transfer of a single record, or the final record of a group, from the control unit to memory while the tape unit is coming up to speed to read the next record. When the tape unit is ready to read the next record into the control unit the previous record is already in memory (Figure 10). This feature can be used when data are transferred from the control unit to memory in 4 milliseconds or less. This time permits transferring a record of approximately 170 characters or less. For a transfer from memory to control unit, the maximum transfer time is 8 milliseconds, using the early start feature. This doubles the size of the record indicated above. A detailed explanation of the early start feature is included under "Control 0027."

Grouped Records

The Type 760 will handle single records of any size up to 1000 characters or any number of grouped records where the total number of characters does not exceed 1000 (Figure 11). The number of records is fixed when the control unit is used with the printer as explained under "Printer Operation." The transfer of data between the control unit and CPU memory is under separate program control from the reading or writing of data on tape. When the 760 is connected to a 702, a single read instruction will transfer only

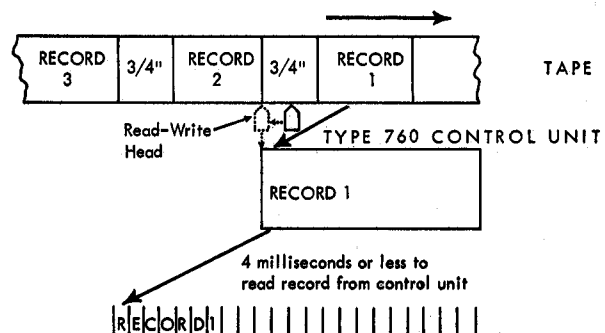


FIGURE 10. EARLY START

one record of a group from the 760 into memory (Figure 11). When the 760 is connected to a 705, all records of a group are read from the 760 to memory, by a single read instruction.

Checking

Checking is performed automatically on data passing between the 760 and the 702-705 and also on data passing between the control unit and the tape or the printer. By programming, a decision can be made to stop the machine on an error or have the machine reread or rewrite the record several times as a correction routine.

The 702-705 is equipped with six check indicators, and two of these check indicators are used to check data moving into or out of the control unit (Figure 12). The two check indicators are:

1. Read-write check 0902
2. Record check 0903 (printer-punch check 0903)

The read-write check 0902 is a character code check on all characters that are moved in either direction between memory and the control unit. This is a vertical check, character by character, to insure that all the data are being transmitted correctly between the two units. When an error is detected in the transmission of data, the read-write check indicator 0902 is turned on at the end of the instruction. The error may cause an automatic machine stop if the 0902 check indicator switch is set to stop, or it may be placed under program control by setting the indicator switch to PROGRAM. Under program control the check indicator may be interrogated by a TRS (transfer on signal) instruction.

The record check 0903 reflects an error in the transfer of data between the control unit and either tape

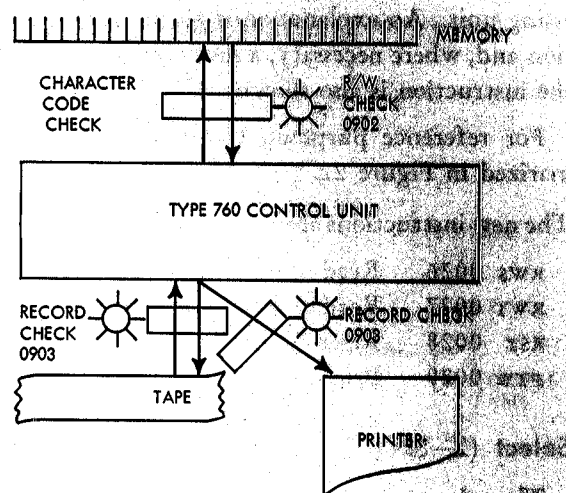


FIGURE 12. CHECKING

or printer. If an error occurs, the check indicator will be turned on during the next read or write instruction. The instruction may be interrogated on a TRS as explained above.

A character-code check is made on data transferred from the control unit to tape and, if an error is detected, the 0903 indicator is turned on. In the transfer of data from tape to the control unit, a longitudinal check is performed on the record and an error also turns the 0903 indicator on. The character code check is a vertical even-count check, character by character. The longitudinal check is an even-count check on each of the seven tape channels at the end of every record. This is a horizontal check to insure that the entire record has been correctly sensed and transmitted by the read head. The 0903 check indicator may be interrogated on a TRS instruction and in the subroutine it is possible to reread or rewrite the record as many times as desired. It is also possible to set the check switch to automatic stop.

An 0903 check is also given to data transferred from the control unit to the printer. This checking is explained under "Printer Operation."

If an error occurs during the writing of a tape mark (WTM), the 0903 check indicator is turned on during the execution of the instruction.

