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IBM 1621 Paper Tape Unit

This manual describes the operation of the Paper Tape Reader and the Tape Punch as they are used in the 1620 Data Processing System, Model 1 or Model 2, and in the 1710 Control System.

This manual has been extracted from and supersedes the publication *IBM 1620 Input/Output Units* (Form A26-5707). Input/Output instructions for the 1621 Paper Tape Unit are described in either *1620 Central Processing Unit, Model 1* (A26-5706) or *1620 Central Processing Unit, Model 2* (A26-5781). The Card Read-Punch is described in the publication *1622 Card Read-Punch* (A26-5835).

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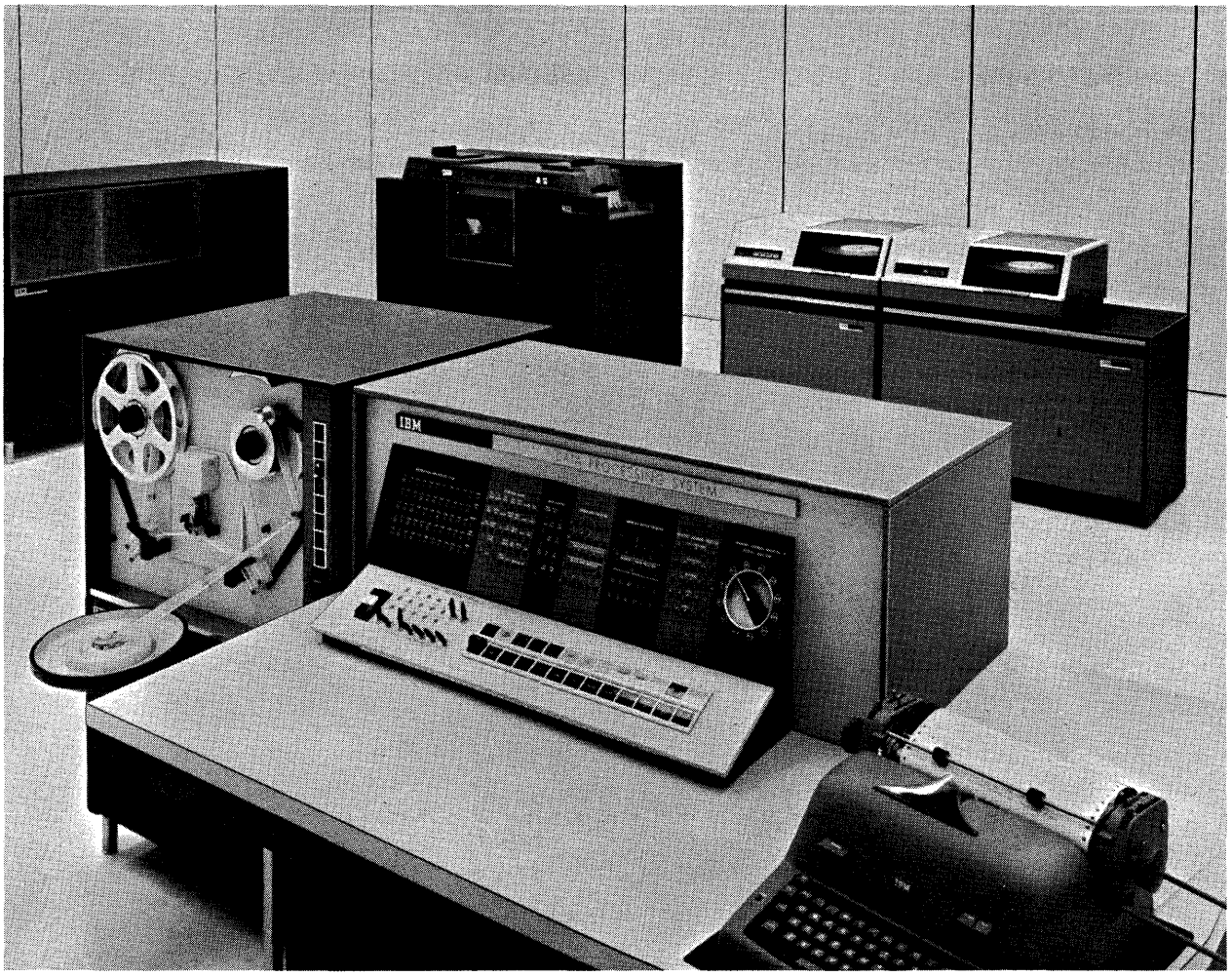


IBM 1620 Data Processing System

The paper tape reader, Figure 1, reads coded alphameric characters from 8-track paper tape at the rate of 150 characters per second. The characters are photoelectrically sensed, converted from 1621 paper tape code to 1620 Binary-Coded-Decimal (BCD), and placed in core storage. If a parity error is sensed, the Read Check indicator is turned on. The computer remains in automatic mode and continues to read until the end-of-record indication (a hole in the end-of-line (EL) channel) is reached. Whether the computer stops or continues processing depends upon the setting of the Input/Output (I/O) Check switch. The end-of-record signal causes a record mark to be placed in core storage as the rightmost digit of the input record.

NOTE: The read head area, including the lens, should be cleaned of paper dust with a lint-free cloth or tissue at least once each operating shift. Grease or oil on paper tape, from hand lotions, etc., renders it transparent, and may result in tape-read errors.

