IBM® Field Engineering Manual of Instruction

1403 Printers

Major Revision, October 1964

This manual, Form 225-6492-3, revises and obsoletes both the previous edition of *Customer Engineering Manual of Instruction: IBM 1403 Printer* (225-6492-2) and *Customer Engineering Manual of Instruction Supplement: 1403 Model 3 Printer* (S25-0004). Principal changes in this revision are:

Consolidation of the basic 1403 manual of instruction with the Model 3 supplement and with data on the new Model N-1. Special features pertaining to the various printer models are included.

Additional photographs and material are added to more fully illustrate the Model 3 printer, the IBM 1416 Train Cartridge, type slugs, skew-correction mechanism, and acoustical dampeners.

The section on *IBM 1403 Printer (Models 1, 2, 4, 5, and 6)* is updated to include the Model 6 printer, E-1 magnetic emitter, printer suspension (shock mounts), translator frame motion, and process meter. The schematic of the type-movement-to-print-hammer relationships has been redrawn for clarity.

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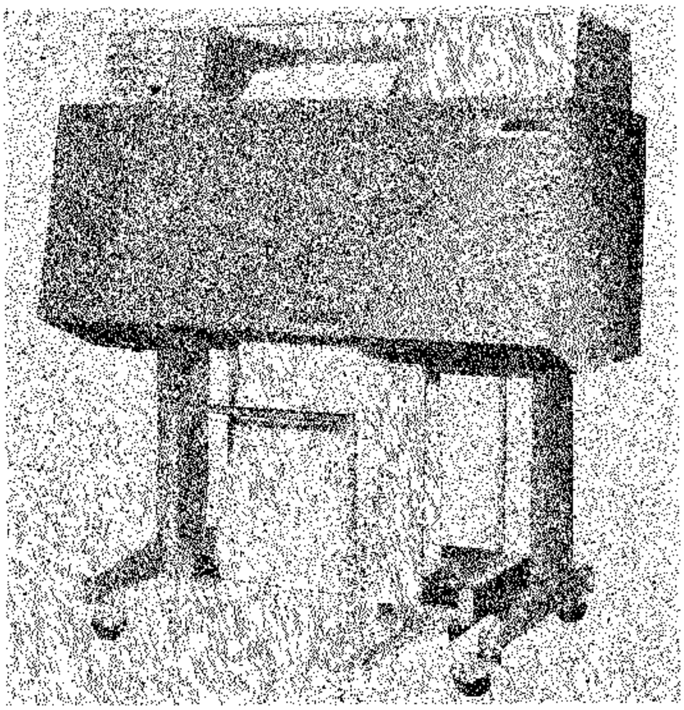

Figure 1. IBM 1403 Printer

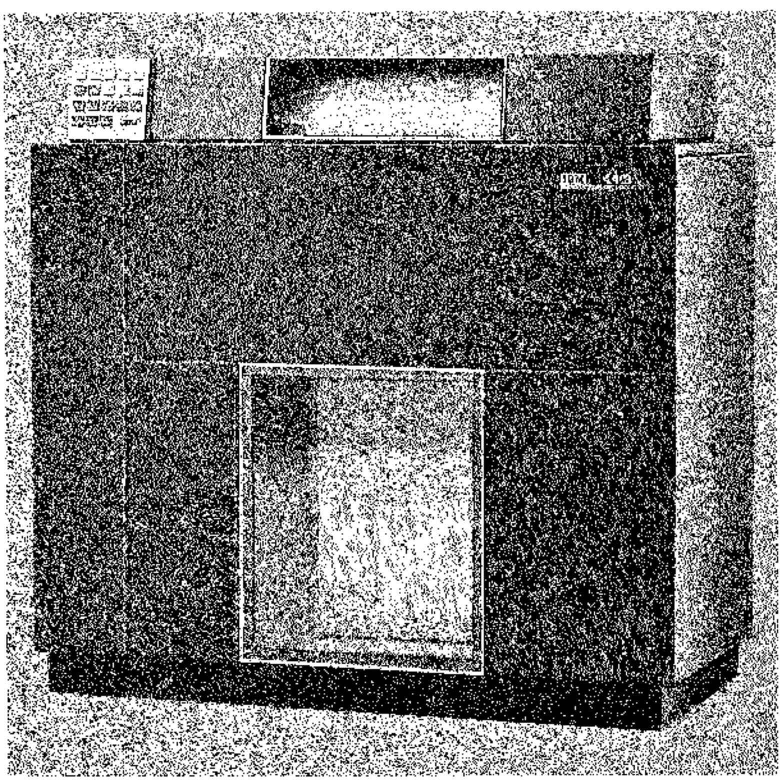

Figure 2. IBM Printer, Model N-1

General Information

- **The IBM 1403 Printers provide printed output for a variety of computer systems.**
- **The 1403 printer is available in seven models, providing four speed ranges and three printing capacities.**
- **Model 3 and the Model N-1 use the high-speed IBM 1416 Train Cartridge and a new style hammer unit. All the other models use a type-chain cartridge.**
- **Because of the noise level due to its high speed, the 1403 Model 3 is equipped with electromagnetic acoustical dampeners.**
- **The Model N-1 printer is similar to the Model 3 except that the acoustical dampeners are replaced by new design acoustical dampening covers.**
- **The top cover on the Model N-1 printer is raised and lowered electrically. Model N-1 uses no forms carts.**
- **Controls for the printers must be provided by circuitry within the system.**

The IBM 1403 printers (Figures 1 and 2) are permanent-record output devices available to a variety of data processing systems, including the IBM System/360. The 1403 comes in seven models, representing an assortment of speed ranges and printing capacities as follows:

IBM 1403

Model	*Print Positions*	*Maximum Speed*	*With Systems*
1	100	600 lpm	1401 (Models A, B, E, F), 1410, 1420, 7010, 7040, and 7044.
2	132	600 lpm	1401 (Models A, B, C, D, E, F), 1410, 1420, 1440, 1460, 7010, 7040, 7044, and System/360 Models 30, 40, and 50).
3	132	1,100 lpm	1410, 1440, 1460, 7010, 7040, 7044, and System/360 (Models 30, 40, and 50).
4	100	465 lpm	1401 (Model G only).
5	132	465 lpm	1401 (Model G) and 1440.
6	120	340 lpm	1401 (Model G) and 1440.
N-1	132	1,100 lpm	System/360 only.

Models 1, 2, 4, 5, and 6 use a printing chain in a unitized cartridge. Model 3 (described separately in this manual because of major design changes in the printing mechanism, and other differences) uses the 1416 train cartridge, and has electromagnetic acoustical dampeners to reduce noise due to high speed.

The chain printers are very similar in operation except for certain important considerations such as chain speed, print option times, etc. To understand the principles of operation, however, it is necessary only to explain a typical machine. Once you understand this machine, you can then adjust your reasoning to take into account the specific differences necessary to understand any particular model. In this light, the Model 2 is used throughout in explaining the 1403 Models 1, 2, 4, 5, and 6.

The N-1 is very similar to the Model 3, except for the covers. In the N-1, an improved design acoustical (hush) cover system that reaches almost to the floor replaces the electromagnetic acoustical dampeners of the 1403, Model 2. In addition, an electric motor raises and lowers the top cover of the N-1. The fuse panel is relocated on the left end of the machine, beside the cable-connector receptacles.

The principles of operation (Figure 3) are the same for all models of the 1403 printers. Output is in the form of printing on continuous-form paper that moves vertically between a horizontal row of print hammers and type faces by a high-speed tape-controlled hydraulic carriage. An inked ribbon, wide enough to span the print hammer positions, moves parallel to the paper, and is interposed between it and the type faces.

The type faces are embossed on a series of slugs arranged in an endless loop, or *chain*. Each standard chain contains five alphameric character arrays. Each type array consists of 26 alphabetic, 10 numeric, and 12 symbol characters.

Printing is accomplished by the timed firing of the print hammers as the type arrays move continuously along the printing line at a constant speed. The hammers are fired by armatures actuated by electromagnets. When the hammers fire, they drive the paper and ribbon against the moving type in an almost instantaneous motion. As the paper and ribbon make contact with the type character, it prints on the paper.

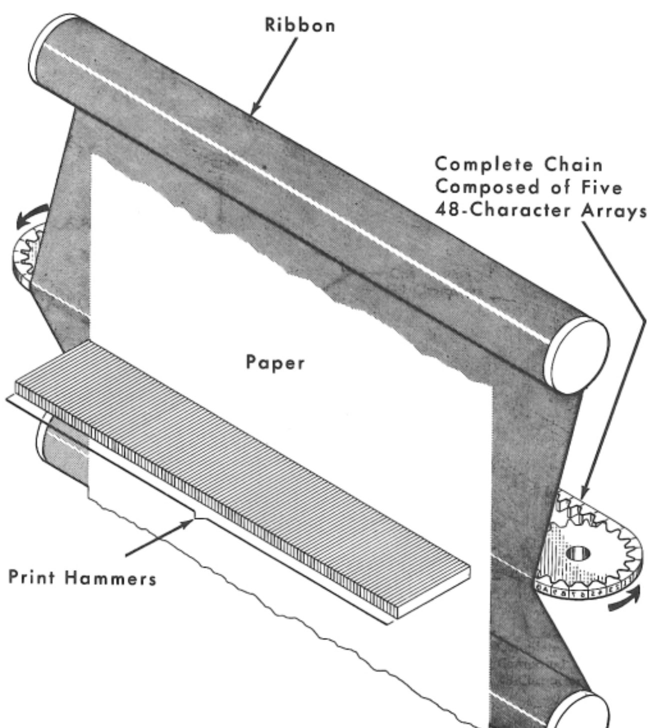

Figure 3. Printing Mechanism Schematic

The paper moves upward from a bulk supply stacked beneath the printer. It passes between the print hammers and the type arrays, and over the curved paper guides at the top. The paper then continues in a downward direction through the stacker at the rear of the machine. Here it is again stacked in bulk for removal by the operator. The 1403 uses forms carts in front and in back of the printer to facilitate handling of the paper.

Three printing capacities are available: 100, 120, or 132 print positions. Each position has a print hammer and an associated position in storage. This can be either buffer storage, or a part of main storage in the processing unit. Buffer storage is an optional feature with some 1403 models, but with the Model 3 and the N-1 printer, it is required.

Four printing speeds are available, measured in lines per minute (lpm), with single spacing. Speeds assigned according to the model of the printer are based on the standard alphameric type arrays. Standard speeds are 340, 465, 600, and 1,100 lpm, including time required for single-spacing.

The high-speed hydraulic carriage is an integral part of the printer, which is packaged as a single unit. The function of the carriage is to advance the paper, at the right times, through the printing station. This is done in two modes: spacing and skipping.

Spacing is a line-by-line advancement of the paper through the printing station. It is always done at slow speed. A manual clutch and line selection knob allows the operator to shift gears so that the carriage can operate at six or eight lines per inch. Spacing can be single, double, or triple and is determined by the program and the space control circuitry in the system.

Skipping is the smooth rapid uninterrupted flow of paper from any line on the paper to a predetermined distance below that line. The length of skips is controlled by the system but is limited by the length of the carriage control tape. Skips in excess of eight lines take place at high speed except for the last eight lines of the skip. Skips of eight lines or less take place at low speed.

Both spacing and skipping can be programmed to occur either before or after printing. Multiple part paper forms can be used.

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Machine Language

- **Characters to be printed are stored in BCD form.**
- **The order of characters in the standard alphameric type arrays is adapted to this BCD coding.**
- **The type arrays contain 48 printable characters arranged in four 12-position groups.**
- **These groups are designated by the four combinations of the A- and B-bits.**
- **The characters in each group are arranged in ascending bit order, from 1 through 12.**
- **The BCD coding to designate the type sequence in the arrays follows a prescribed pattern of ascending logical and numerical bit sums.**

The language that represents characters in the printer is the system of BCD representation used throughout IBM. Figure 4 shows the BCD coding assignments in the order of increasing values of bit sums. All combinations of the six-bit (B, A, 8, 4, 2, and 1) coding are shown, together with their respective card punch codes. (C-bits are not considered although they are shown in Figure 4.)

The character codings are divided into four groups representing the four possible combinations of the A- and B-bits. The groups are shown in the order of ascending logical values as follows: not AB, A not B, B not A, and AB. Each group contains 16 characters for a total of 64 possible characters. Of this total, 26 are alphabetical, 10 are numerical, and 27 (8 are special characters) are symbol characters. The remaining possibility is a blank. This is represented in storage as a C-bit. Figure 4 shows all these possible combinations. Any other combination constitutes an invalid character. Invalid characters produce error (check) conditions in the system.

From these 64 characters, 48 are chosen to compose a type array. Valid characters not in the array make up a category of characters known as *unprintable characters*. The system ignores unprintable characters encountered in printout areas of storage during a print operation. Unprintable characters can cause print checks (errors) which can stop both printing and processing.

Each standard array is identical in the print cartridge and contains 26 alphabetical, 10 numerical, and 12 symbol characters. These 12 are selected from the 27 coded symbol characters available.

The arrangement of type characters in the arrays is based on the principle of the ascending order of logical and numerical bit values of the characters. This principle is very important as it is the basis of a method of keeping track of characters in the chain while it is in motion. This method is described under *Electrical Principles of Printing*.

DEFINED CHARACTER	CARD CODE	BCD CODE
BLANK		C
1	1	1
2	2	2
3	3	C 21
4	4	4
5	5	C 4 1
6	6	C 42
7	7	421
8	8	8
9	9	C 8 1
0	0	C 8 2
#	3-8	8 21
@	4-8	C 84
: Colon (Special Character)	5-8	84 1
> Greater Than (Special Character)	6-8	842
√ Tape Mark	7-8	C 8421

ƀ (Special Character Note 1)	2-8	A
/	0-1	C A 1
S	0-2	C A 2
T	0-3	A 21
U	0-4	C A 4
V	0-5	A 4 1
W	0-6	A 42
X	0-7	C A 421
Y	0-8	C A8
Z	0-9	A8 1
‡ Record Mark	0-2-8	A8 2
,	0-3-8	C A8 21
%	0-4-8	A84
⋎ Word Separator	0-5-8	C A84 1
\ (Special Character)	0-6-8	C A842
⧻ Tape Segment Mark	0-7-8	A8421

NOTE 1: Programmer's Blank

DEFINED CHARACTER	CARD CODE	BCD CODE
—	11	B
J	11-1	CB 1
K	11-2	CB 2
L	11-3	B 21
M	11-4	CB 4
N	11-5	B 4 1
O	11-6	B 42
P	11-7	CB 421
Q	11-8	CB 8
R	11-9	B 8 1
! (Minus Zero)	11-0	B 8 2
$	11-3-8	CB 8 21
*	11-4-8	B 84
] Right Bracket (Special Char.)	11-5-8	CB 84 1
; Semicolon (Special Character)	11-6-8	CB 842
Δ Delta (Mode Change)	11-7-8	B 8421

&	12	CBA
A	12-1	BA 1
B	12-2	BA 2
C	12-3	CBA 21
D	12-4	BA 4
E	12-5	CBA 4 1
F	12-6	CBA 42
G	12-7	BA 421
H	12-8	BA8
I	12-9	CBA8 1
? (Plus Zero)	12-0	CBA8 2
.	12-3-8	BA8 21
⌑	12-4-8	CBA84
[Left Bracket (Special Character)	12-5-8	BA84 1
< Less Than (Special Character)	12-6-8	BA842
‡ Group Mark	12-7-8	CBA8421

Figure 4. IBM Character Codes

Figure 5 shows the sequence of characters in the standard alphamerical type array. The type characters are arranged in four groups according to the logical values of the A and B components of their bit structures. Within each group, characters are aligned sequentially in order of their ascending numerical bit values from 1 through 12. Each of these groups contains three symbol characters. Of the twelve symbol characters included, three are *compromise* characters for which the standard BCD coding is modified.