INSTRUCTIONS

THE CONTROL unit requires new and additional instructions to control the various operations that it performs with the tape units, printers and central proc-

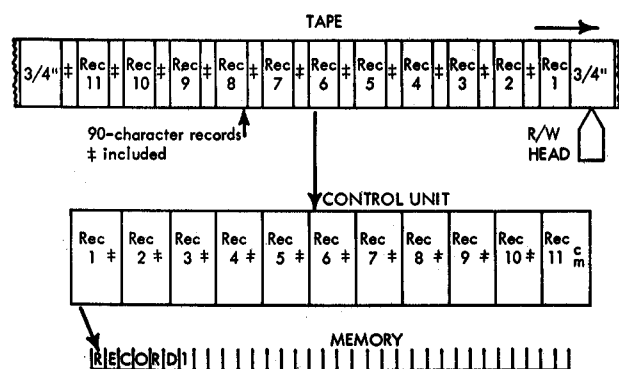


FIGURE 11. GROUPED RECORDS

essing unit. An explanation is given for each instruction and, where necessary, a short program illustrating the instruction is also shown.

For reference purposes, the instructions are summarized in Figure 22.

The new instructions are:

RWS 0026	Read or write to or from 760.
RWT 0027	Read or write (tape only).
RST 0028	Reset 760 counter.
PTW 0029	Print and write on tape.

Select (2—SEL)

The select instruction prepares an input or output unit for a subsequent operation. The address part of a select instruction contains digits that determine which control unit, tape unit or printer is to be used in a subsequent read, write or control instruction. The specific address must contain the following digits for operation with the Type 760.

The *units position* of the address must be 2, 7, or 4. The 2 or 7 establishes which of the two tape units is to be used; the 4 designates the printer. The *hundreds position* of the address must contain a 2, to indicate that a control unit is connected. The *tens position* of the address determines which control unit is to be used. For example, the instruction SEL 0202 specifies tape unit 2 and control unit 1. The instruction SEL 0224 specifies control unit 3 and a printer. The instruction SEL 0217 specifies tape unit 7 and control unit 2. The 2 or 7 in the address makes it possible to switch tape units automatically by adding a constant 5.

The instruction SEL 0205 will cause a no-response light on the console if a Type 754 tape control unit is not connected to the system. When a Type 760 and Type 754 control unit are a part of the system they each should have different addresses. For example:

TAPE ADDRESSES

TYPE 754	TYPE 760
0200 0201	0212
0202 0203	0217
0204 0205	0214 (Printer)
0206 0207	
0208 0209	

With one Type 754 and one Type 760 control unit it is possible to connect twelve tape units.

Control 0026 (3—RWS)

The control 0026 instruction is one of the new instructions used with the 760. It is used in both reading or writing operations. Information in the control unit is not destroyed by the RWS 0026 instruction and may be used again.

READING

The control 0026 instruction causes the tape unit to start while the 702 or 705 proceeds to the next instruction. When the central processing unit is executing the next instruction, the next record or record group is being read into the control unit. Transfer of data from tape to the control unit is stopped by the 3/4-inch inter-record gap. The records of a group are separated by a record mark. The control 0026 instruction will not start the tape unit if the input-output indicator has been turned on by an end-of-file condition. An example of programming for a single record is:

SEL 0212	Housekeeping instructions to move record into the control unit.
RWS 0026	control unit.
SEL 0212	Select tape unit 1 and control unit 2.
RD	Read record from control unit to memory.
RWS 0026	Start tape unit and read next record into the control unit.

Figure 13 shows a 702 program for grouped records. The record mark separates the records of a group in the control unit. The final record of a group has a control mark which is generated by sensing the inter-record gap on tape. Reading from the control unit into memory is stopped by the record mark. The control mark stops the reading of the last record. The initial group of records was read into the 760 by

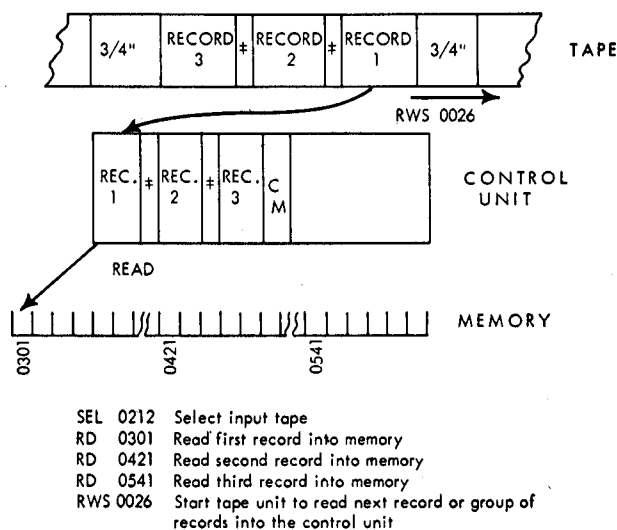


FIGURE 13. READING GROUPED RECORDS

selecting the tape and issuing an RWS 0026 instruction. In a 705 program a single READ reads all records.