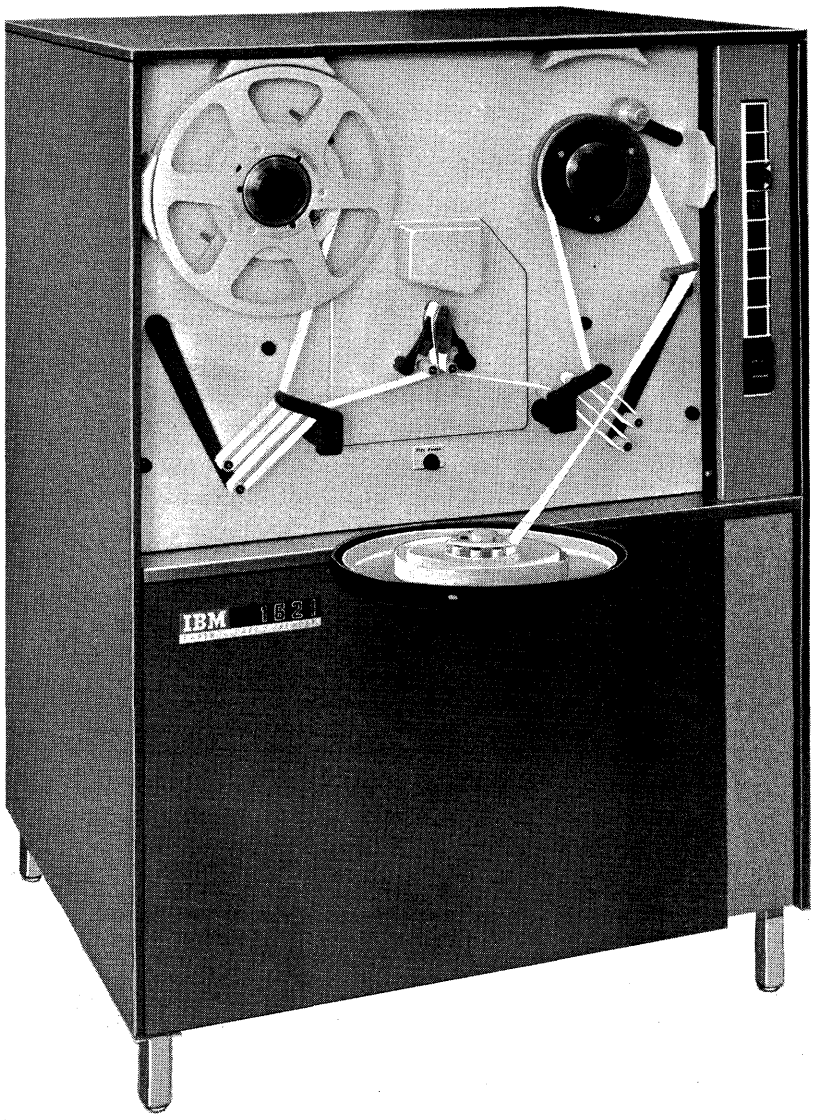


Figure 1. 1621 Paper Tape Unit

Paper Tape and Paper Tape Code

Data is punched and read as holes in a 1-inch-wide chad paper tape (in chad paper tape the holes are completely punched out) at a density of ten characters to the inch. An 8-track paper tape code is used. Seven positions, or tracks, across the width of the tape are used for coding numeric, alphabetic, and special characters. One track is used for EL characters. Figure 2, representing a section of paper tape, illustrates the eight tracks and all coded characters.

The lower four tracks of the tape (excluding the feed holes) are used to record numeric characters in the BCD mode. For example, a hole in track 1 represents a numeric 1; a hole in track 2 represents a numeric 2; a combination of 1 and 2 punches represents a numeric 3; and so on.

The X and O tracks are used in combination with the numeric tracks to record alphabetic and special characters in a manner similar to zone punches in IBM cards. A Read Numerically instruction causes a single X punch to read into core storage as a flag bit (negative zero).

The check track is used to establish correct parity. As a check that every character is recorded correctly, each column of the tape is punched with an odd number of holes. The EL track is not considered in the parity check.

Tape Specifications

The Paper Tape Reader and the Tape Punch are designed to operate with IBM paper tape, P/N 304469 (Figure 3). Other paper tape of equivalent paper stock may be used, but it must conform to Electronic Industries Association specifications, RS-227.

The specifications for dimensions of punched tape can be determined after conditioning the tape to the following requirements for 24 hours:

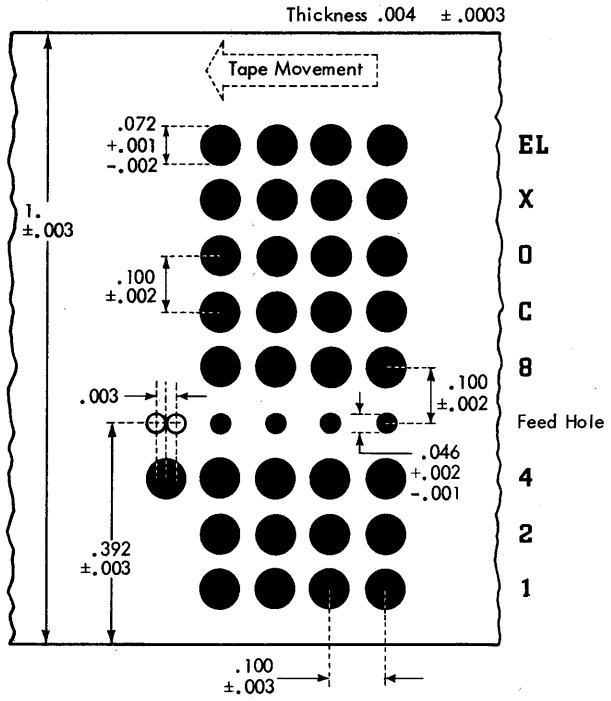


Figure 3. Paper Tape Specifications

75°F ± 3.5°
50% RH ± 2%

1. Width of tape: 1 ± .003 inch.
2. Distance from 3-hole edge of tape to center line of feed holes: .392 ± .003 inch.
3. Vertical distance (across width of tape) between centers of holes: .100 ± .002 inch.
4. Horizontal distance (parallel with edges of tape) between centers of holes:
   (a) .100 ±.003 inch for feed holes.
   (b) .100 ±.003 inch for code holes.