Character in Order of Sequence on the Chain (Standard)		Modified BCD Code				
	B	A	8	4	2	1
1						1
2					2	
3					2	1
4				4		
5				4		1
6				4	2	
7				4	2	1
8			8			
9			8			1
0			8		2	
#			8		2	1
@			8	4		
/		A				1
S		A			2	
T		A			2	1
U		A		4		
V		A		4		1
W		A		4	2	
X		A		4	2	1
Y		A	8			
Z		A	8			1
‡		A	8		2	
,		A	8		2	1
%		A	8	4		
J	B					1
K	B				2	
L	B				2	1
M	B			4		
N	B			4		1
O	B			4	2	
P	B			4	2	1
Q	B		8			
R	B		8			1
—	B		8		2	
$	B		8		2	1
*	B		8	4		
A	B	A				1
B	B	A			2	
C	B	A			2	1
D	B	A		4		
E	B	A		4		1
F	B	A		4	2	
G	B	A		4	2	1
H	B	A	8			
I	B	A	8			1
&	B	A	8		2	
.	B	A	8		2	1
⌑	B	A	8	4		

Figure 5. Standard Type-Array Character Sequence and BCD Code Assignment

Since the standard BCD codings A, B, and BA (unaccompanied by numeric bits) have no assignment in the type array, it follows that their respective character representations (ƀ, –, and &) are unprintable.

The type array assignments do, however, include the BCD combinations A82, B82, and BA82. The respective characters represented by these bit combinations are: ‡, !, and ?.

A compromise was made in the selection of three of these characters in the standard alphamerical array. The characters chosen are ‡, –, and &. The standard BCD coding is modified to let:

A82 represent ‡
B82 represent —
BA82 represent &.

Figure 6 summarizes this character compromise and the BCD code modification. The symbol ‡ can print from either an A or an A82 combination in storage. Likewise, a – will print for a B or B82, and a & will print from BA or BA82. The system circuitry can have each of these characters print if either of their two respective BCD codes are encountered in a storage printout area during printing.

The 1401 does this by simulating the missing numeric bits in the B-register-adjust-print circuits. These circuits cause an AB in the B-register, for example, to appear to the print compare circuits as BA82. This deception has the same effect as if the character in the B-register actually were BA82. Each system has its own way of doing this.

Other special symbol-characters can be substituted in the array by changing type slugs. In this case, a special machine feature is involved, and the bit codings of the displaced characters are not changed. Whenever these codings are sensed during printout, the substituted character prints instead of the original symbol. These variations are currently limited to eight-character positions.

Individual Standard BCD Code	Assigned Symbol Character	Common (Modified) BCD Code	Compromise Symbol Character
A82	‡	A82	‡
A	ƀ		
B 82	!	B 82	–
B	–		
BA82	?	BA82	&
BA	&		

Figure 6. Modification for A, B, and AB Codings

Arrangement A (1403 Models 1, 2, 4, 5 and 6)	B	C	D	E	F	G	H	J	K	BCD Code	Card Code	1403 Models 3 and N-1: A	1403 Models 3 and N-1: H
W										A 42	0-6	W	
V										A 4 1	0-5	V	
U										A 4	0-4	U	
T										A 21	0-3	T	
S										A 2	0-2	S	
/	&	0		&						A 1	0-1	/	
@				〉	⌐	–	'			84	4-8	@	'
#					=	+	=		=	8 21	3-8	#	=
0										8 2	0	0	
9										8 1	9	9	
8										8	8	8	
7										421	7	7	
6										42	6	6	
5										4 1	5	5	
4										4	4	4	
3										21	3	3	
2										2	2	2	
1										1	1	1	
¤				〈	)		)		)	BA84	12-4-8	¤	)
.										BA8 21	12-3-8	.	
&	/		-	-	+	÷	+	÷	+	BA	12	&	+
I										BA8 1	12-9	I	
H										BA8	12-8	H	
G										BA 421	12-7	G	
F										BA 42	12-6	F	
E										BA 4 1	12-5	E	
D										BA 4	12-4	D	
C										BA 21	12-3	C	
B										BA 2	12-2	B	
A										BA 1	12-1	A	
*										B 84	11-4-8	*	
$				°						B 8 21	11-3-8	$	
-				/						B	11	-	
R										B 8 1	11-9	R	
Q										B 8	11-8	Q	
P										B 421	11-7	P	
O										B 42	11-6	O	
N										B 4 1	11-5	N	
M										B 4	11-4	M	
L										B 21	11-3	L	
K										B 2	11-2	K	
J										B 1	11-1	J	
%					(		(		(	A84	0-4-8	%	(
,										A8 21	0-3-8	,	
‡										A8 2	0-2-8	‡	
Z										A8 1	0-9	Z	
Y										A8	0-8	Y	
X										A 421	0-7	X	

(Chart shows only one array. Blank blocks indicate type is same as in arrangement A)

Figure 7. Standard Type Arrangements

Ten alphameric character arrays are available in each of two type styles. The standard type array complement is shown in arrangement A, Figure 7. Other arrangements (B through K) vary only in the content of symbol (special) characters. The standard style type is about .095" high. The alternate style height is about .079".

The style and arrangement of type employed depends on the use of the printed output. Printed output from standard style type can be read by the IBM 1418 Optical Character Reader. Alternate style type can print between punched holes on card-form documents. Systems using COBOL or FORTRAN must use arrangement H.

A numeric chain is available on the 1403 Models 1 and 2 only, as a special feature. It involves special circuitry in the system and permits printing speeds of 1,285 lpm. It consists of 15 identical arrays of eight type-slugs, each having two characters. Again, the ascending order of bits is maintained, although some combinations are omitted. Circuitry in the system, which keeps track of characters in the array, must take these omissions into account. Figure 8 shows the coding assignments in the numerical array. The arrangement of characters on the eight type slugs comprising the numerical array are shown in Figure 9.

An additional special feature, known as *preferred character set* is available only on Models 3 and N-1. It rearranges the types in the array to have certain characters appear more frequently, so as to speed up the printing operation.

Character in order of sequence on the chain (Numeric)	Modified BCD Code					
	B	A	8	4	2	1
1						1
2					2	
3					2	1
4				4		
5				4		1
6				4	2	
7				4	2	1
8			8			
9			8			1
0			8		2	
,		A	8		2	1
—	B		8		2	
$	B		8		2	1
*	B		8	4		
.	B	A	8		2	1
¤	B	A	8	4		

.095" High
.079" High
Type Styles Available

Figure 8. Numerical Type-Array Character Sequence and BCD Code Assignment

0	9	8	7	6	5	4	3	2	1	¤	.	*	$	-	,

(For Card and BCD Codes of Characters, See Figure 7)

Figure 9. Type Arrangement in Standard Numerical Array

IBM 1403 Printer (Models 1, 2, 4, 5, and 6)

Physical Description

- **The printer is a unitized group of assemblies used to print on and to advance continuous-form paper.**
- **The main functional components are: the hammer unit, the print chain, and the tape-controlled hydraulic carriage.**
- **Receptacles are provided to receive power, signal, and control cables from the system.**

The printer is an output device. It consists of an integrally mounted hydraulic carriage, cover frame, and shock-mounted printer frame with covers and controls. The entire unit is supported on a pedestal base.

Paper enters from the bottom of the printer at the front. It passes vertically upward through the printing station, over forms guides at the top, and moves downward at the rear. Here it passes vertically through an adjustable forms stacker and is folded into a stack at the rear. The stacker adjusts to allow for variations in size of the printed forms. The paper is assisted in its downward stacking direction by a set of friction-driven feed rolls. These rolls can be disengaged to permit gravity stacking, if desired.

Above the base, the printer is encased in sound absorbing covers (Figure 10). Just above the left side-cover is the operator's console panel containing the control switches and indicating lights. Inside the left side-cover are two contact-shoe receptacles and a small 13-pin receptacle. Three cables from the system make connection to the printer here. The contact-shoe receptacles each have 160 contact positions. Signal and control lines use these connectors. The small connector is for basic power supply lines only.

The main components of the printer are: machine base, translator frame, T-casting, hammer unit, print chain and drive mechanism, and tape-controlled hydraulic carriage. These are described in the various sections on *Functional Units and Principles of Operation.*

Functional Units

- **Functional units are groups of assemblies or mechanisms that contribute to the overall performance of the machine.**
- **The main functional units of the printer are:**
  - **Base**
  - **Translator frame**
  - **T-casting**
  - **Hammer unit**
  - **Print cartridge and drive**
  - **Ribbon mechanisms**
  - **Other units.**

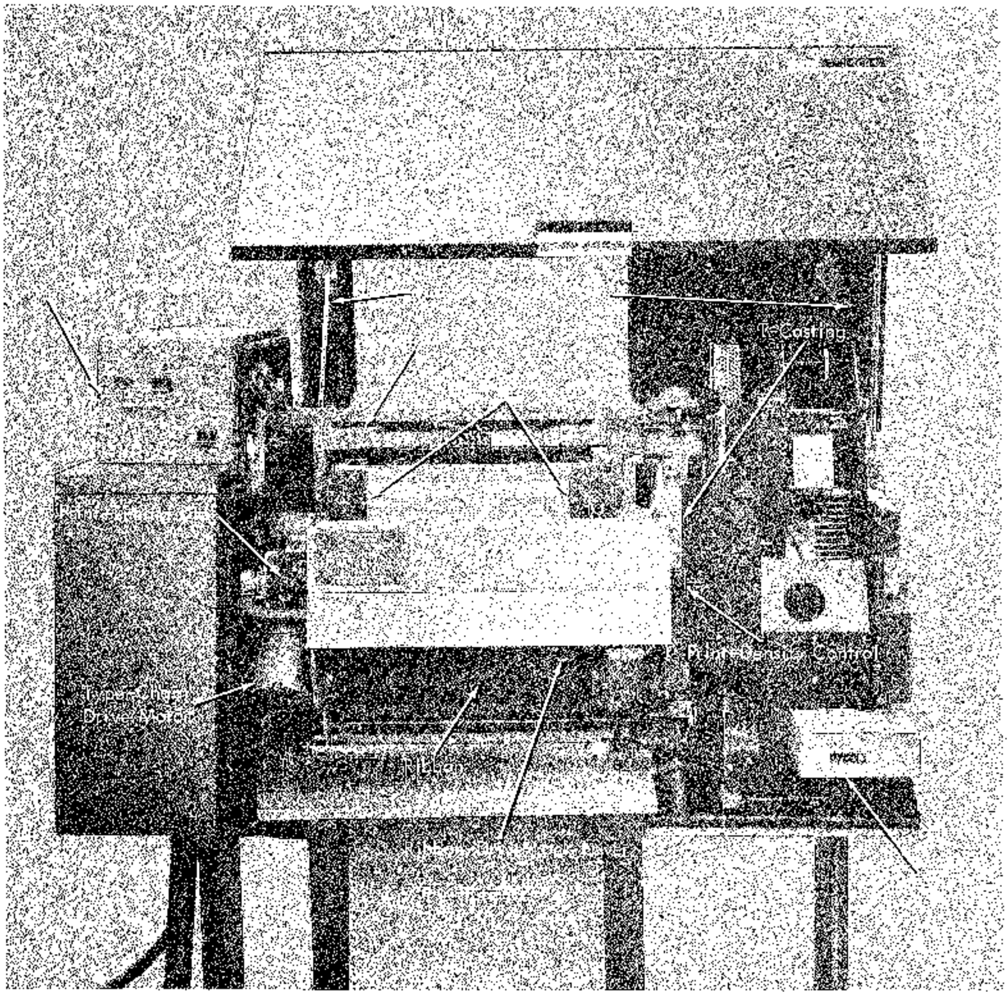

Figure 10. IBM 1403 Printer (Right End Cover and Forms Guide Removed)

Base Frame

- **The printer base frame supports the other functional units.**
- **It is shock-mounted to the pedestal base.**
- **It is surrounded by the cover frame.**

The printer base frame supports all the other functional units of the printer. It consists of a heavy bridge casting at the bottom, two side castings, and a tie bar at the top. This forms a large rigid rectangular framework within which the translator frame is free to move. This base frame is shock-mounted to the pedestal base.

Figure 11 shows how the printer base frame is suspended on two brackets. The base frame is steadied by

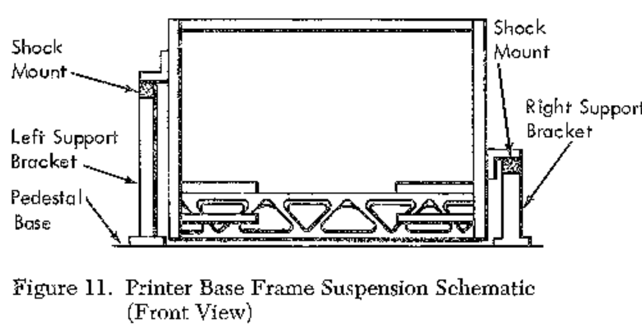

Figure 11. Printer Base Frame Suspension Schematic (Front View)

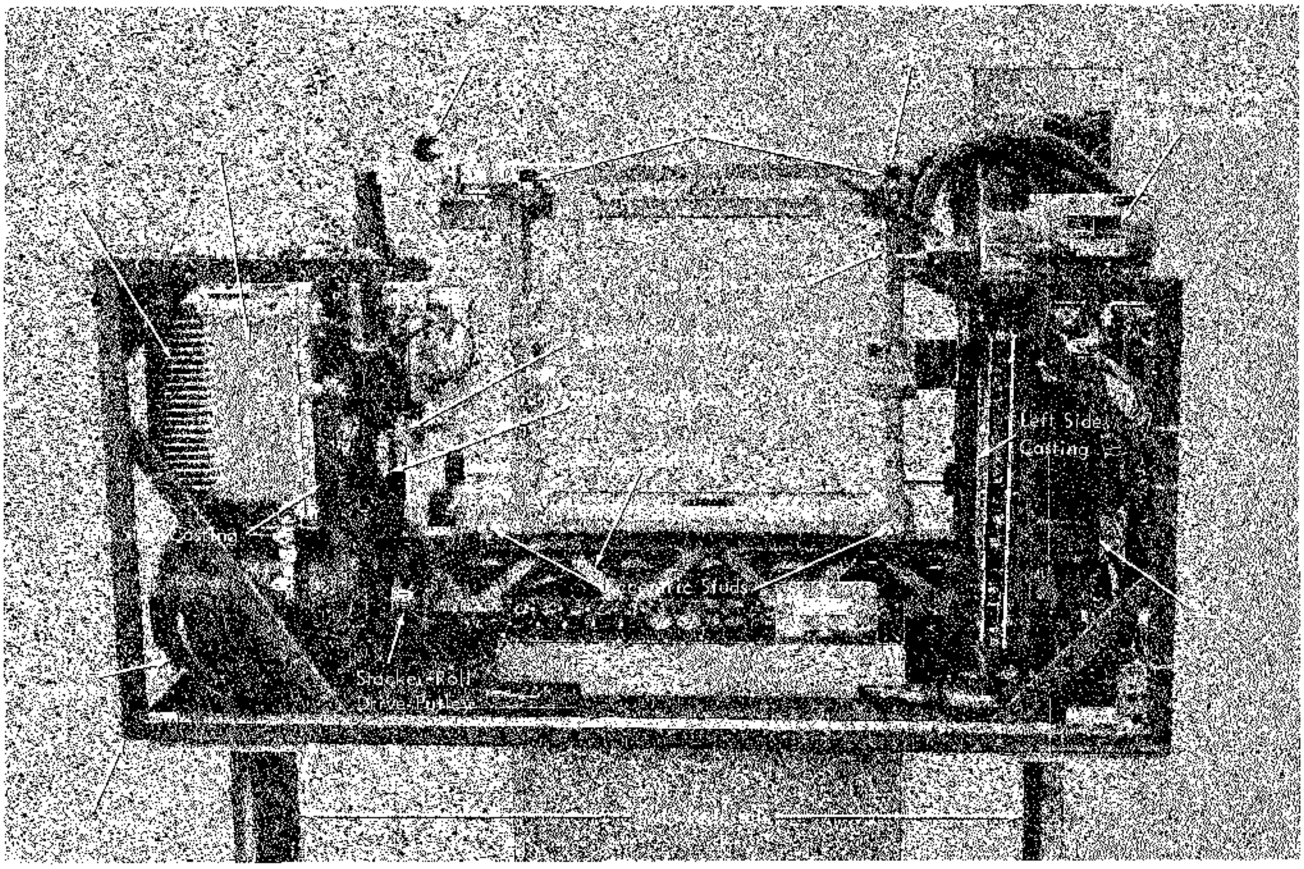

Figure 12. Printer Base Frame (Rear View Showing Main Components)

bonded bumper screws at each end to prevent it from rocking on the resilient shock mounts.