WRITING

To write data on tape from the control unit, the control 0026 instruction is used. This instruction places a control mark in the control unit in place of the record mark of the last record written from memory. The central processing unit then proceeds to the next instruction while the record is written on tape. The control mark terminates the writing but does not appear on tape. A sample program is:

```
SEL 0217 Select output tape unit.
WR   Write record from memory into control unit.
RWS 0026 Write record from control unit on tape.
```

Figure 14 shows the 702 program for a group of records. The write instructions transfer the records from memory into the control unit and the control 0026 instruction writes the records on tape. In this program where grouped records are to be written on tape, the control unit is loaded with records in ascending order not to exceed a total of 1000 characters.

The control 0026 instruction is also used to write from the control unit to the printer. In this operation it also places a control mark in place of the record mark. The 702-705 proceeds to the next instruction while the record is printed from the control unit. The printing is stopped by the control mark. A program for writing single records for the 702-705 is:

```
SEL 0214 Select printer.
WR   Write record from memory into control unit.
RWS 0026 Print record from control unit.
```

This program also writes grouped records when the control unit is used with the 705. On the 702, a series of write instructions will transfer records from memory to the control unit. When grouped records are to be printed, the records are placed in the control unit in groups of ten or five, as explained under "Printer Operation."

With the Type 760 it is possible to transfer data from tape to tape without going through memory, as in this program:

```
SEL 0217 Select output tape.
WR   Any address to put output tape in write status.
SEL 0212 Select input tape.
RWS 0026 Load control unit.
SEL 0217 Select output tape.
RWS 0026 Write data on output tape.
```

COUNTER

The control unit has a counter device that operates from 000 to 999 for the 1000 positions. The control

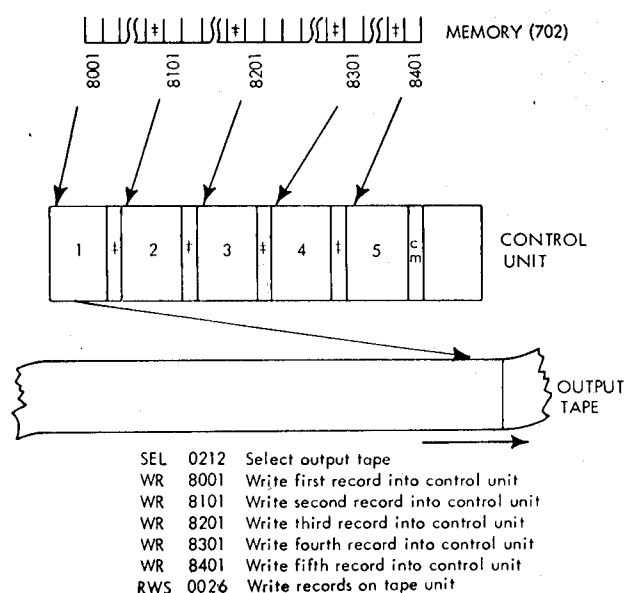


FIGURE 14. GROUPING RECORDS FOR WRITING

0026 instruction resets the counter to 000 at the beginning and completion of the instruction. The counter is reset to 000 so that it is in position to operate on the first character in the control unit.

Control 0027 (3—RWT)

The control 0027 instruction is used only with tape units to control reading and writing operations.

READING

In reading, the control 0027 instruction causes the tape unit specified by the previous select instruction to start accelerating for reading the next record or group of records from tape into the control unit. The control 0027 also permits the next read instruction to move a record into memory from the control unit before the contents of the control unit are replaced by the new tape record. With this operation it is important that the record be read from the control unit into memory in 4 milliseconds or less. A typical program is:

```
SEL 0212 Housekeeping instructions to move record into the
RWS 0026 control unit.
SEL 0212 Select input tape unit.
RWT 0027 Start tape unit for next record.
RD 0301 Read record into memory address starting 0301. This
        reduces the tape start time to 6 milliseconds
        (10—4).
```

Only one read instruction should follow a control 0027 instruction. Additional read instructions will be delayed until a new tape record has been moved to the control unit.

A 702 program for moving five grouped records is as follows:

```
SEL 0212 Housekeeping; move first group of records into con-
RWS 0026 trol unit.
SEL 0212 Select input tape unit.
RD 0501 Read first record into memory.
RD 0601 Read second record into memory.
RD 0701 Read third record into memory.
RD 0801 Read fourth record into memory.
RWT 0027 Start tape unit for entering new group of records into
the control unit.
RD 0901 Read fifth record into memory during the time that
the tape unit is being started.
```

This program reduces the tape start time from 10 milliseconds to 6 milliseconds. The last record must be read into memory in 4 milliseconds or less. The control 0027 instruction will not be executed if the input-output indicator is on because of an end-of-file condition.