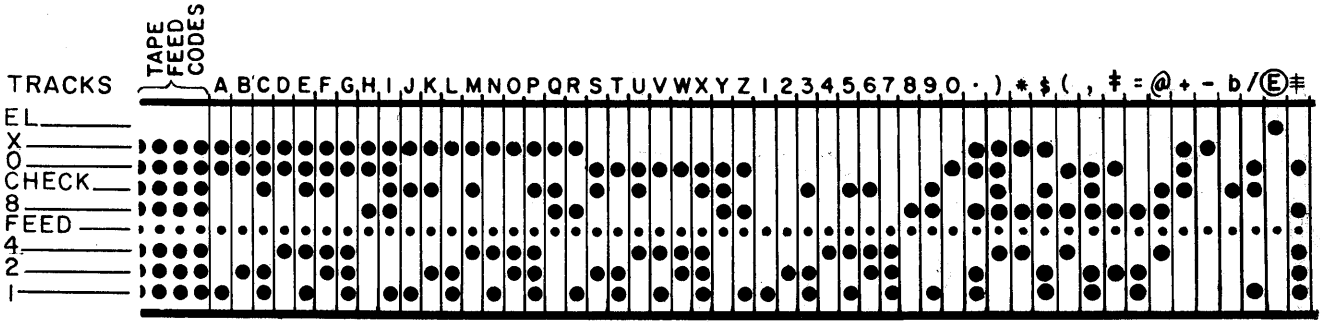


Figure 2. Paper Tape Codes

5. Vertical distances (across width of tape) across holes:
   (a) .072 +.001 −.002 inch for code holes.
   (b) .046 +.002 −.001 inch for feed holes.
6. Relationship of feed holes to code holes. Tolerances on the location of code holes relative to the center line of the feed hole in a row are:
   (a) ± .002 inch in a vertical direction.
   (b) ± .003 inch in a horizontal direction.
7. Thickness of tape:
   (a) Paper — .004 ±.0003 inch.
8. Spliced Tape:
   Spliced tape that is within the tolerances outlined under "Punched Tape Specifications" can be used.
   (a) Total thickness of the spliced tape area must be less than 0.010 inch.
   (b) The splice must be approximately as strong as IBM paper tape.
   (c) The splice width must match the width of the tape itself.
   (d) The splice must be flexible.
   (e) The splice must not create a gum or hindrance in the tape feed area.

Tape Splicing

Paper tape handling and processing will occasionally require tape splicing when the paper tape needs to be altered in length, edited, or repaired. If possible, a splice should be made in nondata portions of the tape. The ability of the tape reader to successfully and reliably read spliced tape depends upon the quality of the splice. The following is a procedure for manually splicing two lengths of paper tape together:

1. Punch tape feed codes into the two ends of the tape to be spliced together.
2. Cut the tapes at approximately a 45° angle.
3. Holding the ends of the tape with the tape feed holes, overlap the tape end in the left hand over the tape end in the right hand approximately 1/16 inch.
4. Glue in this position with holes aligned, using a quick-setting glue such as IBM tape mucilage, P/N 221030.

Other methods of tape splicing require the use of special tape splicing equipment. Appendix B contains more detailed information regarding tape splicing, including the advantages and disadvantages of types of splices.

Loading the Paper Tape Reader

Paper tape can be handled in three forms. The procedure for loading each varies slightly. The names of machine components used in the following descriptions of loading procedures are given in Figure 4.

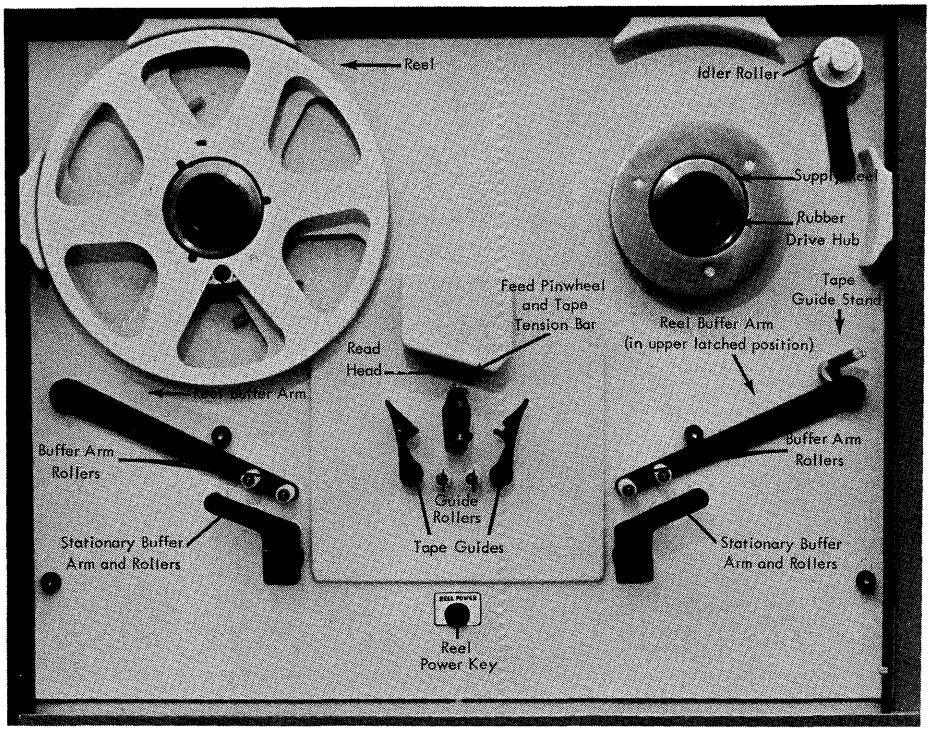


Figure 4. 1621 Tape Loading Area

Strip Form. Small strips of tape may be loaded directly onto the read head, as shown in Figure 5, by following this procedure:

1. Position the Reel Strip switch to STRIP.
2. Open the tape guides, form an inverted U (∩) with the leading 12 inches of paper tape, and install the tape around the read head with sufficient tension to keep the run-out and tape tension contacts closed. Start on the take-up reel side of the read head. Run a finger up over the tape on top of the read head, smoothing the tape down with a firm, moderate pressure so that the tape tension bar is slightly depressed and the right side of the feed pinwheel engages the tape feed holes. Be careful not to tear the feed holes. The tape feed holes must mesh with both sides of the pinwheel.
3. Close the tape guides.

Center Roll Feed. The center roll feed eliminates the necessity for rewinding paper tape rolls to expose the starting end of the tape on the outside of the tape roll. Figure 6 shows that tape is supplied from the inside of the center roll feed, to the supply reel, around the read head, and onto the take-up reel.