The right side casting supports the hydraulic unit and drive motor, as well as the tape-controlled carriage mechanisms. Figure 12 is a rear view of a partially assembled printer. The T-casting has not yet been installed. The figure shows the printer base components as well as the relative positions of the hydraulic unit, drive motor, translator frame and cover frame.

The tie bar at the top guides and positions the translator frame, and supports the side castings and upper curved paper-guides.

The cover frame is a welded structure of square metal tubing which supports the covers and electrical controls. It surrounds the printer and is bolted to the pedestal base. When the covers are attached, they completely enclose the printer above the pedestal base. Covers are held in place by quick opening fasteners.

Translator Frame

- **The translator frame supports the T-casting and the printing mechanisms.**
- **It provides vertical and horizontal movement of the printing mechanisms with respect to the forms.**
- **It maintains a constant print chain-to-hammer relationship regardless of its movement.**

The translator frame (Figure 13) is a single open rectangular casting. It is mounted within the larger framework formed by the printer base-frame castings. It can move limited distances up and down, and from side to side within this framework. This allows adjustment of the printing line with respect to the forms. Since all components of the printing mechanism are mounted on the translator frame, a fixed relationship between them is maintained, regardless of this movement.

Lateral movement of the translator frame is assisted by two rollers. These rollers are mounted on two slides on the front of the translator frame, and bear the entire weight of the frame and the printing mechanisms. The slides are mounted in slots at the bottom of the frame near each side. Two shoulder screws (through vertically elongated holes) hold the slides in place.

An eccentric shaft passes through bearings in these slides and the translator frame, and protrudes to the right. A toothed sector, which meshes with a pinion gear, is clamped to this shaft. A large *vertical print*

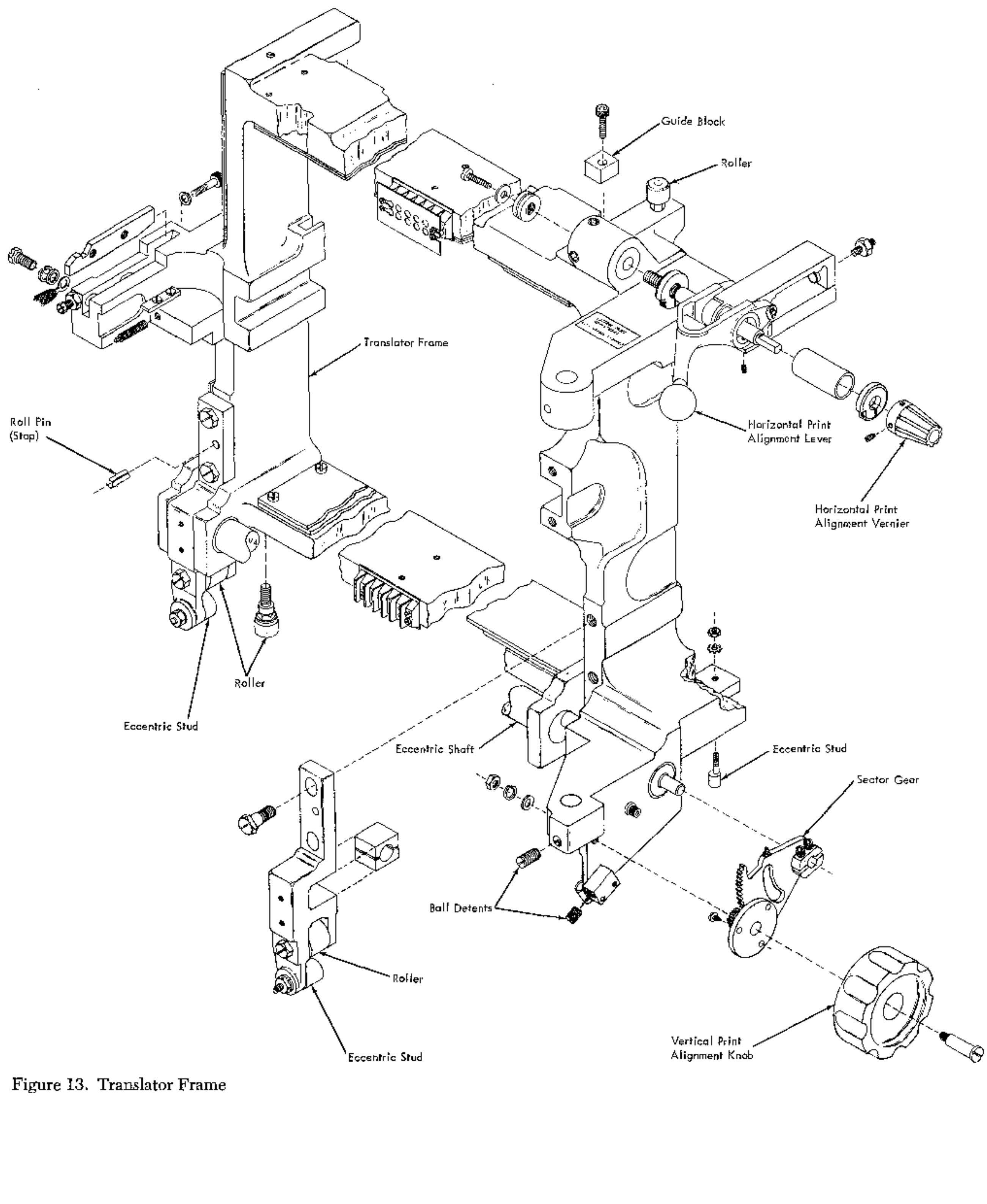

Figure 13. Translator Frame

alignment knob is attached to the pinion gear. By turning the knob, the eccentric shaft turns within the limits of the sector.

Since the rollers on the slides are kept in contact with the bed formed by the machined surfaces of the bridge casting, they cannot move vertically. Consequently the eccentric motion of the shaft raises or lowers the translator frame. The vertical position of the frame is maintained by two spring-loaded ball detents. One or both balls can engage the hardened teeth of the sector. In the center position, both balls engage the sector. In the extreme sector positions, only one ball is engaged.

Figures 14 and 15 show the vertical and horizontal print alignment mechanisms, the control knob, right-hand translator slide, and the relationships of the eccentric shaft, sector, pinion gear, and ball detents. The eccentric stud at the bottom provides a minimum clearance to the underside of the bridge-casting machined surface. This keeps the vertical position of the slide fixed. The left-hand slide is the same except for a roll pin protruding from a hole between the mounting screws. The purpose of the pin is to stop the translator frame before it can damage the paper guide on the lower left forms tractor. The pin stops the frame when it contacts the lower left forms tractor. In the Model 3, a new-design lower-ribbon guide replaces the pin and paper guide.

To keep the translator frame in a vertical plane within the printer base frame, the translator frame has

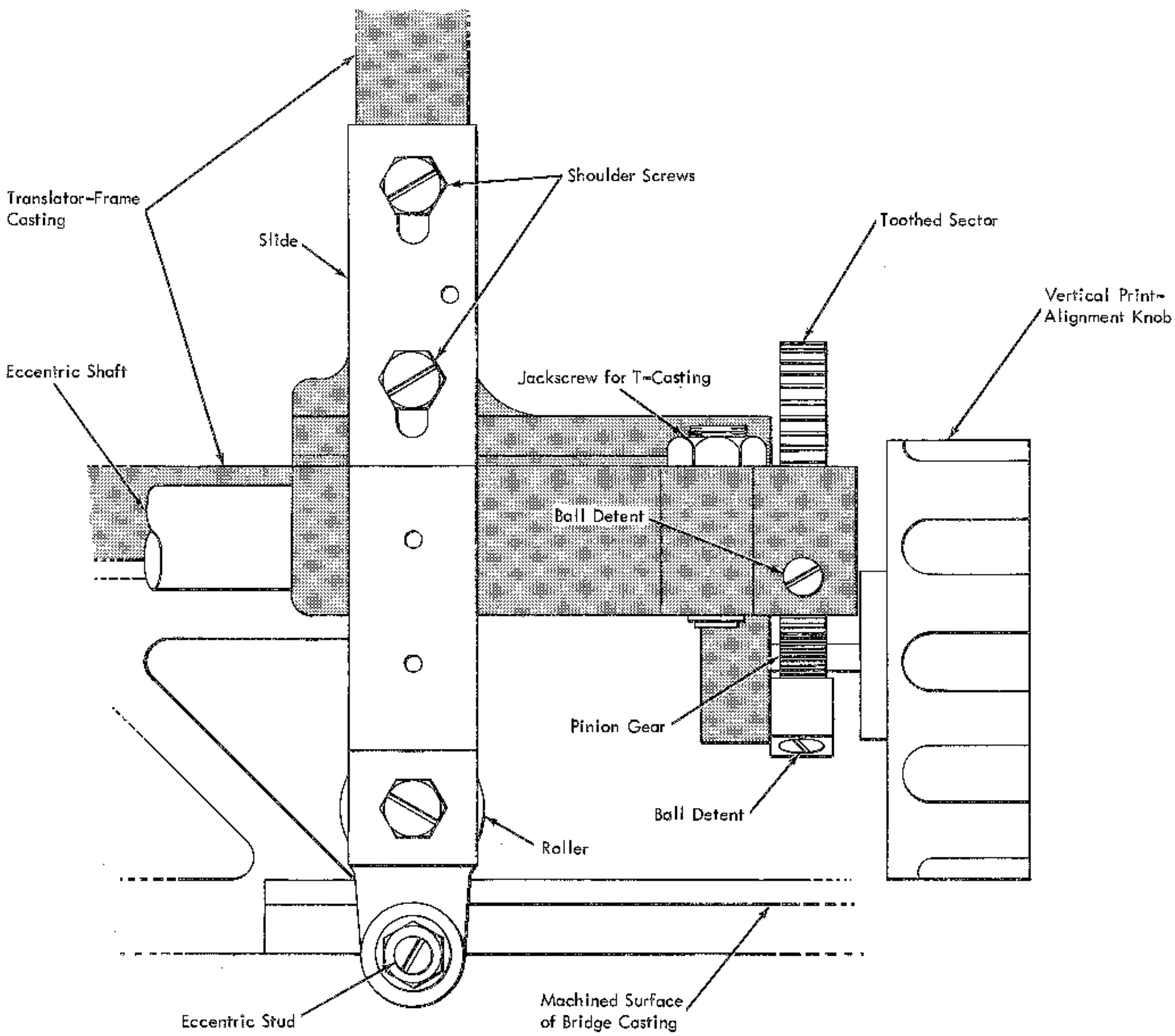

Figure 14. Vertical Print-Alignment Mechanism

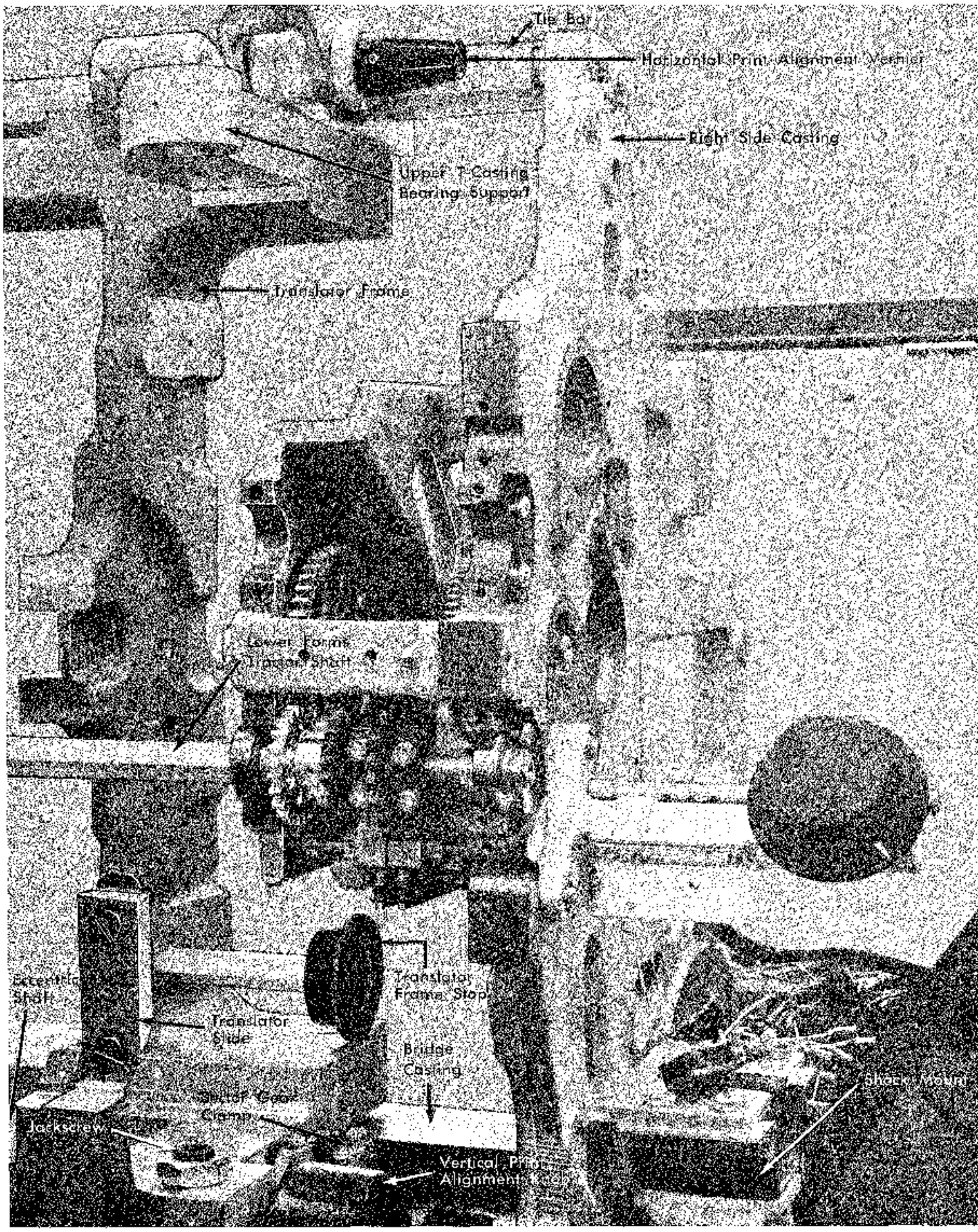

Figure 15. Translator Frame Detail

four rollers, each with a vertical axis. Two are at the top rear, and two are at the bottom front. The top rollers slide along the rear face of the tie bar with which they are kept in contact by guide blocks on the front. The bottom rollers are kept in contact with the machined front surfaces of the bridge casting by vertical eccentric studs that contact the rear faces.