WRITING

The control 0027 instruction starts the selected output tape for writing while the record to be written is moved from memory into the control unit. The data must be moved from memory to the Type 760 in 8 milliseconds or less. If the full 8 milliseconds is used, the tape start time is reduced to 2 milliseconds (10—8). The program for the Type 702 would be as follows:

Single record

```
SEL 0212 Select output tape unit.
RWT 0027 Start tape unit.
WR 6001 Write from memory position 6001.
```

Grouping three records

```
SEL 0212 Select output tape unit.
WR 6001 Write first record into the control unit.
WR 6091 Write second record into the control unit.
RWT 0027 Start output tape.
WR 7081 Write third record from memory into the control
unit.
```

The program for the Type 705 machine is:

```
SEL 0212 Select output tape unit.
RWT 0027 Start output tape.
WR 6001 Write record or grouped records into control unit
(8 milliseconds or less).
```

Only one write instruction should follow the control 0027 instruction. If additional write instructions are added, the machine will replace the original contents of the control unit with new data after the original data have been written on tape.

Control 0028 (3—RST)

The control 0028 instruction resets the Type 760 counter so that the next record is read from or written into the beginning of the control unit. This instruction does not destroy the information in the

control unit, but only restores the counter. The first position of the control unit is numbered 000 and the thousandth position is numbered 999. The counter is reset to position 000 to be ready for the first position. With this instruction it is possible to read the same record repeatedly into memory without using the tape unit. A revised record in memory may be substituted for one already in the control unit before recording it on tape. To reread or rewrite a record beyond the first one of a group, a series of read instructions cause counting to the desired record location in the control unit. A program for rereading the second record is:

```
SEL 0212 Select input tape unit.
RWS 0026 Load control unit.
RD 0501 Read first record into memory.
RD 0401 Read second record into memory.
RD 0501 Read third record into memory.
RST 0028 Reset counter in control unit.
RD Counter starts at beginning.
RD 0401 Counter at second record.
```

The counter of the Type 760 control unit is automatically reset to 000 at the beginning and completion of a control 0026 (RWS) operation. The counter is also reset to 000 after the read or write instruction that follows the control 0027 instruction.

Control 0029 (3—PTW)

When it is necessary that the same information be both printed and written on tape the control 0029 instruction is used. By programming, the information is placed in the control unit once for both operations. The printer must be selected first to properly load the control unit for printer operation. A typical 702 program is:

```
SEL 0214 Select printer.
WR 0301 Write first record from memory to control unit.
WR 0421 Write second record from memory to control unit.
WR 0541 Write third record from memory to control unit.
RWS 0026 Print record group.
SEL 0212 Select output tape.
PTW 0029 Write record group on tape.
SEL 0217 Select input tape.
RWS 0026 Load control unit.
RD 0301 Read first record into memory.
```

In a 705 program one write instruction is sufficient to write single or grouped records from memory.

Read (Y—RD), 702

When a group of records is located in the control unit, each read instruction will cause one record to be read into memory. The records are read from the control unit in sequence, starting at counter position

000. The address part of the read instruction specifies the memory location where the first character of the record will be located. The read instruction is terminated by a record mark or control mark. The record mark separates the grouped records in the control unit and the control mark defines the last record. If the control unit has not been reset after the last record has been read from the control unit, a read instruction will turn on the input-output indicator. The read instruction will not be executed.

The read instruction is delayed, if issued after a control 0026 instruction, until the new tape record or record group has been put into the control unit.

Read (Y—RD), 705

A group of records can be read from the 760 into 705 memory by a single read instruction. A control mark ends the read instruction. The record mark is read like any other character.

Write (R—WR)

A write instruction causes a record in memory to be transferred to the control unit. If there are no records stored in the control unit, the record is placed at the beginning of the control unit. If one or more records are already stored in the control unit, the next record will follow the last record stored in the unit.

The address part of the write instruction specifies the memory location of the first character of the record. In the 702 the record mark terminates the operation. In the 705, the group mark terminates the operation.

Only one write instruction should follow a control 0027 instruction and it must be executed within 8 milliseconds. A second write instruction will be delayed, if necessary, until the contents of the control unit have been written on tape. When a write instruction follows a control 0027 instruction, a control mark is placed in the control unit in place of the final record mark. The entire contents of the control unit, except the control mark, are recorded on tape which has been set in motion by the control 0027 instruction.

The central processing unit proceeds to the next instruction as soon as the control unit has received the record specified by the write instruction.