The procedure for loading paper tape from the center roll feed is as follows:

1. Position the Reel Strip switch to REEL.
2. Place the reel buffer arms in the upper latched positions.
3. Open the tape guides and form an inverted U (∩) with the center section of the first eight feet of paper tape. Wrap the paper tape around the read head with sufficient tension to keep the runout and tape tension contacts closed. Start on the take-up reel side of the read head. Run a finger over the tape on top of the read head, smoothing the tape down with a firm, moderate pressure so that the tape tension bar is slightly depressed and the right side of the feed pinwheel engages the tape feed holes. Be careful not to tear the feed holes. The tape feed holes must mesh with both sides of the pinwheel.
4. Close the tape guides.
5. Thread the leading section of paper tape under the guide roller, between the stationary buffer rollers and buffer arm rollers, and onto the take-up reel, as shown in Figure 7.
6. Thread the paper tape from the right side of

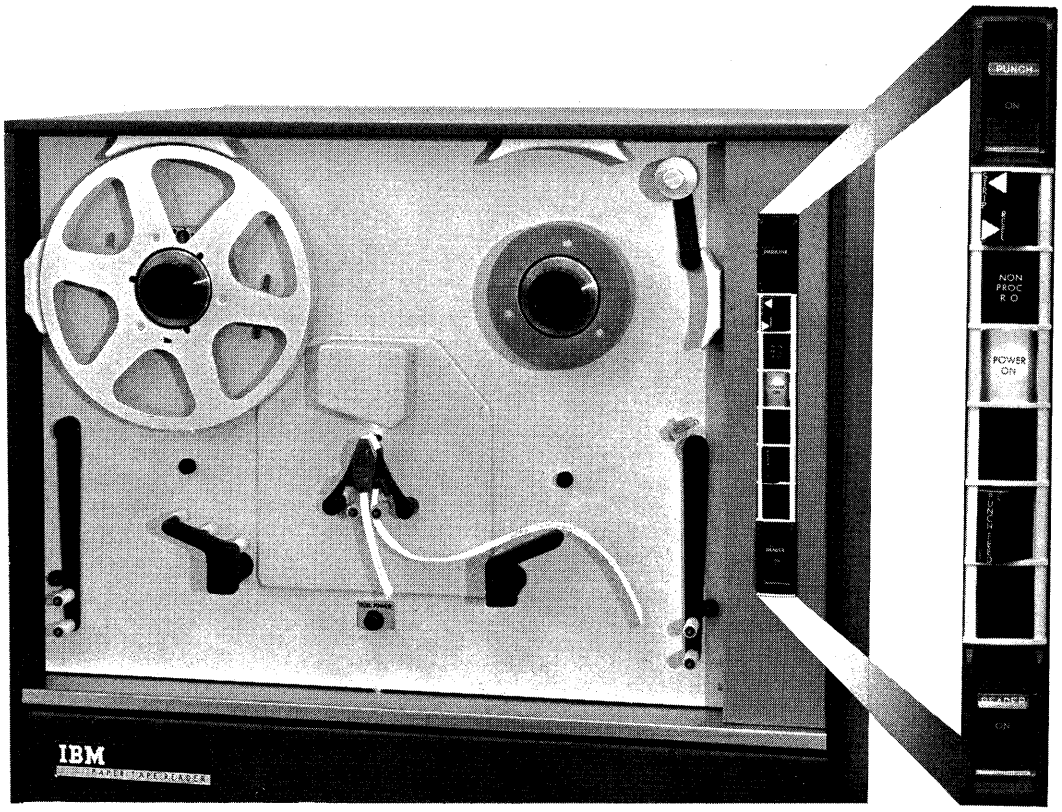


Figure 5. Strip Tape Loaded

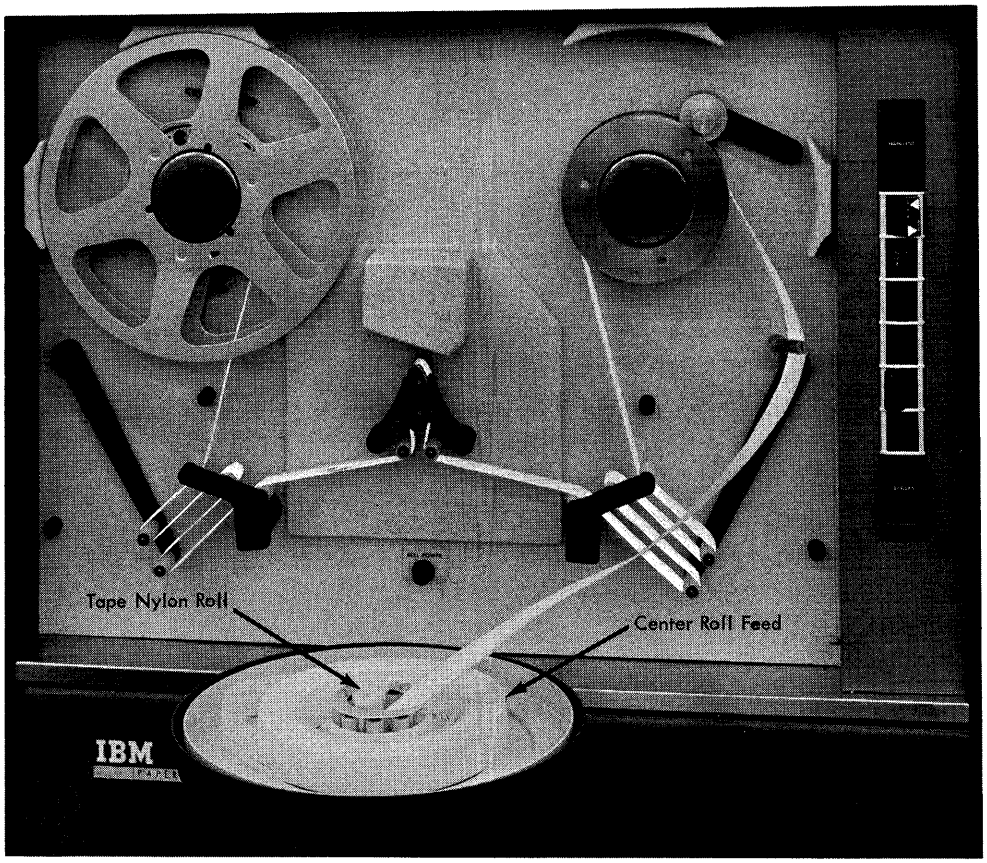


Figure 6. Center Roll Feed Loaded

the read head, under the guide roller, between the stationary buffer rollers and buffer arm rollers, over the supply reel (the rubber drive hub must be installed), around the tape guide stand, and around the tape reel nylon roll.