The translator frame supports the T-casting, hammer unit, print chain, and associated mechanisms. It has bolts on the back for attaching customer engineering service rails. You can slide the heavy hammer unit out on these rails and rotate it for servicing. When not in use, the rails are stored inside the machine.

T-Casting (Figures 16 and 17)

- **The T-casting is a heavy casting that pivots on the right front of the translator frame.**
- **It supports the type cartridge, ribbon-feed and correction mechanisms, and timing disk, as well as their associated drive mechanisms.**
- **It contains a hinged ribbon shield and print-position indicator.**

The T-casting is a heavy casting that supports the type-cartridge, sense head, timing disk, type-chain drive motor, and ribbon mechanisms. It follows the horizontal and vertical movement of the translator frame on which it is mounted. The T-casting is hinged to the right-front member of the translator frame. This allows the T-casting group to open and close like a gate. When closed, the T-casting latches to the translator frame. This keeps the print cartridge and ribbon locked in the printing position.

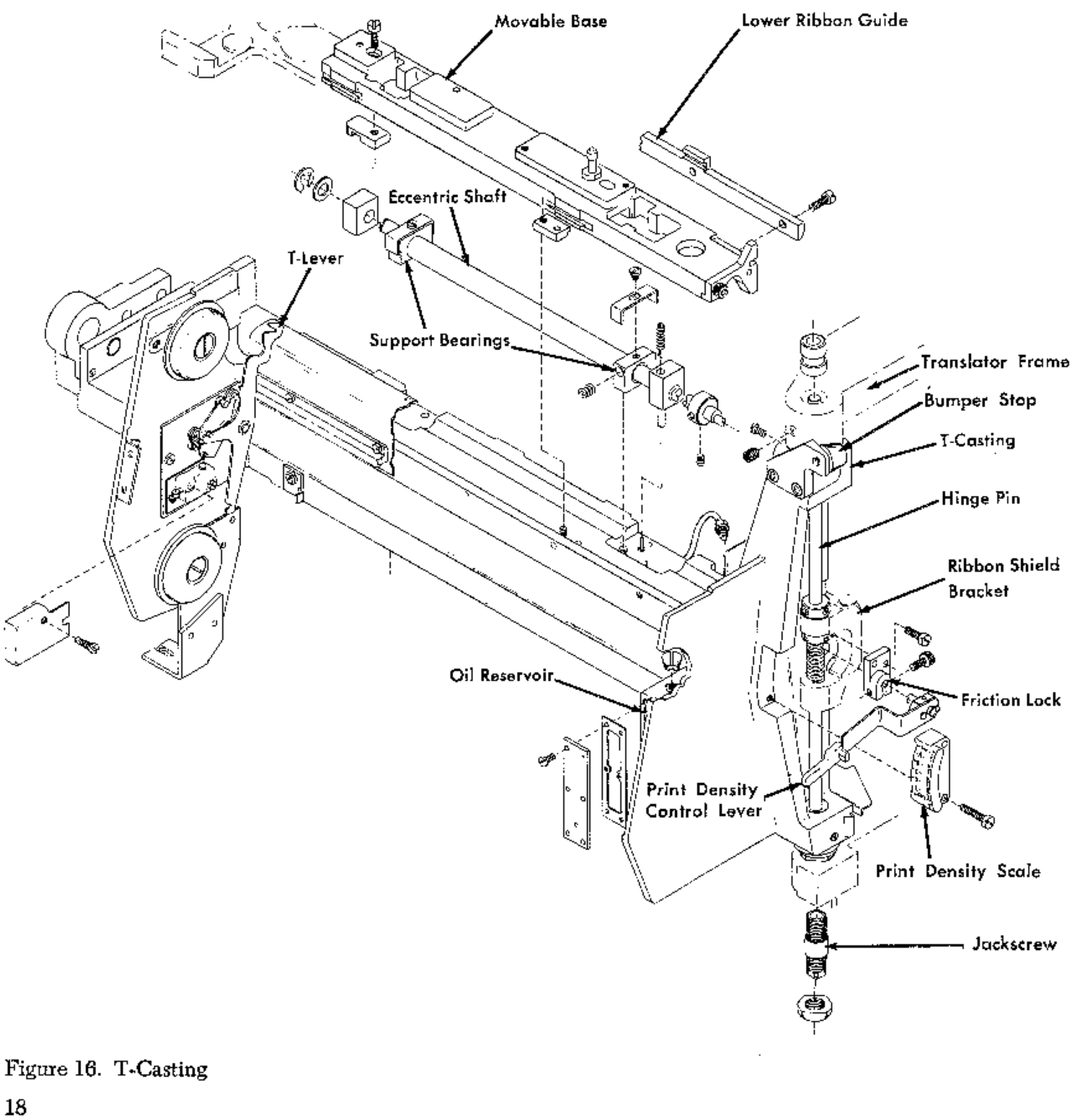

Figure 16. T-Casting

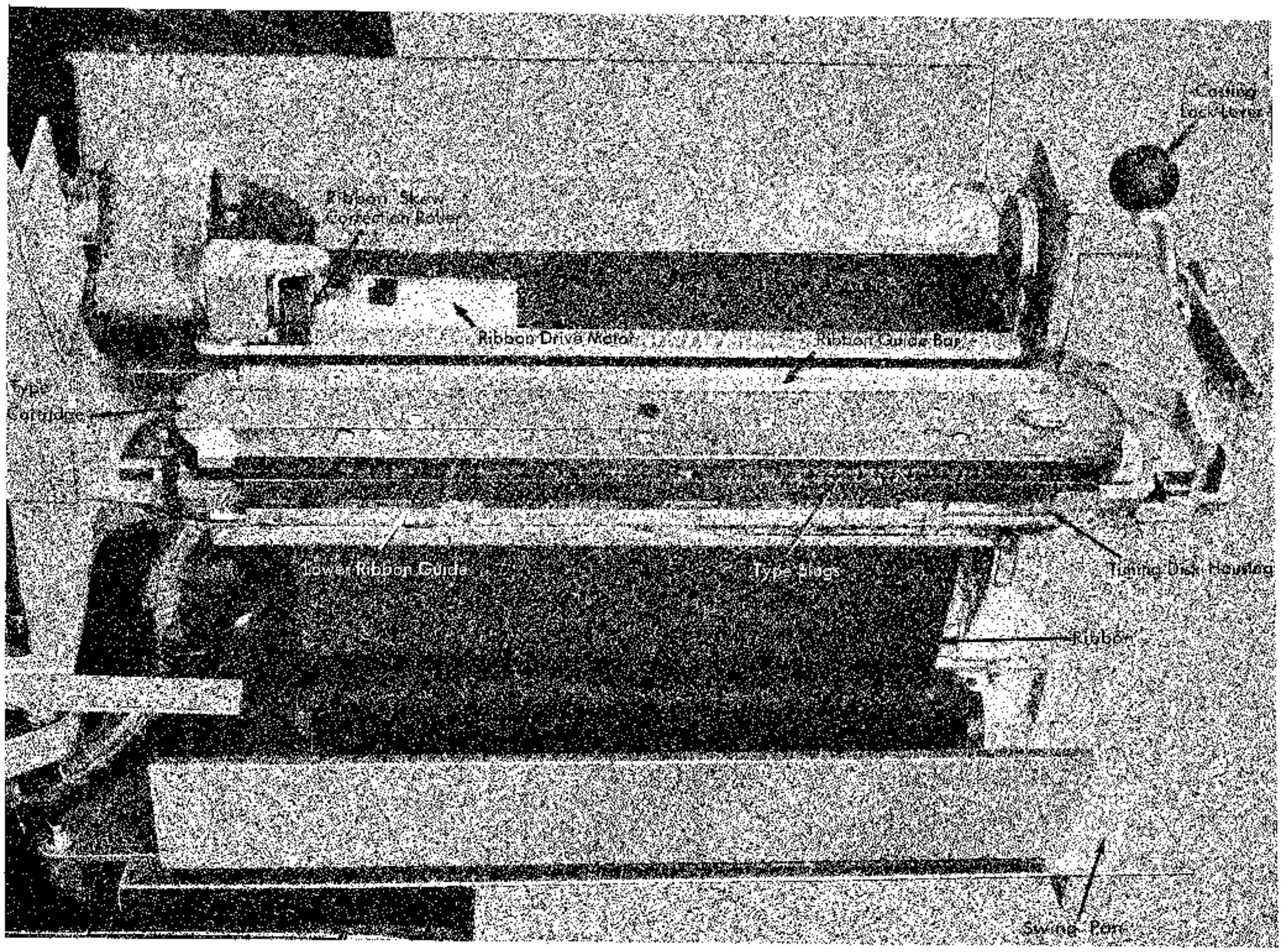

Figure 17. Rear View of T-Casting with Ribbon Lowered

The T-casting has upper and lower hinge bearings (Figure 18) that allow it to pivot horizontally about a long vertical hinge pin. The bearings are eccentric for correct T-casting adjustment. A thrust washer supported by an adjustable jackscrew carries the weight of the casting. Adjustments are covered in the *Customer Engineering Reference Manual: IBM 1403 Printer,* Form 225-6493. A bumper stop near the upper-hinge bearing limits the outward swing of the T-casting.

Closely related to the T-casting, and mounted between its bearings on the same hinge pin, is the ribbon shield-print line-indicator assembly. This is a long dual-purpose bar with a print-position indicator scale attached. Since it shares a common pivot with the T-casting, it can swing in an arc along with the horizontal arm of the T-casting. The bar has a spring-loaded hinge and is normally latched against the T-casting where it performs its ribbon-shield function. When the T-casting is open, and the bar is unlatched, the tension of the hinge spring swings it up against the paper forms to guide the operator in positioning the print

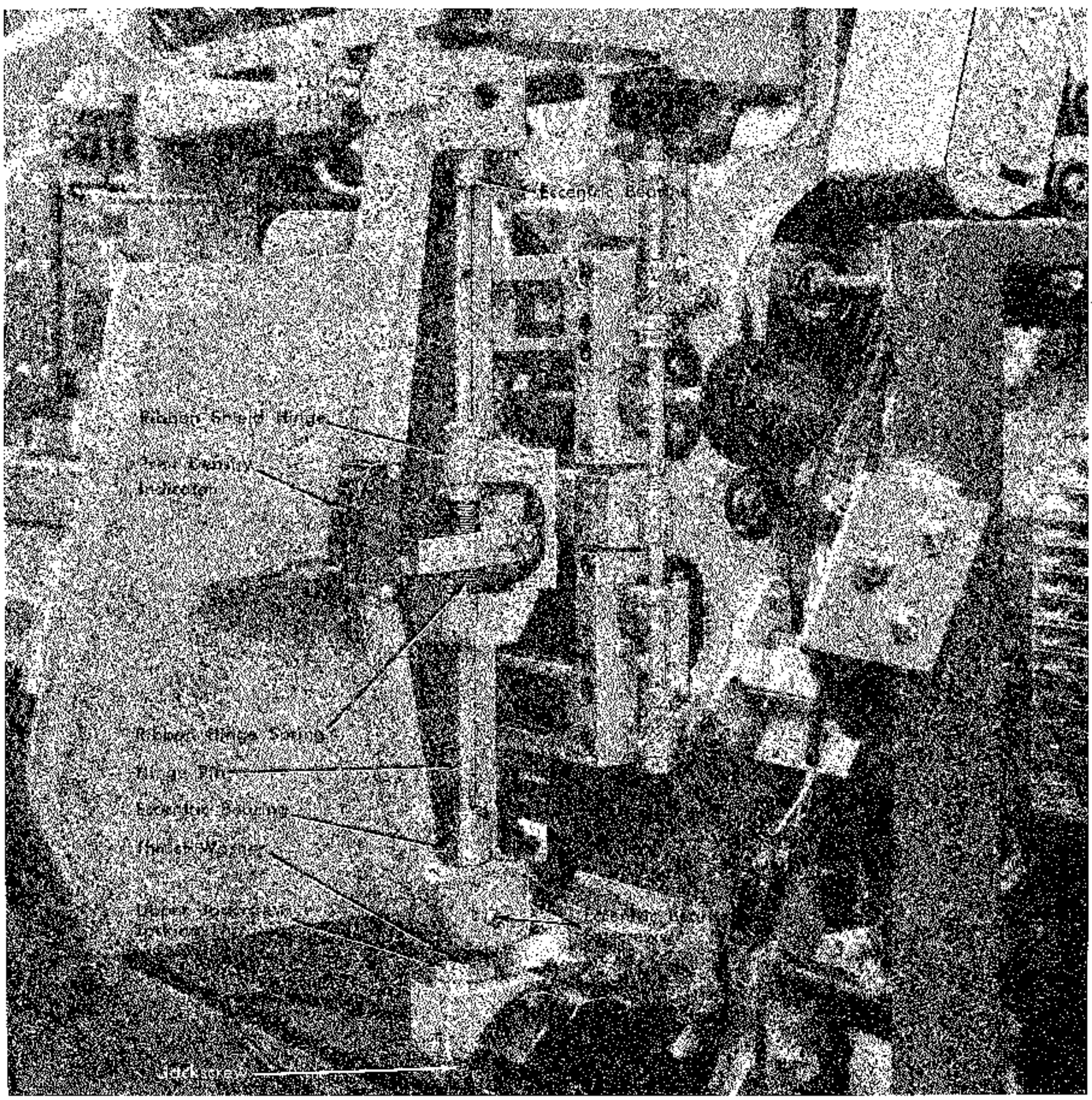

Figure 18. T-Casting (Hinge-Pin End)