TAPE INPUT-OUTPUT INDICATOR

WHENEVER a unit is selected by a program instruction, the input-output indicator associated with that unit is also automatically selected. The instruction select 0212, therefore, not only selects a tape unit and control unit, but also selects the input-output indicator for that unit.

An indicator is either on or off. Once an indicator is turned on, it remains on until it is turned off either by the program or by a manual operation. The tape input-output indicator can be turned off by a control 0000 (IOF) instruction or by depressing the unload key on the tape unit.

The status of an indicator is tested by a transfer-on-signal instruction in the program. The input-output indicator is turned on by the following conditions:

1. Sensing the tape mark when reading from tape into the control unit as a result of a control 0026 (RWS) or control 0027 (RWT) instruction.
2. Sensing the physical end of tape when writing as a result of the control 0026 or control 0027 instruction.
3. The control 0003 (ION) instruction.
4. A read instruction following the reading of a record in the control unit with a control mark. The exception to this rule is that, if a control mark is sensed during the execution of the read instruction following the control 0027 instruction, the input-output indicator will not be turned on by another read instruction.

With the input-output indicator on, control instructions which will be executed are:

INSTRUCTION	FUNCTION	STATUS OF TAPE UNIT	
		READ	WRITE
RWS	start tape	not executed	executed
RWT	start tape	not executed	executed
RST	reset	executed	executed
PTW	start tape	executed	executed

RECORD, GROUP AND CONTROL MARKS

THE FUNCTIONS of the record mark, group mark, and control mark are explained for both the Type 702 and 705 when used with the Type 760.

Record Mark, Type 702

The record mark is used to separate grouped records in the 760, 702 memory, and on tape. It is transferred

between the various units during a reading or writing operation. When a record is transferred from the 760 to the printer, the record mark is moved but is not printed.

Reading from the control unit into memory is terminated by the record mark. With this operation it is possible to read a group of records into the control unit, and then read single records from the control unit into memory for processing. The record mark is automatically generated in memory when records are read from the control unit into memory.

When records are written from memory into the control unit, the record mark stops the write operation. The record mark is moved from memory into the control unit. By a series of write instructions, it is possible to load the control unit with grouped records, but they must not exceed a total of 1000 characters. When information is printed on the high-speed printers the control 0026 instruction is used to write records from the control unit to the printer. The record mark stops writing a line from the control unit when the records are grouped. The control mark stops the writing operation on the last record of a group or single record.

Record Mark, Type 705

When the 705 is used with the control unit, the record mark functions in the same way as for the 702 except for these differences:

1. It does not terminate a write operation from memory.
2. It is not automatically generated when reading from the control unit into memory.

Group Mark

The group mark is used only with the Type 705 and the control unit. It terminates writing out of memory. The group mark is moved into the control unit but it is changed to a control mark when records are written from the control unit. The group mark is not automatically generated in memory but must be emitted or punched in the card and positioned.

Control Mark

The control mark is associated with the control unit. It cannot be programmed but is automatically generated by the machine by certain operations or

instructions. When single or grouped records from tape are read into the control unit, the inter-record gap produces a control mark in the control unit at the end of a single record or group of records.

When information is written on tape or printer, the control 0026 or control 0027 instruction will change the last record mark or group mark in the control unit to a control mark. If records are written from the control unit onto tape, the control mark stops the writing operation for either single or grouped records. If records are printed from the control unit, the record mark stops writing grouped records and the control mark stops writing the last record.

Operations

Use of the group mark, record mark and control mark is illustrated by several programs. Figure 15 shows the reading of grouped records from tape. The select instruction selects the control unit and tape unit. The control 0026 (RWS) instruction reads into the control unit the group of records from tape, including the record marks. The inter-record gap produces the control mark. The first read instruction brings into memory the first record. Successive read instructions transfer the remaining records. The record mark stops the reading from the control unit, except the last record where the control mark stops the reading. The Type 702 generates a record mark following each record read into memory. In the Type 705 no mark is generated.

Figure 16 shows a single record that is read from tape into memory. The control mark appears in the control unit when the inter-record gap is reached.

Figure 17 shows the position of the group mark when single records are written from 705 memory.