7. Lower the idler roller onto the supply reel.
8. Lower the buffer arms gently.
9. Press the Reel Power key. The buffer arms should swing down to a neutral position, applying tension to the paper tape.

NOTE: The roll of paper tape must be positioned centrally, or evenly, around the center rollers to prevent excessive vibration during reading.

Reel. A reel of paper tape may be read on the 1621 by removing the rubber drive hub from the supply reel and mounting the reel of tape in its place. The tape is threaded from the right side of the reel, directly to the stationary buffer rollers, and to the take-up reel as described in the Center Roll Feed section. Figure 8 shows a reel of tape threaded on the 1621.

Operating Switches and Lights (Figure 5)

The following switches and lights are used in the operation of the Paper Tape Reader and the Tape Punch:

Mainline Switch. With this switch on, power is supplied from the 1620 to operate the Tape Punch and, in addition, to operate the 1621 with the Reader On/Off switch positioned on. The Mainline switch should not be turned off with the 1620 in automatic mode because parity errors and loss of core storage data can result.

Punch Feed Switch. The Tape Punch punches 15 tape-feed characters per second when this switch is on.

Reader On/Off Switch. This switch is installed only when the 1621 is installed on a 1710 Control System. When this switch — and the Mainline Power switch — are on, power is supplied for operation of the 1621. This switch should be turned off when the 1621 is not in use to improve long-term reliability of the 1710 Control System.

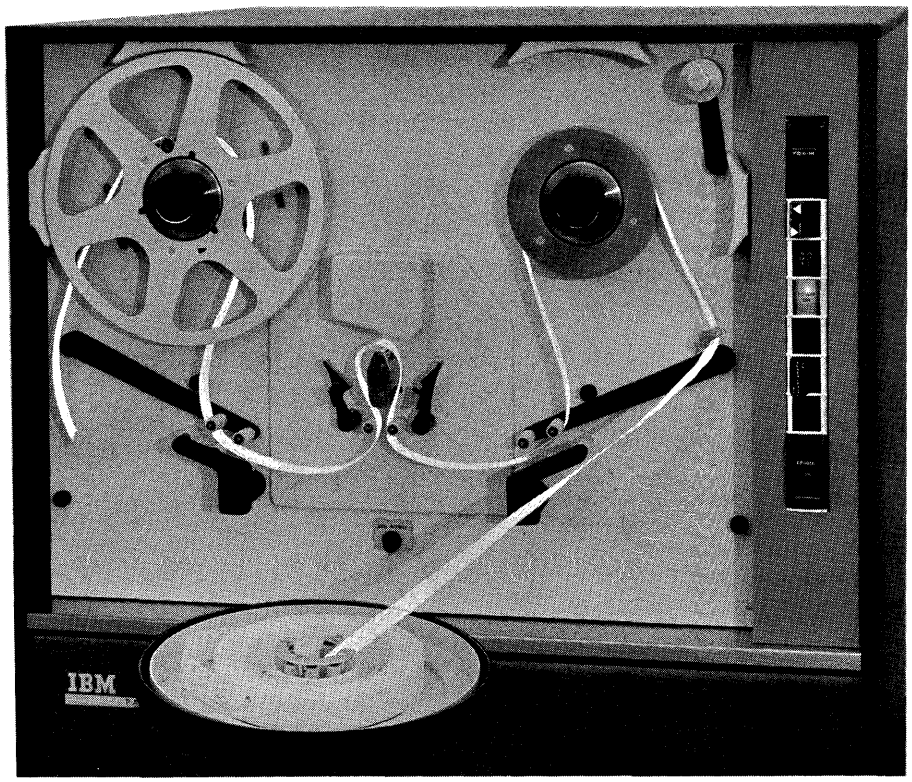


Figure 7. Threading Tape from Center Roll Feed

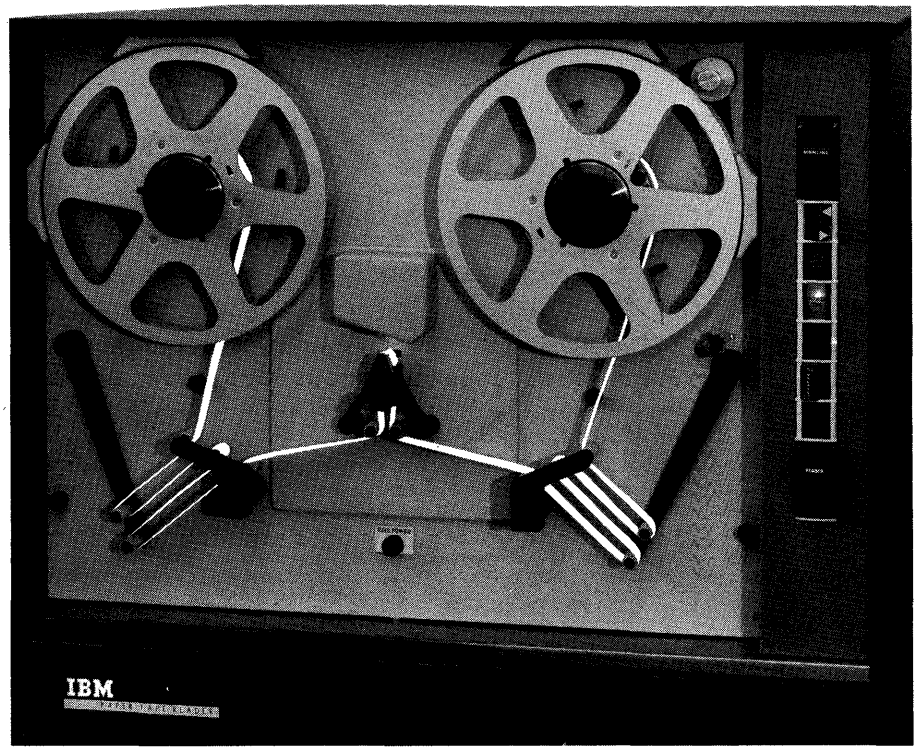


Figure 8. Paper Tape Reel Loaded

Reel Strip Switch. In reel mode, tape is fed from the supply reel, to the left, and onto the take-up reel. In strip mode, short pieces of tape may be read without reel operation.