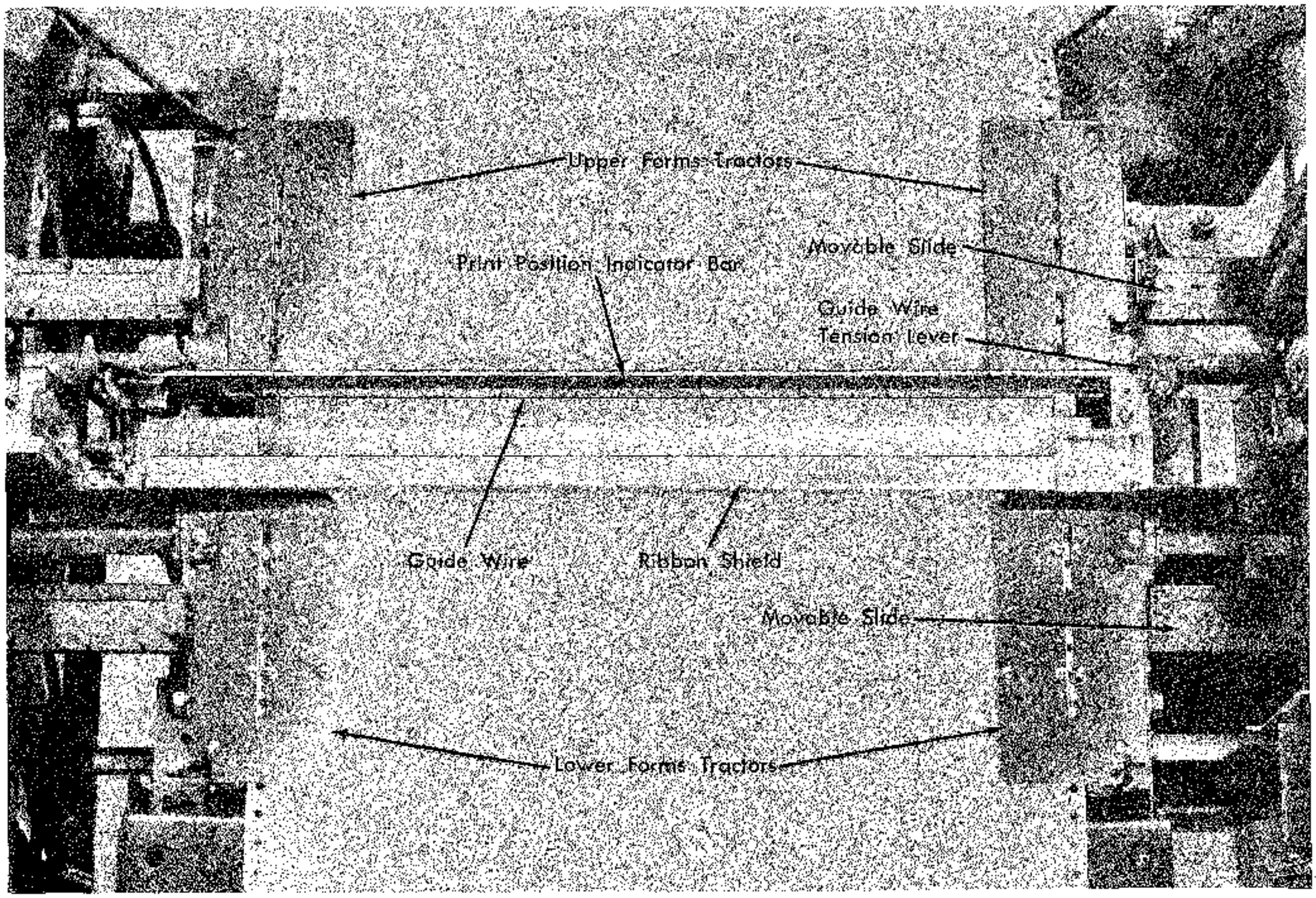

Figure 19. Front View of Print Area (T-Casting Open)

line. Figure 19 shows the bar in the print-line-indicating position with the T-casting open.

The new style ribbon shield has the print position locations marked on a bar at the top. This makes it possible for the operator to line up the print unit with the continuous forms, with the T-casting closed. To do this (after the forms have been inserted in the machine), the procedure is as follows:

1. Set the 6-8 line clutch in either the 6-line neutral or the 8-line neutral position with the manual-clutch-line-selection knob, depending upon the spacing to be used.
2. With the paper advance knob, position the paper until that portion on which the first line is to print is just visible above the new ribbon guide bar.
3. Align the print hammer position laterally with the lateral print-alignment lever and vernier, while observing the relationship of the new ribbon guide-bar markings to the form.
4. Adjust the form vertically so the bottom of the first line of print will be at, or just below, the top surface of the ribbon guide bar.
5. Now, turn the paper advance knob *backwards* three line spaces if in 6-line neutral, or four line spaces if in 8-line neutral. The distance in either case is ½".
6. Restore the carriage to channel 1 and engage the 6-8 line clutch. The form is now in position to print the first line in the desired location on the form.

A detachable guide wire spans the length of the indicator. The wire prevents the constantly moving ribbon from smudging whenever the paper is standing still. The wire is not used in the Model 3 or the N-1.

The horizontal arm of the T-casting supports a flat movable base (Figure 20). The type-chain cartridge and timing disk assembly, together with the read head and the timing disk housing, are mounted on this base. An eccentric shaft passes through the bottom of the base, and through two support bearings that are fastened to the T-casting. A lever is attached to the right end of this shaft. This motion is enough to shift the movable base (with the print cartridge) closer to or farther away from the print hammers. The total movement is slight (about 0.016"). This is the print density control.

The horizontal arm of the T-casting also supports the chain-drive motor, and the ribbon-feed and skew-correction mechanisms. An oil reservoir is just inside the right end of the T-casting. This provides lubrication, through a wick, to the chain cartridge.

The left end of the T-casting has a lock lever. It engages the latch on the left side of the translator frame to lock the T-casting in the printing position. The lock lever is fitted with a ball-shaped handle. It has a mechanical and electrical interlock. When the T-casting is open, a microswitch actuated by the lock lever, opens to stop the chain drive motor. The mechanical interlock prevents closing the microswitch by the lock lever unless the T-casting is latched closed.

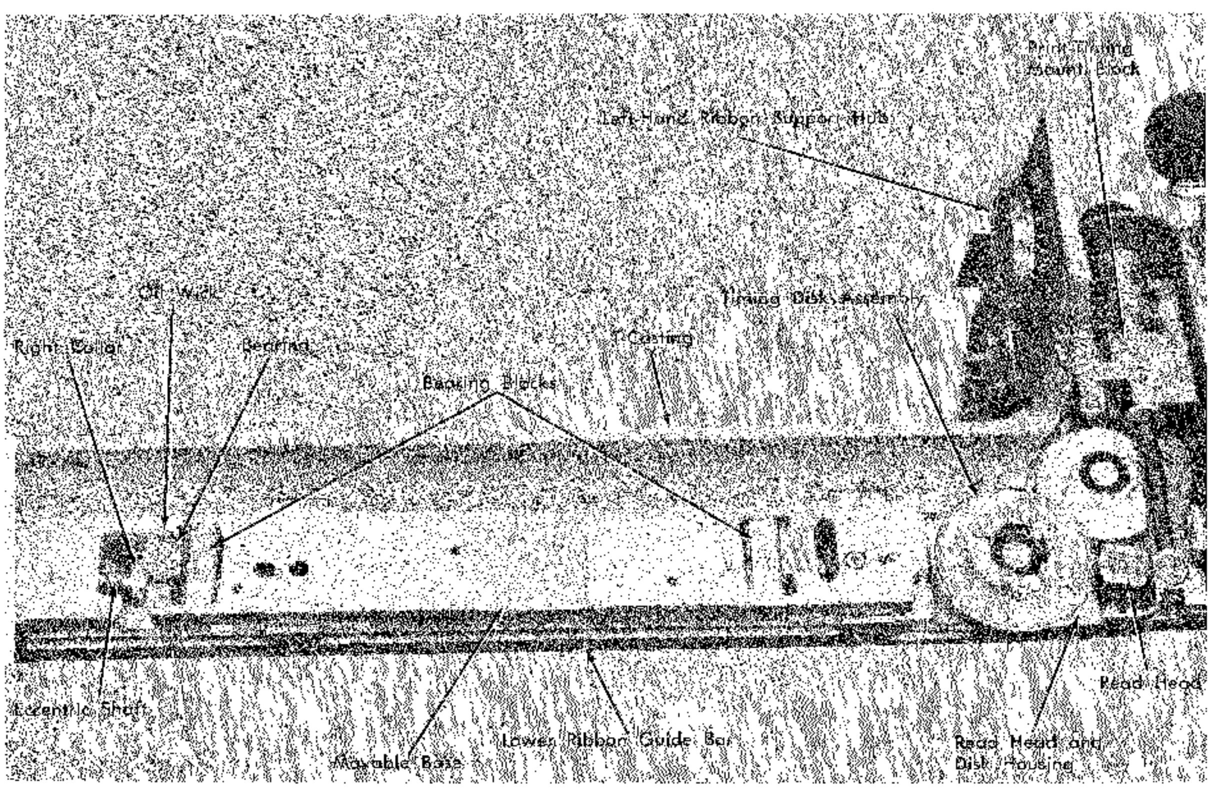

Figure 20. Movable Base

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Timing Disk, Read Head, and Type-Chain Drive Motor

- **The timing disk and read head generate pulses to control the printing.**
- **They are mounted on the movable base.**
- **The timing disk is keyed to the type-chain drive gear.**
- **The read head can move along the periphery of the timing disk. It is operated by the print timing dial.**
- **The type-chain drive motor is fixed to the T-casting.**

The timing disk is a flat magnetized disk with 144 equally spaced grooves or slots scribed on its circumference. One extra slot is centered between two of the others to mark a home position. The disk is fastened to the type-chain drive gear with respect to this home position. The disk and type-chain, therefore, maintain a fixed relationship throughout their motion. The disk and type-chain drive gear rotate at a constant speed when the T-casting is closed. The speed depends on the model.

Positioned close to the edge of the disk is the read head. This device contains a coil of wire in which a pulse is generated each time one of the slots in the magnetized disk passes it. This pulse is shaped and amplified by two SMS cards in the printer and sent to the system to control the printing. The timing of the pulses can be retarded or advanced by moving the read head slightly in (against) the direction of disk rotation. This is to correct for variations in time of flight of the print hammers at different print-density settings. The control used to do this is the print timing dial. Both the read head and the timing disk are mounted on the movable base on the T-casting.

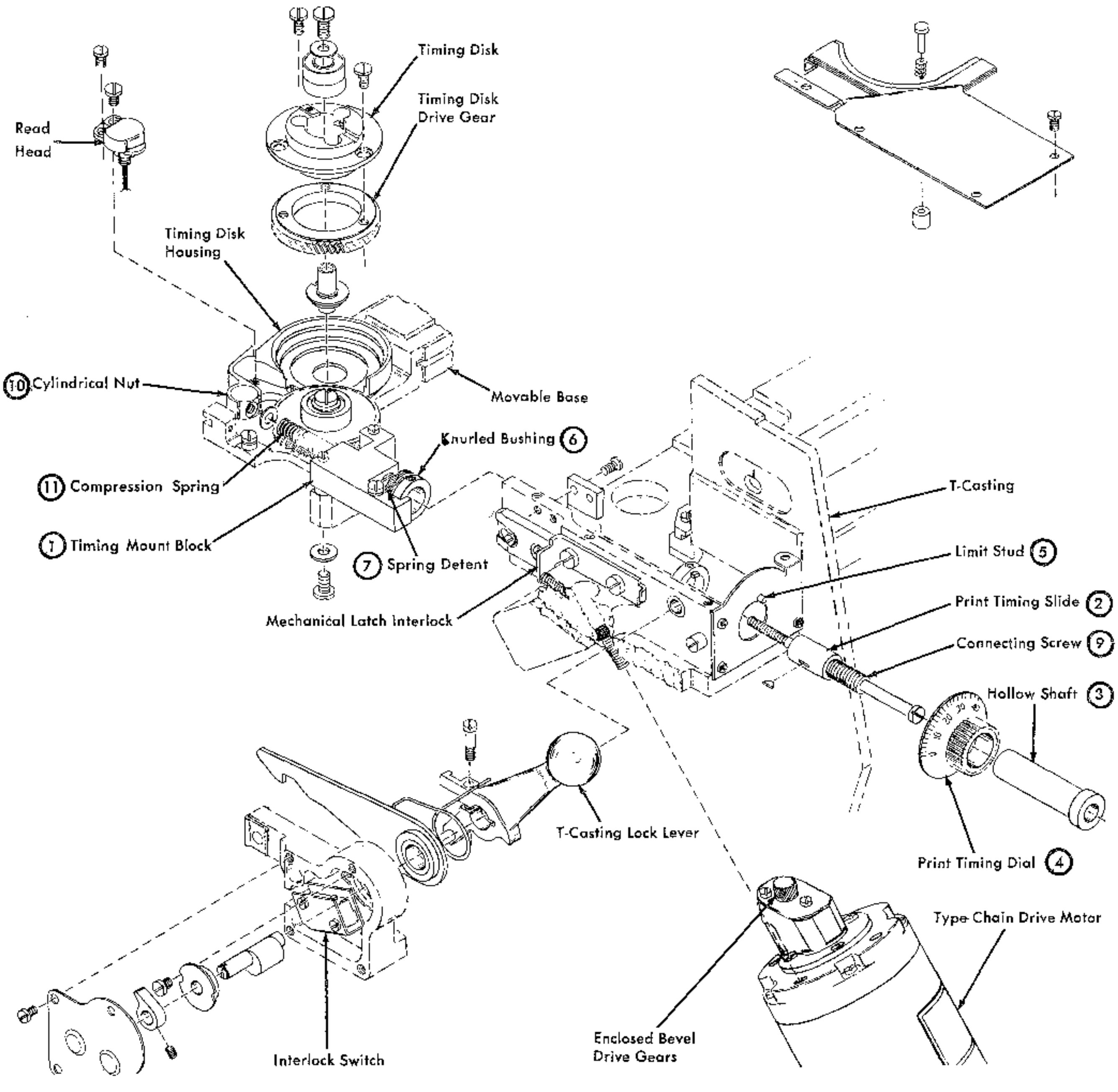
The chain drive motor, however, is fixed to the T-casting and cannot be moved. A thermoswitch is built into the motor (01.07.1).

The movable base is positioned vertically by the T-casting. Two clamps at the front and two clamps at the rear of the plate restrict vertical movement. The base is positioned left to right by a block with a slot, which fits over a stud in the T-casting. The movable base is held to the block by a screw. With this screw loosened, the base can be positioned left to right for the correct gear mesh between the inclined chain-motor drive gear and the timing-disk-drive gear idler. The base is positioned front to rear by two eccentrically operated blocks. The blocks operate from eccentrics on the shaft that holds the print-density control lever.

The timing-disk-drive gear (Figure 21) fits around a hub on the bottom of the timing disk. Screws fasten the disk to the gear. The spindle for the timing disk passes through the read-head disk housing. A boss on the spindle restricts the vertical movement of the housing. A stud on the spindle fastens the spindle to the movable base. The spindle is also the pivot for the read-head disk housing, which can be rotated to position the head with respect to the timing disk.

The read head is fastened to the housing. An adjustable stop collar prevents the head from hitting the timing-disk-drive gear idler, which is fastened to the movable base and transmits motion from the drive motor to the timing disk. The print-timing-dial mechanism moves the read-head housing. The print-timing dial mechanism consists of the following parts:

1. Print-timing mount block. This is fastened to the movable base and contains a slot in which a key in the print-timing slide rides.
2. Print-timing slide. Its axis is positioned (front to rear) so the slide can slide along the axis without rotation. The slide has a triple thread on its reduced outside diameter.
3. Hollow shaft. This butts against the front of the print-timing mount block, and has a triple thread on its inner surface that meshes with the threads on the print-timing slide.
4. Print-timing dial. A collar and setscrews fasten this to the hollow shaft.
5. Stud. This limits the rotation of the print-timing dial.
6. Knurled bushing. Setscrews fasten this to the hollow shaft.
7. Spring detent. This detents the knurled bushing and keeps the hollow shaft at the rotational position to which it is set.
8. Index for the print-timing dial (scribed on the outer cover).