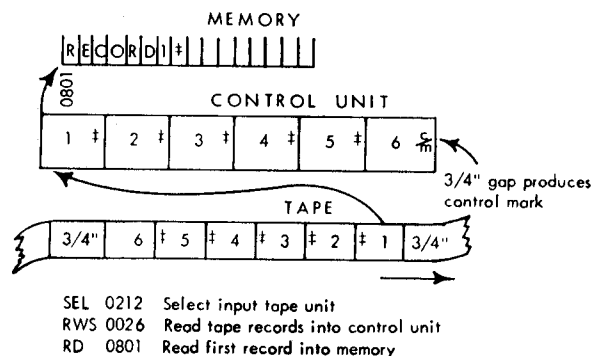


FIGURE 15. READING GROUPED RECORDS

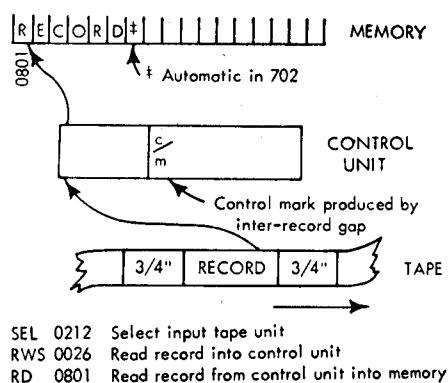


FIGURE 16. READING SINGLE RECORD

The write instruction is stopped by the group mark in the 705 or the record mark in the 702. The group mark and record mark are transferred from memory into the control unit, but the control 0026 or control 0027 changes either mark to a control mark. The sensing of the control mark causes an inter-record gap on tape.

In the 705 it is possible to process a group of records individually and separate each record in memory by a record mark. The last record contains a group mark to stop writing. As grouped records are sent into the control unit, the record marks and the group mark are transferred into the control unit. The control 0026 instruction changes the group mark to a control mark and writes the contents of the control unit up to the control mark onto tape. The program for writing grouped records on the Type 705 is:

SEL 0217 Select output tape unit.
WR 0901 Write records from memory into control unit.
RWS 0026 Write record group on tape.

In writing grouped records on the Type 702, a series of write instructions moves the records and record marks from memory to the control unit. The control 0027 instruction changes the last record mark to a control mark and writes the contents of the control unit onto tape. The control mark stops the writing operation from the control unit.

PRINTER OPERATION

THE CONTROL unit, Type 760, is used with all of the high-speed printers. The Type 719 prints a 60-character, and the Type 730 prints a 120-character line, at a rate of 1000 lines per minute. The Type 720 prints a 120-character line, at a rate of 500 lines per

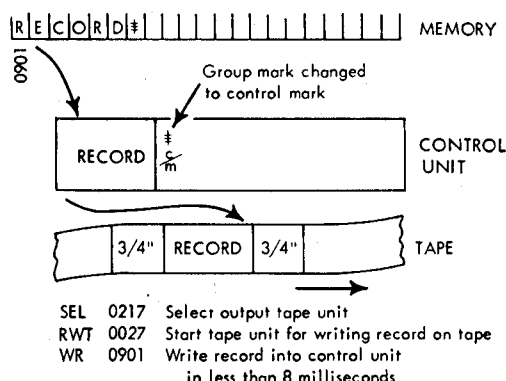


FIGURE 17. WRITING SINGLE RECORD

minute. Either grouped or single records may be printed under control of the central processing unit or from tape on an independent tape-to-printer operation.

Single Record Printing

Single records (up to 60 characters on the 719 and up to 120 characters on the 720 and 730) may be printed either under tape or central processing unit control. Figure 18 shows single record printing when the 760 is used with the 702.

Under CPU or independent operation, there is no automatic printing of a second or succeeding lines when the number of characters exceeds the maximum of 60 or 120 characters for one line. A control mark follows the last character of the record in the control unit. On the Type 702, information is taken from memory to the control unit and the transfer is stopped by a record mark. This record mark is entered into the control unit following the last character of the record and is later automatically replaced with a control mark by the control 0026 instruction. On the

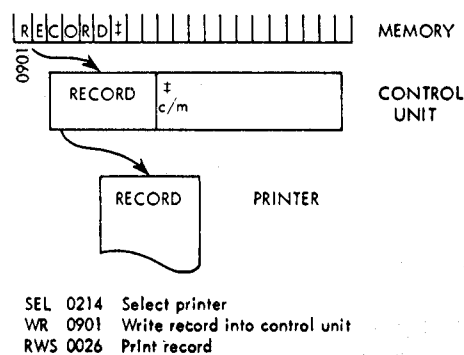


FIGURE 18. SINGLE RECORD PRINTING

Type 705, information is taken from memory to the control unit and the transfer is stopped by a group mark in memory. This group mark is entered into the control unit following the last character of the record. The group mark is changed to a control mark by the control 0026 instruction.

When printing is under tape control with either the 702 or 705, the inter-record gap at the end of the record causes a control mark to be placed in the control unit following the last character of the record.

A program switch on the carriage of the printer allows selection of automatic single spacing (1), automatic double spacing (2), or carriage control by the Type 702 or 705 program (P). When the switch is set to 1 or 2, the first character of the record is printed; when it is set to P, the first character is used for carriage control only. There is always a control mark at the end of the record. Thus, a single record to be printed on the Type 719 may be a maximum of 62 positions when the switch is set to P, or 61 positions when the switch is set to 1 or 2. For the Type 720 and 730 the maximum number of positions for one record is either 122 or 121, depending on the setting of the program switch.