Reel Power Key. Press this key to operate the supply and take-up reels which position the paper tape for reading and place the machine in ready status.

Nonprocess Runout Key. Press this key to cause paper tape to feed. Ready status is terminated and all data transfer is blocked until all paper tape has passed. Paper tape must be reloaded and the Reel Power key pressed before the machine can be returned to ready status.

Power On Light. This light is on when power is supplied from the 1620.

Tape Punch

The tape punch is housed below the tape reader in the IBM 1621 (Figure 9) and punches data from core storage into paper tape at the rate of 15 characters per second. The characters are sent serially from core storage, starting with the location addressed by an output instruction. Each character is translated into an 8-track code before being punched.

When a record mark is sensed during the execution of a Write Numerically (WN-38) or Write Alphamerically (WA-39) instruction, an EL hole is punched and the operation stops. A Dump Numerically (DN-35) command causes punching to continue, regardless of record marks, until the highest-numbered core storage address of the 20,000-position module addressed by the Dump Numerically instruction is read and punched. At this point an EL hole is punched and the operation stops. If a character with incorrect parity is transmitted from core storage and punched, or a valid character is incorrectly punched, the tape does not advance. Operation is the same regardless of the setting of the I/O Check switch on the Console.

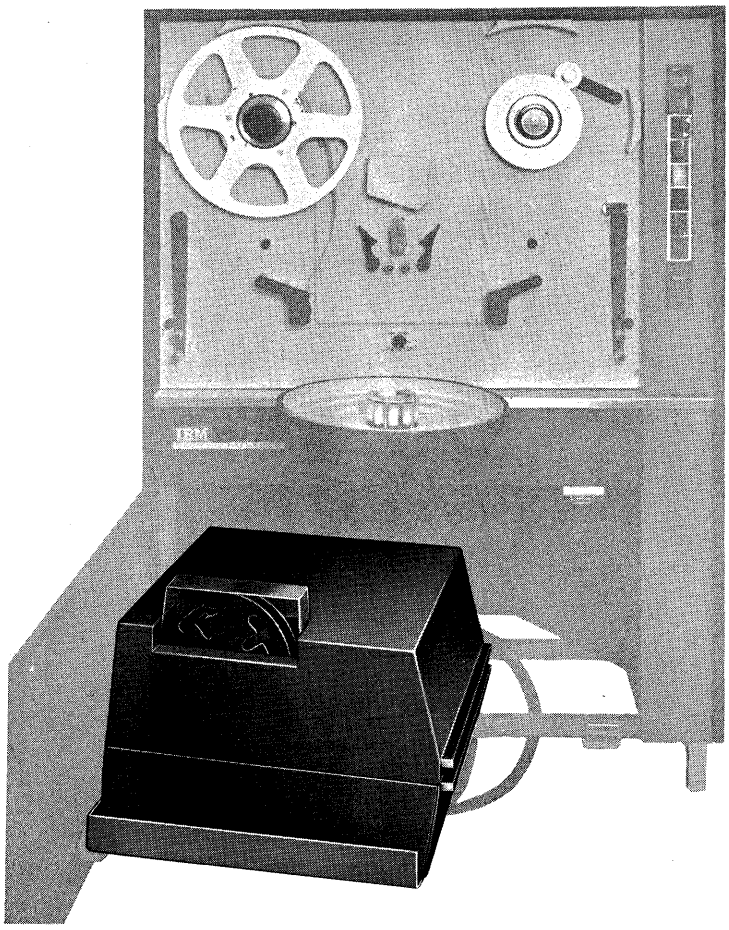


Figure 9. Tape Punch Location

Tape Punch Error Procedure. The tape feed does not advance. The computer stops in both the automatic and manual mode; the Automatic and Manual lights and the Punch/Disk Interlock (Write Interlock light in the 1620-2) and Write Check lights on the 1620 Console are turned on. Program processing can be resumed with the following "re-start" procedure:

1. Position the Punch Feed switch ON.
   a. The feed code (all punches) is punched over the incorrect character. If the instruction is Write Binary Paper Tape (1620-2 only) an EL character is also punched.
   b. The Punch/Disk Interlock and Write Check lights are turned off.
   c. The machine is returned to manual mode only.
2. Press the Start key on the 1620 console.
   a. The original character from storage is again punched. If an incorrect character still persists, the record may be corrected, if desired, before processing continues.
   b. The computer continues processing.

If the Tape Punch is used in a 1710 Control System, and the I/O Check switch is positioned to PROGRAM, the computer can branch to an error-handling routine. This routine can record the fact that an error has occurred and the computer resumes operation with the incorrectly punched character in paper tape.

If the Tape Punch runs out of paper tape, the machine stops in automatic mode and the Punch/Disk Interlock light is turned on. Machine operation may be resumed by loading a new roll of tape (as described in LOADING THE TAPE PUNCH) and using the "restart" procedure just described.

When the restart procedure is used to correct the incorrect punching of a valid character, and the character is again punched incorrectly, the Single Instruction Execute (SIE) key can be used to determine the cause of the incorrect punching, as follows:

1. Use the SIE key to execute one instruction at a time.
2. When the Write Check light is turned on, observe the Memory Buffer Register (MBR) display to determine if the character is valid.

A transient condition may cause the Write Check light (but not the Punch/Disk Interlock light) to come on even though a valid character has been correctly punched. Should this occur, turn on the Punch Feed switch briefly, to turn off the Write Check light, then press the console Start key and proceed with the program.

The punch registration (proper hole spacing) can be verified by use of a standard paper-tape gage. Off-line punching equipment can be checked in the same manner.