Note: Circled numbers refer to paragraphs in text.

Figure 21. Left End of T-Casting

9. Connecting screw. This is inserted into the print timing slide from the front and extends through the slide to provide for customer engineering adjustment.

10. Cylindrical nut. This is free to pivot in the read-disk housing, and joins the housing to the connecting screw.

11. Compression spring. Slipped around the connecting screw, this presses against both the cylindrical nut and a washer (that rests against the print-timing mount block).

The washer surrounds the opening for the print timing slide. Spring tension holds the hollow shaft against the mount block, and allows the head to move as the hollow shaft is rotated. The force due to spring tension is transmitted through the cylindrical nut to the connecting screw, from the connecting screw head to the print-timing slide, through the threads on the print-timing slide to the threads in the hollow shaft.

Type-Chain Cartridge

- **The type-chain cartridge is a unitized assembly. It includes:**
  A centerplate.
  A platen.
  An endless loop or chain of type slugs.
  A drive sprocket (gear).
  An idler gear.
- **The type chain travels counterclockwise around the centerplate and platen at 90.3" per second in the Models 1 and 2.**
- **It is driven by the sprocket that is keyed to the timing disk. A three-phase motor drives the timing disk and chain.**
- **The chain contains 240 type characters. Each slug contains two type characters.**
- **With power on, the chain runs continuously as long as the T-casting is closed.**
- **A reservoir in the right-hand end of the T-casting feeds oil to the type slugs.**

The major parts of the chain cartridge (Figure 22) are: a centerplate and platen, a type sprocket, a type idler, a plastic-coated steel tape to which the type slugs are attached, an upper plate, and a lower plate.

In Models 1 and 2, the tape and its attached type slugs are guided around the centerplate at a speed of 90.3" per second. The platen, fastened at the rear of the centerplate along the print line, supports the type in front of the hammers. The type sprocket at the left end of the centerplate drives the chain of type by engaging the clamp at the back of each type slug. The type idler at the right end of the centerplate maintains tension in the type tape. The feet of the type slugs press against the upper and lower periphery of the type idler. The middle section of the outer edge of the type idler is reduced (smaller diameter) around the entire circumference.

The type sprocket is driven by a keyway that fits over a key on the upper surface of the timing disk. To ensure that the type sprocket is concentric with the timing disk, an extension (boss) on the type sprocket fits into the bearing hole in the center of the timing disk hub.

The spindles for the type sprocket and type idler are attached to the upper plate. The type sprocket spindle is bolted, and is not adjustable. The type idler spindle is adjustable left to right within the limits of an oversized hole in the upper plate.

The type chain is placed in the type sprocket with the *9 0* type slug aligned to the keyway in the sprocket. The nine is aligned with the slot.

An oil-soaked wiper, fastened to the upper plate, transfers oil to the back of the chain.

The upper and lower plates position the type slugs in the vertical direction.

There are two characters per slug. Each slug is fastened to the type tape by a clamp. Screws at the top and bottom fasten the clamp to the slug.

The type tape is 0.003" thick, 0.200" wide, about 36" long, and has a plastic coating. The particular *X Y* type slug (or *7 8* with the numerical chain) that covers and clamps the overlapping ends of the type tape is 0.004" less in thickness than any other type slug. It is identified by a small dot between the *X* and the *Y* (or the *7* and the *8*).

Ribbon Mechanisms

- **The 1403 ribbon mechanisms provide for ribbon feed, ribbon reversal, and skew correction.**

Ribbon Feed

- **The ribbon feeds vertically behind the cartridge and the moving type arrays.**
- **It is fed by an electric motor through a system of gears and electromagnetic clutches.**
- **The feed mechanism can accommodate ribbons of two different widths.**

Description

Ribbon

The ribbon is a strip of inked fabric or plastic available in two widths: 11" and 14". It is attached at each end to a cardboard tube (spool). The tube has notches at each end to engage drive pins on the supporting plugs. Near each end of the ribbon, a reversing bar extends across its width and projects a short distance beyond each side. These extensions of the bar engage the reversing mechanism.

The width of the ribbon should be wide enough to

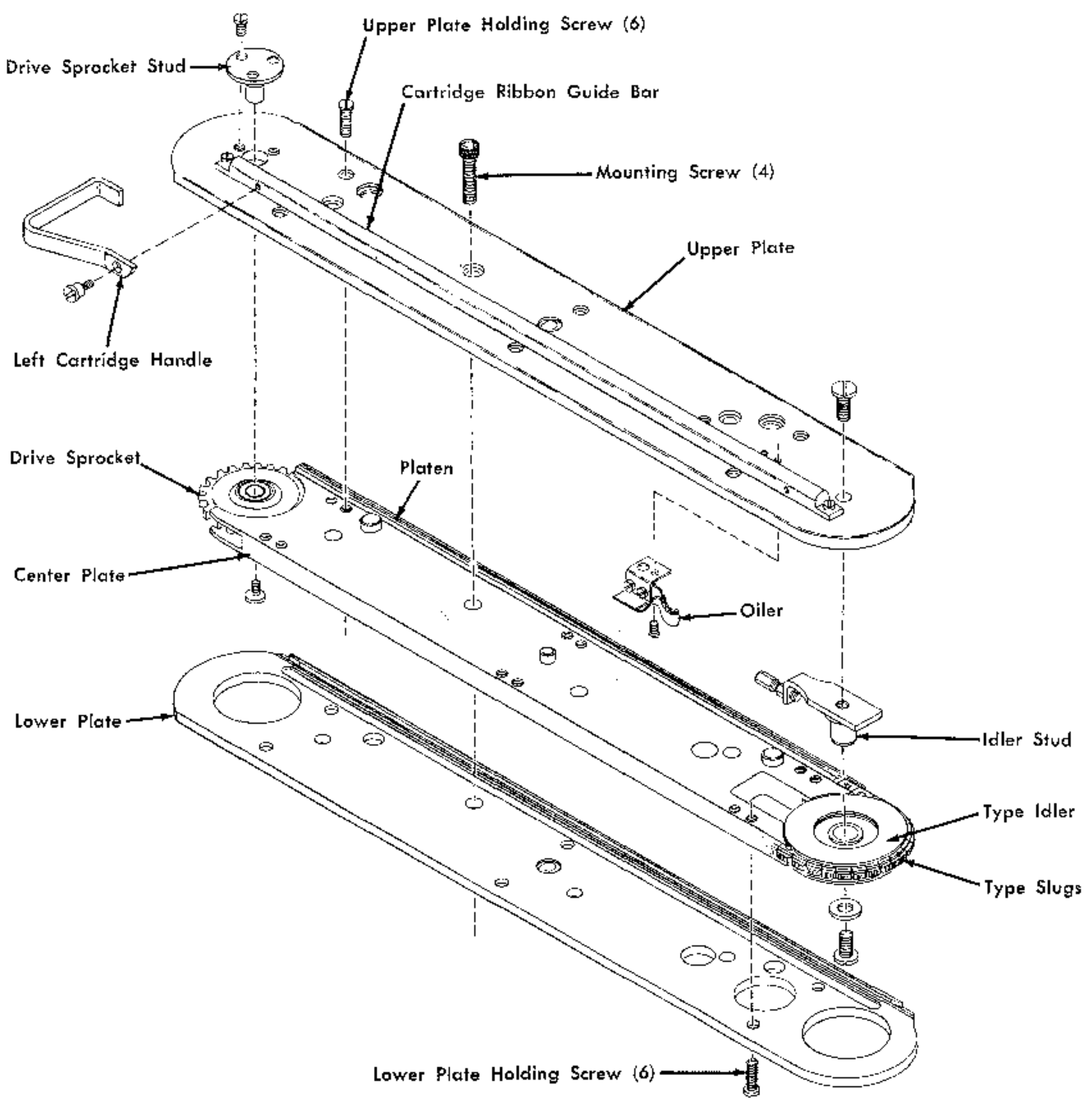


Figure 22. Type-Chain Cartridge Assembly

span the desired field of print positions. The ribbon is mounted on the ribbon feed mechanism and passes between the type-chain and the paper. When installing ribbons, install the full spool on the lower mounting hub and drive plug. This is because skew correction occurs only when the ribbon is winding onto the upper spool.

Ribbon Drive (Figure 23)

The ribbon drive (feed) mechanism is on the front of the T-casting. It has a left- and a right-hand component.

The left-hand component consists of two free-spinning idling hubs that support the ribbon tube (spool). The reversing mechanism T-lever and switch are between these idling hubs.

The right-hand component is a group of active assemblies on a slide. This slide can be moved laterally across the T-casting. It has a locking lever and notches in which the slide can be locked to accommodate either of the two ribbon sizes. The slide supports the ribbon drive motor, electromagnetic clutches, gear trains, and reverse drags. Also included on the slide is the ribbon-skew correction device. The gear trains and clutches transmit their motion to a pair of tapered plugs. These plugs support the right ends of the ribbon tubes (spools). Protruding pins on the plugs engage notches in the tubes to prevent slippage as the plug drives the ribbon spool.

On Models 1, 2, 4, 5, and 6 the ribbon mechanism runs continuously, feeding the ribbon as long as power is on, and the T-casting is closed.

Motor

The motor is 20-rpm, single-phase and rated at 1/100 hp. It operates on 208v or 230v ac.

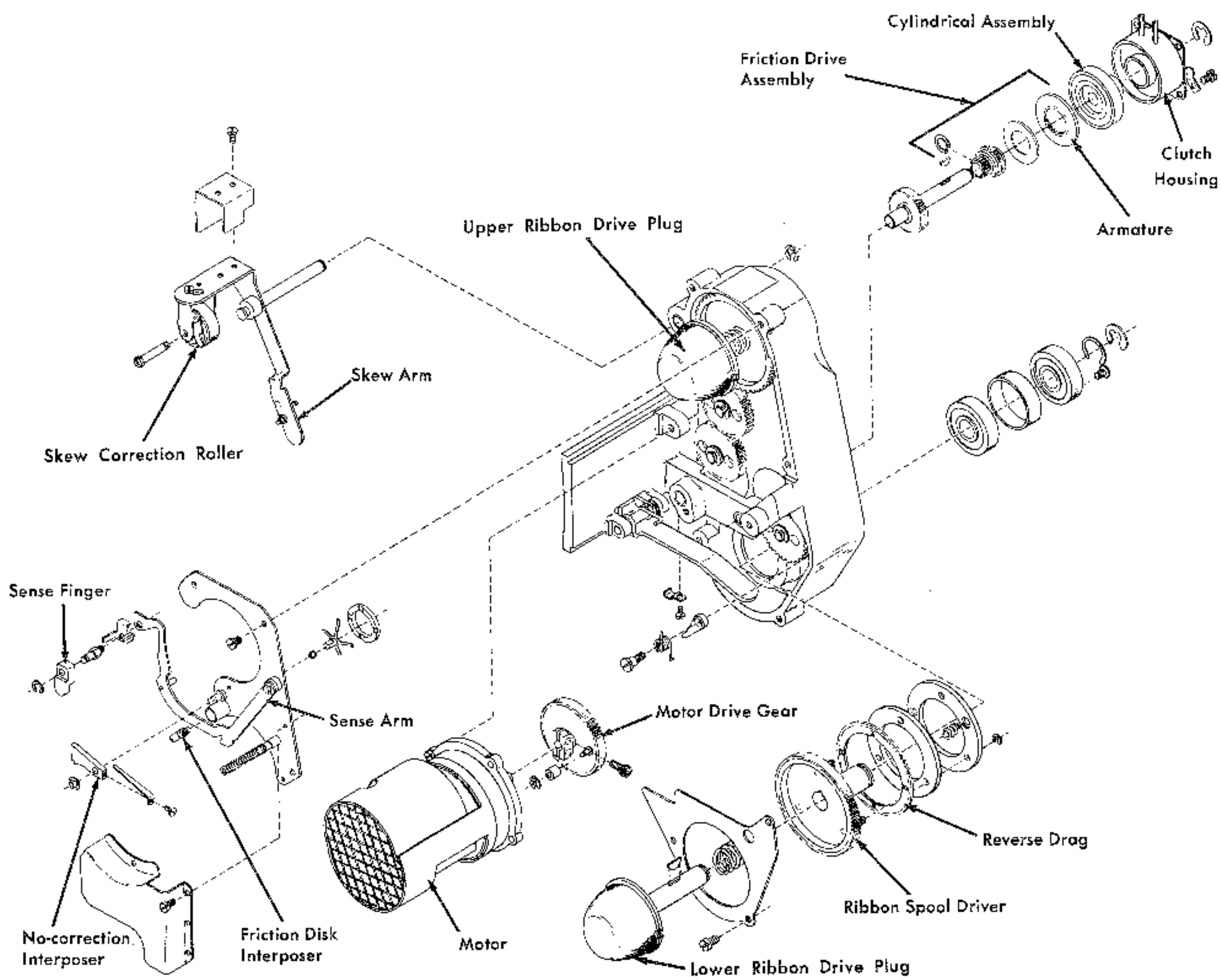


Figure 23. Ribbon-Drive and Skew-Correction Mechanisms

Clutches

Two friction clutches control the transmission of motion from the motor to the two spool drives. This control is exercised within the two gear trains.

Each clutch is composed of three basic elements:

1. A driven member. Consists of the drive-gear assembly.
2. A driving member. Consists of the cylindrical assembly.
3. An actuating unit. Consists of a clutch housing and a coil.

The clutch is engaged when the coil is energized. When engagement occurs, the drive gear assembly locks to the cylindrical assembly. This assembly is fastened to, and rotates with, the clutch shaft.

When the clutch is not engaged, the drive gear assembly is free to turn around the clutch shaft. A flat circular disk serves both as an armature and as a clutch face.

This face is driven by one end of the cylindrical assembly, which serves as the other clutch face.

Gear Train

The upper gear train for the ribbon drive is as follows: motor drive gear, upper clutch shaft, clutch, drive gear, *two* idlers (to cause opposite direction of rotation from that of the lower spool), and the upper ribbon spool driver.

The lower gear train for the ribbon drive is as follows: motor drive gear, lower clutch shaft, clutch, drive gear, *one* idler, and the lower ribbon-spool driver.

Reverse Drag

There are two reverse drags: one on each spool driver. The drag is effective when the spool driver is not driven (ribbon unwinding).

The spool-driver has two circular faces between which a nylon friction disk is held. Three helical springs force the friction surfaces together. The friction disk has teeth around its circumference, and a pawl rides along these teeth. When the spool driver is winding up the ribbon, the pawl rides up and over the teeth. When the spool driver is unwinding the ribbon, the pawl falls into a tooth and prevents the friction disk from turning. This causes a drag on the ribbon as it unwinds and turns the spool driver in the nondriven direction.