Grouped Record Printing

For printing, the 1000 positions of the control unit are divided into ten sections of 100 positions each (Figure 19). Thus, as many as ten individual records may make up a group. The records may be of any size up to 99 characters. As each is recorded, it is automatically placed in a separate section. This ten-section arrangement for grouped records applies to all printers. The Type 760 is automatically divided into ten sections when it is used with the Type 719. It is divided into five or ten sections, depending on the setting of the record grouping switch, when used with the Type 720-730. For detailed information refer to "Record Grouping Switch."

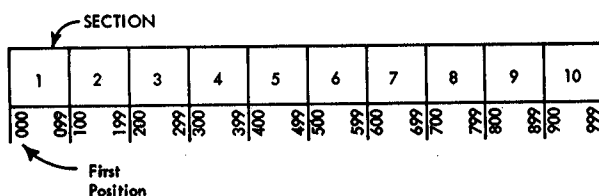


FIGURE 19. CONTROL UNIT FOR PRINTER OPERATION

On the 702, the record mark at the end of each record causes the next record to be stored in the next section. The record mark itself is stored following the record. Later, the record mark following the last record of the group is automatically converted to a control mark. On the 705, the same is true except that the last record is followed by a group mark which is converted to a control mark.

Ten records can be stored at one time in the control unit. Each record is automatically printed on a separate line. For the 719, the maximum record length including the record mark or control mark is 61 or 62 characters, depending on whether a carriage control character is required (Figure 20). For the 720 and 730 the maximum length is 99 characters, including the record mark or control mark and the carriage control character.

To provide for storing records of sufficient length to make maximum use of the printing width of the 720-730 (120 positions), a switch is placed on the printer which permits regrouping the storage area into five groups of 200 positions each. Thus, up to five 120-character records may make up one group for printing, and are automatically printed on separate lines (Figure 21).

Instructions

The *select* instruction is used to alert the printer for a subsequent write operation. The instruction SEL 0214 designates control unit number 2 and the printer.

The *write* instruction is used to transfer information from the central processing unit to the control unit following a select instruction.

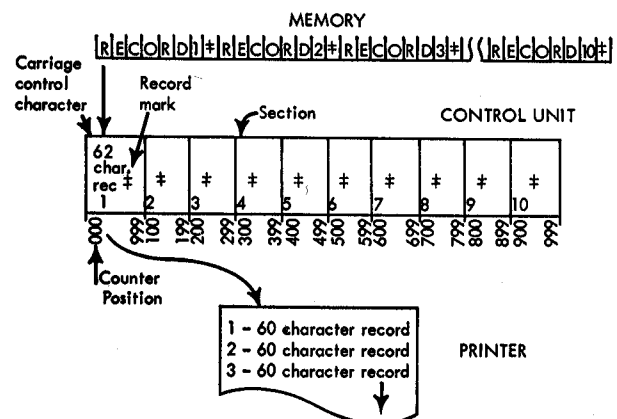


FIGURE 20. PRINTING SIXTY-CHARACTER RECORDS

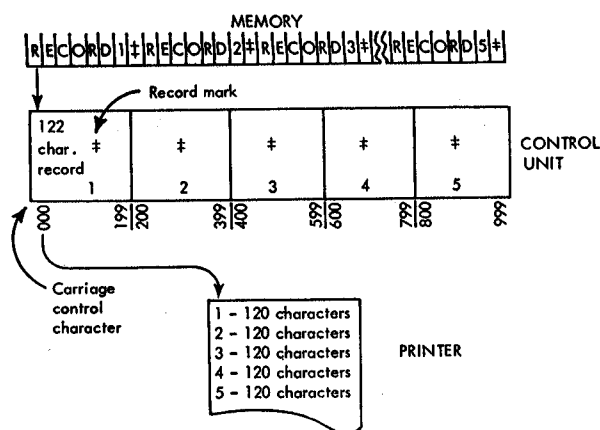


FIGURE 21. PRINTING 120-CHARACTER RECORDS

On the Type 705:

1. Writing is stopped by a group mark in memory.
2. Individual records within a group are defined by a record mark and are placed in the control unit in blocks of 100 or 200 with each record followed by a record mark. An example is the following program:

```
SEL 0214 Select printer.
WR      Write record from memory into control unit.
RWS 0026 Print records from control unit.
```

3. Only one write instruction is required.

On the Type 702:

1. Writing is stopped by a record mark in memory.
 2. Individual records within a group are each defined by a record mark at the end and are placed in the control unit in divided sections of 100 or 200 positions by successive write instructions. Each record is followed by a record mark in the control unit.
- Sample program:

```
SEL 0214 Select printer.
WR      Write first record.
WR      Write second record.
WR      Write third record.
WR      Write fourth record.
RWS 0026 Print records from control unit.
```

The control 0026 instruction takes data from the control unit and writes it on the printer. At the beginning and end of this instruction, the control unit counter is automatically reset to 000. The counter, therefore, is in position to read the first character at 000. With the Type 702, the last record mark in storage is automatically replaced by a control mark. With the Type 705, the group mark is replaced by a control mark. Information starting at storage position 000 is written on the printer up to the record

mark, then spacing occurs to another printing line. When the end of the last record is sensed by a control mark, the control 0026 operation is stopped and the control counter is reset to 000. No more information may be entered into the control unit until the control 0026 instruction is completely executed. Information in the control unit is not destroyed by the control 0026 operation and may be used again.

Input-Output Indicators

When an overflow condition in the printer is sensed, the input-output indicator is turned on. It can be turned off by a control 0000 instruction. When the indicator is on, it will not stop any instructions pertaining to the printer.

Check Indicators

Read-Write Check Indicator (0902) checks the transfer of data between the central processing unit and the control unit. If an error is detected, the 0902 indicator will be turned on at the completion of the write instruction during which the record was transferred. The machine may be set to automatic stop on this condition, or corrective routines may be built into the program.

Record Check Indicator (0903) reflects an error in the transfer of data between the control unit and either a tape unit or the printer.

When the printer is under the control of the central processing unit, checking involves the positioning of a code rod in the printer. The code rod sets up the various characters to be printed. A "code rod" error will not stop the printing of the contents of the control unit. The 0903 indicator will be turned on during the second write instruction. With this operation, one additional line is printed after the line in error is written.

Independent Operation

The printer may be operated under control of the central processing unit or by an independent connection not requiring the CPU. In either operation the Type 760 must be used.

On an independent operation the printer and a tape unit are connected by cable to the Type 760 to provide a method of direct printing of information from magnetic tape. Information is printed in the same

order in which it is read from tape at a maximum speed of 500 (720) or 1000 (719-730) lines per minute.

Records of 120 characters or less may be printed on the Type 720 or 730. Records of 60 characters or less may be printed on the Type 719. Records of 61 or 121 characters may be read with the carriage control switch set to program where the first character is not printed but is used for carriage control.

The tape unit is prepared for operation by placing the proper reel on the tape drive and closing the cover. Depressing the load-rewind key brings the tape automatically to the starting point. Depressing the tape unit start key then turns on the ready light on the tape unit.

Depress the reset key on the Type 760 to clear the previous record or records in the control unit. The printer is made ready by inserting the proper paper form, by inserting a carriage tape if any is required, adjusting impression, turning on main line switch and depressing the start key.

Information read from tape into the 760 is given a horizontal check for an even number of bits for each of the seven tape tracks for each record or group of records. This determines whether a single bit has been changed in any track in reading a record. A failure stops the machine before printing the erroneous record and turns on the read check light on the printer.

To reread a record found to be in error, the tape may be backspaced one record by depressing the backspace key on the printer. The read check light must be turned off before depressing the backspace key. The read check light is turned off by depressing both the reset and stop keys. Depressing the start key on

the printer will resume the operation with the same tape record or records being reread into the 760.

If it is not necessary to reread the record or group of records when an error is detected, the read-check light may be turned off and the operation resumed by depressing the start key.

The information read from the 760 to the printer is given a print check which is a check of the positioning of the code rod in the printer for each character. If the print error turns the print check light on, the machine will stop after printing one additional line.

Should a printing error be detected when writing single records, the erroneous record and one additional line (record) will be printed and the third record will be in the 760. Therefore, to reprint the erroneous record the tape must be backspaced three records by three depressions of the backspace key. The print check light may be turned off by depressing both the reset and stop keys. After backspacing the records the operation may be resumed by depressing the start key. When a printing error is detected when writing grouped records, the erroneous record and one additional line (record) will be printed.

Instruction	Code	Oper. Part	Remarks	Operating Time in Milliseconds	
				702	705
Read	RD	Y	From control unit to memory	.138+	.023N
Write	WR	R	From memory to control unit	.138+	.023N
Ctrl 0026	RWS	3	Time required to transfer a record group from tape to the control unit or from control unit to tape is $10 + R(.067N)$.163	.051
Ctrl 0027	RWT	3	R = no. of records in group N = no. of char. in control unit	.163	.051
Ctrl 0028	RST	3	Reset counter in control unit	.163	.051
Ctrl 0029	PTW	3	Time to write record group on tape is $10 + R(.067N)$.163	.051

FIGURE 22. INSTRUCTIONS USED WITH THE TYPE 760