Loading the Tape Punch

Place the roll of unpunched tape on the turntable and thread as shown in Figure 10. The tape retainer (F) must be rotated to the left by pushing back on its extended left edge. This also moves the tape lever (D) forward to facilitate threading. An unwound section of tape is then threaded as follows:

1. Through the tape guide (A).
2. Inside the tape guide (B).
3. In front of the tape tension guide (C).
4. In back of the tape lever (D).
5. Between the punching mechanism and the punch guide block (E), which can be seen in front of the tape.
6. Between the guides on the tape retainer (F). With the end of the tape held to the left, the tape retainer (F) is returned to normal position, which causes the pins on the feed roll to pierce through the blank tape. The tape lever simultaneously returns to normal position with the top guide above the tape.

The Punch Feed switch is used to repetitively punch automatic feed punches and to provide a leader section of paper tape. The approximately 60 inches of leader needed for threading paper tape on the 1621 can be obtained from the Tape Punch in 40 seconds. The leader is threaded into the take-up reel so that the top edge of the tape is at the outside of the reel.

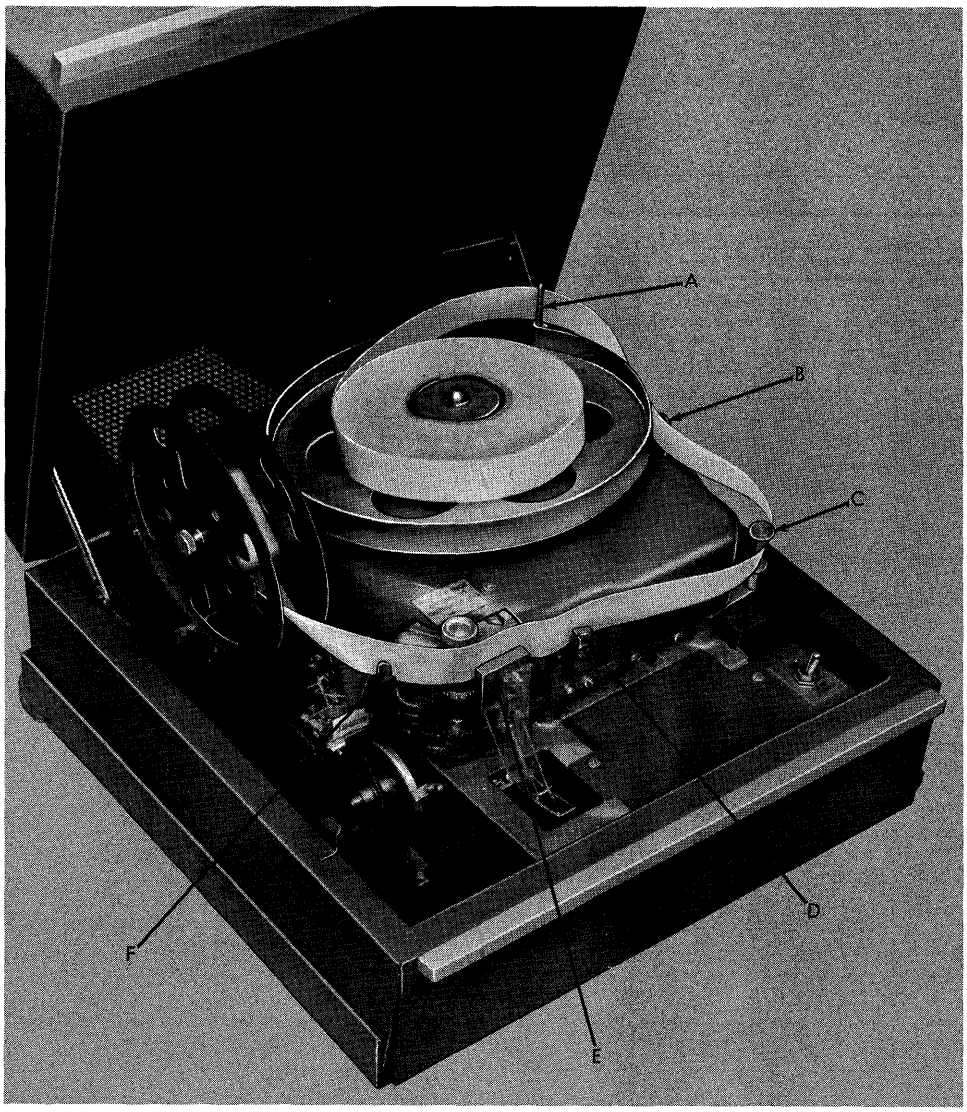


Figure 10 IBM Tape Punch

Appendix A

Character Coding

	Character	Input			Core Storage		Output		
		Typewriter	Tape	Card	Alpha	Num	Typewriter	Tape	Card
ALPHAMERIC MODE	(Blank)	(Space)	C	(Blank)	C	C	(Space)	C	(Blank)
	. (Period)	.	X0821	12,3,8	C	3	.	X0821	12,3,8
	)	)	X0C84	12,4,8	C	4	)	X0C84	12,4,8
	+	+	X0C	12	1	C	+	X0C	12
	$	$	XC821	11,3,8	1	3	$	XC821	11,3,8
	*	*	X84	11,8,4	1	4	*	X84	11,4,8
	- (Hyphen)	-	X	11	2	C	-	X	11
	/	/	0C1	0,1	2	1	/	0C1	0,1
	, (Comma)	,	0C821	0,3,8	2	3	,	0C821	0,3,8
	(	(	084	0,4,8	2	4	(	084	0,4,8
	=	=	821	3,8	3	3	=	821	3,8
	@	@	C84	4,8	3	4	@	C84	4,8
	A-I	A-I	X0, 1-9	12, 1-9	4	1-9	A-I	X0, 1-9	12, 1-9
	0 (—)	(None)	(None)	11,0	5	C	- (Hyphen)	X	11,0
	J-R	J-R	X, 1-9	11, 1-9	5	1-9	J-R	X, 1-9	11, 1-9
	1-9 (—)	J-R	X, 1-9	11, 1-9	5	1-9	J-R	X, 1-9	11, 1-9
	S-Z	S-Z	0, 2-9	0, 2-9	6	2-9	S-Z	0, 2-9	0, 2-9
	0 (+)	0	0	0 or 12,0	7	C	0	0	0
	1-9 (+)	1-9	1-9	1-9	7	1-9	1-9	1-9	1-9
	≠	≠	082	0,2,8	C	C82	(Stop)	EOL	0,2,8
NUMERICAL MODE	(Blank)	(Space)	C	(Blank)		C	0	0	0
	0 (+)	0	0	0		C	0	0	0
	0 (-)	$\bar{0}$	X, X0C	11,0		F	0	X	11,0
	1-9 (+)	1-9	1-9	1-9		1-9	1-9	1-9	1-9
	1-9 (-)	$\bar{1}$-$\bar{9}$	X, 1-9	11, 1-9		F, 1-9	1-9	X, 1-9	11, 1-9
	≠	≠	082	0,2,8		C82	(Stop, WN) ≠ (DN)	EOL(WN) 082 (DN)	0,2,8
	$\bar{\neq}$	$\bar{\neq}$	X82	11,8,2		F82	$\bar{\neq}$	X82	11,8,2
	≠	≠	08421	0,7,8		*C8421	≠	08421	0,7,8
	$\bar{\neq}$	$\bar{\neq}$	X8421	12,7,8		F8421	$\bar{\neq}$	X8421	12,7,8
	Num Blank †	@	C84	4,8		C84	@	C84	(Blank)