Skew Correction

- **Motion of the print chain causes ribbon skew.**
- **Skew is counteracted by the correction mechanism.**
- **Correction occurs only when the ribbon is winding onto the upper spool.**

Description

Skew Correction Mechanism

The correction for skew is made only while the ribbon is feeding onto the upper ribbon spool. To insure that the ribbon never skews toward the right, the left ends of the ribbon spools are closer to the rear of the printer than the right ends are. This offset tends to skew the ribbon toward the left. To provide some degree of control over this tendency, the left end of the upper ribbon spool has a limited adjustment, front to back.

The skew correction device pulls the ribbon to the right to a predetermined margin to prevent skew. A skew arm pivots on a shaft fastened to the casting of the ribbon feed mechanism. The lower end of the arm is spring loaded. The upper end holds the skew roller assembly, which (when lowered), rests on the ribbon. A ratchet on the skew roller prevents it from rolling unless the ribbon is feeding onto the upper roll. If the ribbon reverses during a correction cycle, the ratchet prevents correction.

The skew roller assembly can be set manually by changing the axis of the skew roller with respect to the left-right center line of the printer to provide the necessary degree of correction. The usual setting is 16°.

A roller (cam) on the motor-drive gear lifts the skew arm 20 times per minute. When the ribbon is feeding off the upper spool, a friction disk interposer is turned into engagement with a step on the skew arm. The friction disk interposer is turned by the upper clutch idler gear. This interposer keeps the skew arm raised and the skew roller away from the ribbon.

When the ribbon is feeding onto the upper spool, the friction disk interposer is turned out of engagement with its step on the skew arm. This action conditions the skew arm to drop and the skew roller to correct, if a correction is needed.

The need for correction is detected by a sense arm and a sense finger. The roller (cam) on the motor drive gear lifts the sense arm before it lifts the skew arm. When the sense arm is lowered, it rests on the sense finger.

The upper end of the sense finger pivots at the top of the sense arm. As long as the bottom of the sense finger is not resting on the ribbon, it holds the sense arm in the raised position. With the sense arm raised, a stud on the arm pivots a no-correction interposer (by spring action) away from the skew arm allowing this arm to drop and the skew roller to correct.

However, if the sense finger rests on the ribbon, the bottom of the sense finger is moved so that the finger no longer supports the sense arm. The sense arm drops, allowing the no-correction interposer to engage the skew arm. Engagement occurs as the roller raises the skew arm by the roller on the motor drive gear. The correction roller is held above the ribbon, and no correction is made.

The spring on the no-correction interposer allows the sense arm to be raised even though the no-correction interposer is engaged. At 20 rpm, correction can occur every three seconds.

The ribbon should be installed with the full spool on the bottom spindle. This is because correction for ribbon skew is made only when the ribbon is feeding onto the upper spool.

Ribbon Reversal

- **Ribbon reversal is obtained by switching electromagnetic drive clutches.**
- **The reversing switch is actuated by a T-lever and a metal bar built into the ribbon.**

The method of ribbon reversal is very simple. The mechanism consists of a T-lever and a microswitch (Figure 24). The steel reverse bar contacts the T-lever and overthrows it, due to its toggle action. This motion transfers the contacts in the microswitch. The wiring of the switch is such that the electromagnetic clutch that is winding the ribbon stops, and the clutch that was idle is energized. This winds the ribbon in the opposite direction.

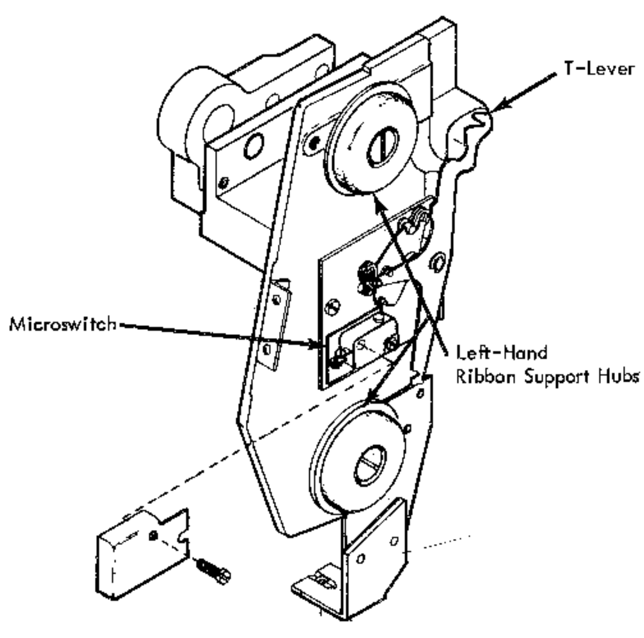


Figure 24. Ribbon-Reverse Mechanism

Hammer Unit

- **The hammer unit includes the:**
  Print magnets,
  Armatures,
  Hammers,
  Impression control pad.
- **The unit is mounted in slots in the sides of the translator frame.**
- **CE service rails provide easy access to the hammer unit.**

The hammer unit (Figure 25) slides into the translator frame from the rear. It slides in slots, which guide and align it. Adjustable stops on the hammer unit position this unit in the translator frame so that the hammer clearance to the type chain is correct (0.083″) at density setting *C* (on Models 1, 2, 4, 5, and 6).

In the restored position, the hammers rest against the magnet armatures, which in turn rest against the backstops. When a hammer is fired, the armature tip moves the hammer for the first 0.042″ of the total ham-

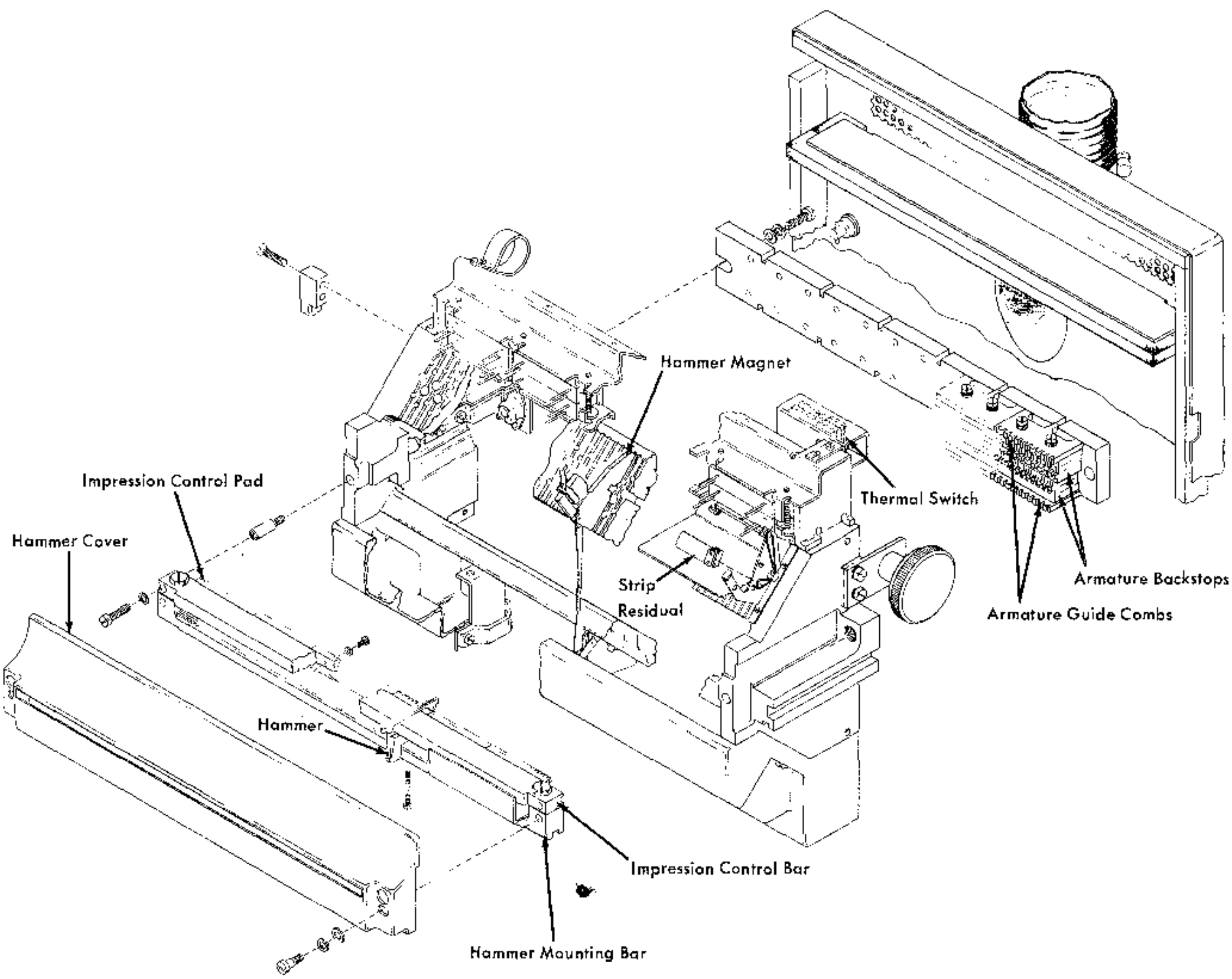


Figure 25. Hammer Unit

mer travel. At this point, the armature seals. If single-part forms are used, the hammer must travel about 0.075″ before it strikes the paper and the type. At the point where it has traveled about 0.042″, the hammer has received all of its energy from the magnet armature. Thereafter, it travels under its own momentum. When it has traveled 0.055″, it contacts an impression-control pad. Any additional travel beyond this point compresses the pad.

For single-part forms, the pad is compressed about 0.020″. If thicker forms are used (more parts), the pad is compressed correspondingly less, and more energy is absorbed in printing.

Forms of different thickness require different amounts of energy from the hammer to produce the same density of print impression. The pad is designed to absorb from the hammers all energy in excess of that required to print with a given density regardless of forms thickness (within the maximum form thickness specified for the printer).

To control the density of printing, move the type cartridge in relation to the hammer unit. This changes the length of hammer travel after it contacts the pad. (See the section *Print Density Control Lever.*) A thermoswitch is in the hammer unit at the upper right.

Description

Armature Backstop

As an armature rebounds after firing a hammer, an armature backstop (metal facing bonded to rubber), absorbs the energy in the armature and stops it in time to refire.

Hammer-Magnet Armatures and Guide Combs

From the hammer magnets near the top and bottom of the hammer unit, the armatures extend to the center of the unit, at the front, where the hammers are mounted. The front edge of each armature (near its tip) is aligned with a hammer. Two sets of guide combs (one for the upper bank, and one for the lower) keep the armatures aligned to the hammers. The hammers extend to the vicinity of the print line.

Hammers and Impression Control

Each end of the hammer is supported by a flat spring, and two hammers (side by side) are supported as an assembly on one base. The bases are fastened to a mounting bar, which is bolted to the impression control bar. The flat springs allow each hammer to move in a horizontal line toward and away from the type array.

The hammers have two steps on their underside, one at the front and one at the rear. Under the hammers, and between the two steps, an impression control bar is fitted. As a hammer is fired, the rear step engages a rubber pad on the bar and compresses it. The thickness of the forms printed determines how much the pad is compressed. The pad compresses slightly for thick forms, more for thin forms. The impression control bar is bolted to the front of the hammer unit.

Hammer Magnets

The unit has an upper and lower bank of hammer magnets. Odd-position magnets are in the lower bank, with position one at the extreme left.

Note: Upper and lower magnet-armature assemblies are different and cannot be interchanged.

Each magnet assembly is fastened individually to its support bar in a vertical plane. Each has a slot in its base to receive the special, eccentric tool that adjusts the armature-to-core air gap. The air gap is set to provide each hammer with the same energy and flight time. The time required for a hammer to impact is about 1.52 milliseconds (ms). Remember that the type moves 0.001″ in 11 microseconds (μs). Each bank of magnets has a common plastic residual strip.

Blower

A blower cools the hammer unit. The blower is bolted to the left side of the cover frame, at the top. The blower motor extends to the rear. Air enters through openings in the left side printer cover and passes through an intake filter to the blower. Air from the blower passes through a flexible hose that goes through an opening in the rear cover of the hammer unit. Here it circulates throughout the unit, cooling the print magnets. The air exhausts at the bottom of the unit.

Service Rails

CE service rails can be bolted to the rear of the translator frame to support the hammer unit while the hammer unit is removed for inspection or servicing. The rails are stored inside the machine when not in use.

The quick-disconnect electrical connections to the hammer unit do not have to be disconnected when the rails are used.

Decals are provided to identify:

1. Hammer magnets.
2. Hammer magnet leads in the quick-disconnect plugs.

Acoustical Dampening Device

To minimize noise, an acoustical dampening device is attached to the T-casting in the swing-pan area. In Models 1, 2, 4, 5, and 6 this is a hinged brush that spans the paper below the print line and prevents noise from traveling down the form. It is for use only with single-part forms, and should be rotated out of position when multiple-part forms are used. Refer to the 1403 customer engineering reference manual for adjustments.

Manual Controls

- **Manual controls are knobs and levers that permit mechanical adjustment of the machine by the operator.**

Description

Most manual printer controls are accessible with the front cover raised. Each control is discussed. For controls that specifically relate to the carriage and forms handling, see the *Hydraulic Carriage* section.

Lateral Print Alignment Lever

This lever permits the entire printing mechanism to move horizontally with respect to the form. When the lever is raised, the translator frame is unlocked and you can position it horizontally within its travel of 2.4".

Lateral Print Alignment Vernier

This vernier aligns the printing to the vertical columns on the form after you make an approximate setting, using the lateral print alignment lever. The vernier provides a fine adjustment to the position of the translator frame.

Print-Timing Dial

The print-timing (Figure 26) dial moves the read head in relation to the timing disk. This movement changes the starting time of hammer-firing to compensate for hammer flight time and type movement. It allows each hammer to impinge the ribbon and paper on the type at the instant that the type is in exact alignment with a hammer.

Print-Density Control Lever

The hammer unit adjusts automatically for different thicknesses of forms. However, a print-density control lever permits vernier control of print impression. When this lever is set at *E*, print impression is light. When this lever is set at *A*, print impression is dark. *C* is considered the normal setting. The lever moves the type cartridge closer to or farther from the hammer unit. Total movement is about 0.016".

Note: You must consider the setting of this lever together with forms thickness to determine the average setting of the-print timing dial.

Print-Line Indicator and Ribbon Shield

The ribbon shield is also a print line indicator. It pivots on the axis of the T-casting. Refer to the *T-Casting* Section.