† For Card Format Use Only
* Recorded as 0, 8, 4, 2, 1 in disk storage

Appendix B

Tape Splicing

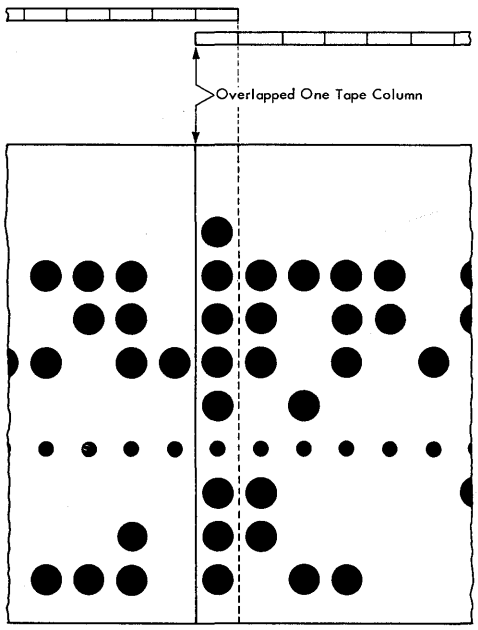
The use of tape splicing equipment should be considered if it becomes necessary to repeatedly edit tape or alter the length of tape. Special splicing equipment and materials will provide efficient, accurate, and more permanent tape splices. The selection of appropriate splicing equipment, from the many types now being offered by various manufacturers, depends upon the quality of the splice desired, life expectancy of the splice, time allotted to make the splice, and a price justification. The best splicing results will be obtained by first analyzing paper tape splicing needs and then purchasing the tape splicer and splicing materials best suited to these needs.

Types of Tape Splices

There are two types of splices; overlap splice and butt-joint splice.

Overlap Splice

The overlap splice consists of two matching paper tape ends overlapped by at least one tape column and held together with an adhesive.



With some splicing equipment, the pieces are welded together through a process of heat, pressure, and a liquid bonding agent. With this type of equipment, alignment accuracy of the tape is not required of the splice equipment operator, and the tape splicing rate is approximately one per minute.

With other overlap-type splice equipment, the tapes are glued together with a quick drying adhesive. In this process, some alignment accuracy of the tapes is required of the splice equipment operator. Tape splicing rate is about three to five minutes per splice.

ADVANTAGES OF OVERLAP SPLICING

1. A large variety of overlap splicing equipment is commercially available.
2. Many splicers are available at a low investment cost.
3. Quality of splice is not usually dependent upon the operator's skill.

DISADVANTAGES OF OVERLAP SPLICING

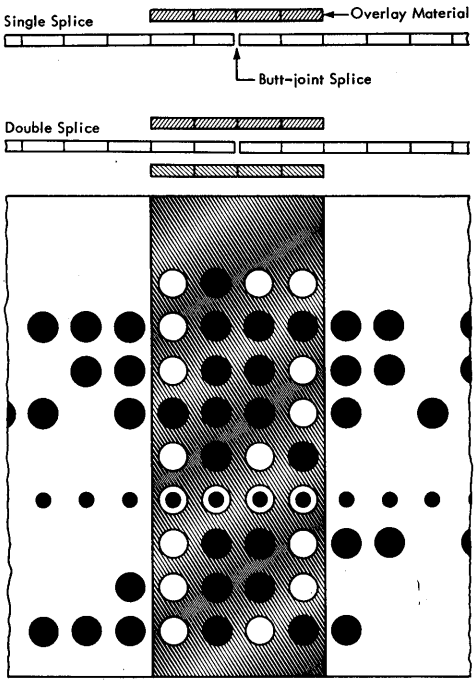
1. An overlap-type of splice is not suitable within the tape data area because overlapped columns will result in lost data, parity errors, and/or invalid codes.
2. Low production on some splicing equipment, due to the lengthy time required for the glue to dry.
3. Short life of splice.

Butt-Joint Splice

The butt-joint splice consists of two symmetrically matched paper tape ends, butted together and held into position by a bonding agent and an overlay material. The overlay material can be plastic or paper, and can be placed on one or both sides of the tape.

With some splicing equipment, the overlay material is heat sensitive and is bonded to the tape through the use of a heated iron. Alignment accuracy of the tapes is not required of the tape splicing operator. Tape splicing rate is approximately one per minute.

With other butt-joint splice equipment, the paper is bonded to the overlay material by an adhesive on the overlay material. Alignment accuracy of the tapes depends upon the skill of the splice equipment operator. Tape splicing is approximately one per minute.



ADVANTAGES OF BUTT-JOINT SPLICE

1. The splice can be made in a data-portion of tape without losing or altering data.
2. This type of splice permits tape repairing due to tears or damage.
3. A thinner splice – the total thickness of the tape and splice (with a plastic overlay) is usually thinner than two thicknesses of paper tape.
4. Reasonably long life of splice.

DISADVANTAGES OF BUTT-JOINT SPLICE

1. The quality and accuracy of each splice may depend upon the skill of the splice equipment operator.
2. There is a limited variety of accurate butt-joint splicing equipment.

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