T-Casting Lock Lever

The T-casting lock lever on the left end of the T-casting holds the T-casting and type chain in printing position. Push the lever in to lock the T-casting. When unlocked, it allows the T-casting to swing open for

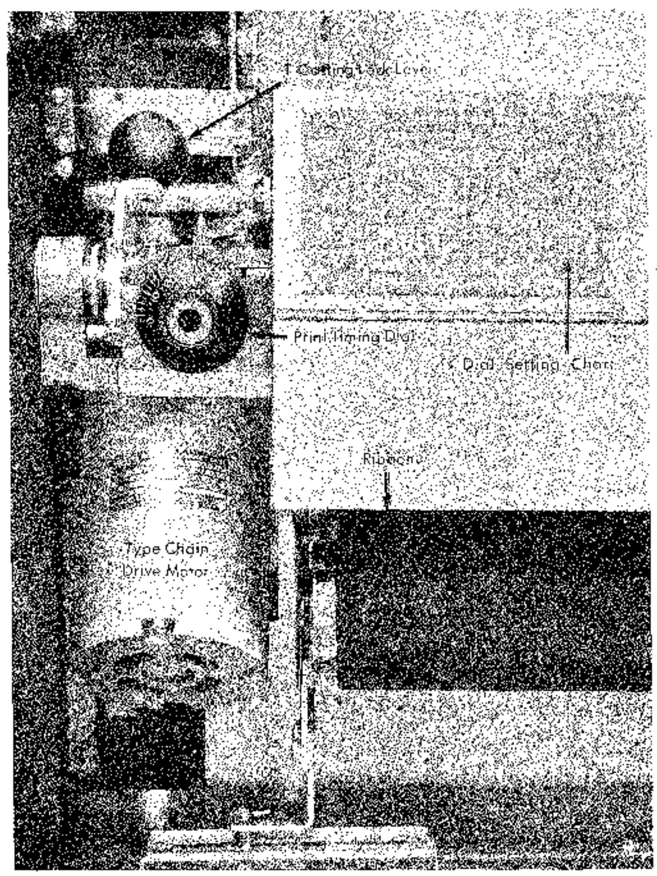


Figure 26. Left Front View of T-Casting

access to the forms. A mechanical interlock prevents this lever from locking if the T-casting is not fully closed. When the lever is not locked, the gate interlock switch contacts (01.07.1) are in the normally closed position. This lights GATE INLK and prevents the chain and ribbon motors from operating.

Vertical Print Alignment Knob

This knob is at the lower right front of the translator frame. It allows the print line to position vertically with respect to the form.

The knob is geared to a sector which turns a horizontal shaft in the translator frame. Two eccentrics on the shaft support the translator frame on two vertical translator slides. The slides are fastened to the translator frame in such a manner that only vertical relative motion is allowed between the slides and the translator frame. When the translator frame is moved horizontally, the frame and slides move as a unit on rollers at the bottom of the slides. (See *Lateral Print Alignment Lever.*)

Electrical Controls and Lights

- **Electrical controls and lights permit the operator to change and observe the operational status of the machine.**

Description

The electrical controls are on a panel at the left front of the machine, on the rear cover, and inside the front cover at the lower right (Figure 27).

For the Carriage Controls, see *Electrical Carriage Controls and Lights.*

This section describes briefly the controls and lights that can be used in the printer in any given system. More specific details of these controls and lights must be obtained from the manuals of instruction for the system that uses the printer.

Start Key

This key places the printer under the control of the system to which it is attached. The remote start key performs the same function and is located at the rear of the printer for operator convenience.

Either key (01.06.1) causes the +U start-key line to go from floating to ground, the +U not-start-key line to go from ground to −12V, and the −T run-mode line to be commoned to the −T start-relay line.

Check Reset Key

This key resets a printer error condition, or (in some systems), conditions the printer for operation after the carriage stop key is operated.

This key (01.06.1) causes the +T check-reset line to shift from −12V to +6V. This line can be used to reset error latches in the printer error-detection circuits of the system.

Stop Key

This key causes printing to stop at the end of the line being printed. The remote stop key performs the same function.

The two keys operate in parallel (01.06.1). Either one causes the −T stop-key line to go from floating to −6V. This provides a signal which may be used to stop operation of the process unit.

Single-Cycle Key

Pressing this key starts operation of the printer for one print cycle. This operation overrides the forms interlock switch until a hole in channel 1 of the carriage tape is sensed. This allows printing to progress until the form in process is completed, and a skip to 1 is accomplished.

The single-cycle switch (01.06.1) causes +6V (through a 560-ohm resistor) to shift from the −T single-cycle line to the +U single-cycle line.

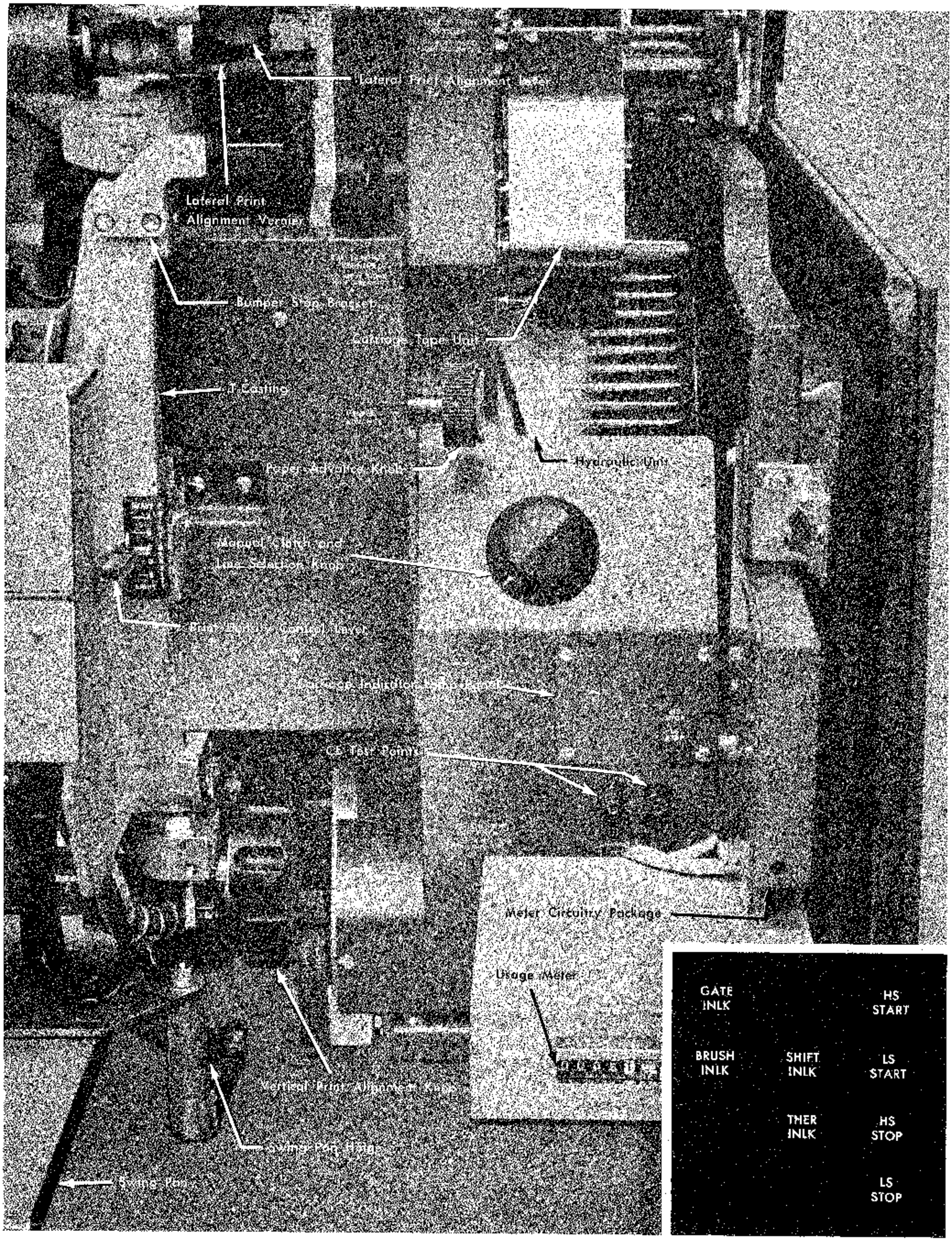


Figure 27. Right Front End of Printer

Print Ready Light

This light indicates that the printer is in condition to print and that all error-detecting devices are reset.

The +U ready-ind line (01.06.1) from the system lights this light when the chain motor is up to speed and the printer is ready to start. The light is returned to −12V.

Print Check Light

This light indicates a print error.

The +U print-check-ind line (01.06.1) from the system lights this light if an error occurs in any of the print control circuits. The light is returned to −12V.

Sync Check Light

This light is turned on by the +U sync-check-ind line (01.06.1) from the system to show that the chain was not in synchronization with the compare counter for the printer at some time during a print operation. The timing is automatically corrected. To turn the light off, press the check reset key.

Gate Interlock Light

GATE INLK indicates that the T-casting is not locked in position. A gate interlock switch (01.07.1) controls the −60V to the chain and ribbon motor relay. The gate interlock contact transfers when the T-casting is properly locked. When the contact is normal, the gate interlock light lights.

Thermal Interlock Light

THER INLK indicates either the chain motor thermal or hammer unit thermal has operated because of an over-temperature condition. When this occurs, fuse 14 or 15 (01.07.1) requires replacement.

Theory of Operation

Mechanical Principles of Printing

- **Printing consists of forcing the paper and ribbon against a continually moving type chain.**
- **The motion of the type-chain produces constantly changing relationships of time and distance.**
- **These relationships involve the speed of the chain and the physical sizes of the print hammers and the type faces.**
- **They develop a repetitious pattern of timing sequences that must be suitably controlled by the system.**

Printing consists of forcing the paper and ribbon against the type faces (Figure 28). This is a mechanical operation performed by mechanical units. The units involved are the type-chain cartridge and the hammer unit. The hammer unit contains the print magnets, armatures, and hammers. An impression control pad to regulate the print impression quality runs the length of the hammer unit. It is straddled, front-to-back, by the duplex print-hammer assemblies. Its function is explained in the *Hammer Unit* section.

As the print magnet is energized, it attracts its associated armature. (The long end of the armature normally is in contact with the back end of the hammer.) When attracted, the armature partially rotates on its pivot, and drives the hammer, paper, and ribbon against the typeface. The typeface is one of two per slug in the arrays of the type chain. If the character aligned to print is the one desired, the hammer fires.

Each hammer must be able to print any character on the chain. The motion of the chain, together with the physical sizes of the hammer and type faces, produces a pattern of changing relationships. This pattern is repetitive, and the relationships vary at a constant rate. These relationships can be reduced to two, in which the hammer unit is the common element:

1. Chain (typeface) to hammer sizes (distance).
2. Chain (typeface) to hammer movement (time).

These relationships result in a definite sequence of printing that is inherent in the printer and that must be matched by appropriate controls in the system.

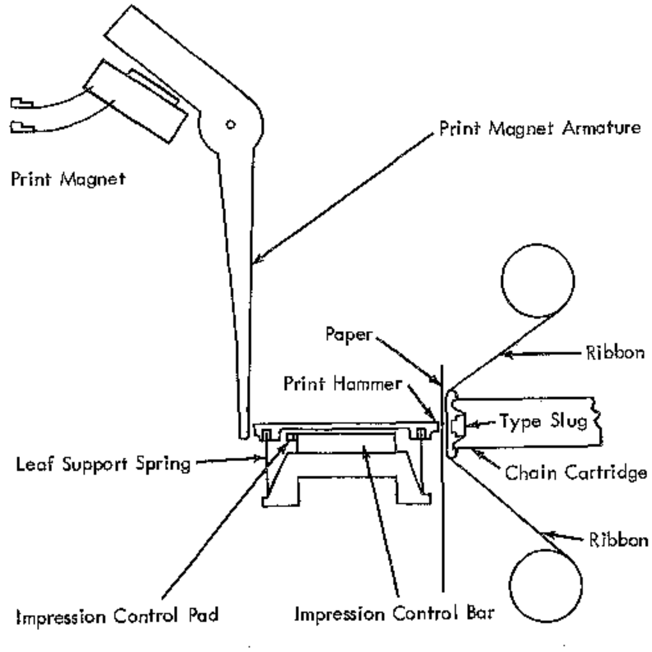


Figure 28. Mechanics of Printing

Printing Sequences

- **Printing is performed serially as every second character becomes aligned with every third hammer.**
- **A subscan is the time required to option one third of the print positions.**
- **A print scan (3 subscans) is the time required to option all print positions once.**
- **Print options always start with subscan 1, when some character is aligned with hammer 1.**
- **The alignment of type character 1 (digit 1) with print position 1 (hammer 1) is called the home position of the chain. This is the first option after the home pulse.**
- **A complete print line requires 49 scans. The last scan is for checking purposes only.**

Printing takes place serially, one character and one print position followed by another character and another print position. Printing options always start when there is a character aligned with print position 1 (subscan 1).

To illustrate the operation, the home-position print scan (starting with the digit 1 aligned with hammer 1) is explained. At this time, the character in storage (that it is desired to print) is compared with the character that is aligned to print. If the characters are identical, hammer 1 fires and prints the character 1. During this first storage cycle, the chain has moved only enough to align the third character with print position 4. The comparison is again made of the character that is in storage to be printed and the character that is aligned with position 4. If they are identical, the character (3) prints. If not, the hammer does not fire. Again, the motion of the chain during the print cycle is sufficient only to align the fifth character (5) with print position 7.

This slight creep of the chain establishes the sequence of printing: every third hammer, every second type-character. This sequence continues until, at the 44th cycle, the character C is aligned to print at position 130. These 44 print cycles, in which every third hammer from position 1 through 130 are optioned to fire, is called *subscan 1.*

At the end of subscan 1, the total chain movement is enough to align the second character in the chain (digit 2) with print position 2. Printing now starts at position 2, and proceeds with every third hammer, every second character until the character D aligns with print position 131. This sequence, starting with print position 2, is called *subscan 2.*

The total chain movement to this point is enough to align the third character (digit 3) with print position 3. Again, printing takes place every third print position and every second character until the character E aligns with position 132. This sequence, starting with print position 3, is called *subscan 3*. At the end of this subscan, the total chain movement has aligned the second character in the array (digit 2) with print position 1. The combination of subscans 1, 2, and 3 is called a *print scan.*

It is now apparent that during one print scan (3 subscans) each of the 132 hammers is optioned to print one character. Only those hammers that have the correct characters aligned are fired.

These print subscans are based on the home position of the chain; That is, with digit 1 aligned to print in position 1.

Now the second character is aligned with print position 1, a new print scan begins, optioning each of the 132 hammers to print a second character. Since there are 48 different characters in the array, as many print scans are required to option all the print positions to print every character.

Much time would be wasted if printing always started at the home position, as the system would have to wait for the chain. In the interest of time, printing can begin when *any* character in the array is aligned with position 1. This is the definition of *subscan 1,* with which all printing starts. The sequence of printing always remains the same: every third hammer, and every second character, starting with subscan 1, followed by subscans 2 and 3, and repeating until 49 print scans are completed. These are the conditions which the control circuits in the system must meet.

Thus, with the 132-position alphamerical printer, there are 48 × 132 or 6,336 possible print selection times. When the numerical print feature is used, there are 16 × 132, or 2,112 possible print selection times. In both cases, only 132 of these are used to print a line. Print selection times are also called *options to print.* During each of these times, the character aligned to print is compared with the character in storage that is supposed to print. If it is the same, it prints. This comparison, or option to print, is also a function of the system, and it must be performed by circuitry within the system. Of these options to print, one and only one is used to select each print position in which a character is to be printed. This use is called *allocation of a print time to a print position* and causes the hammer to fire. It occurs when the character to be printed is aligned for printing in the selected print position. An extra print scan, during which no printing takes place, is taken for checking purposes.

Hammer Unit to Type-Chain Size Relationship

- **The hammer unit to type-chain size relationship is one of distance, based on the physical dimensions of the hammer and typefaces.**

The size and spacing relationships of the print hammers and type faces are shown in Figure 29. The 1403 Model 2 is designed to operate on a print cycle of about 11.1 μs, based on these relationships and the speed of the chain.

The distance between the first and last (100 or 132) printing position is called a *line span*.

The distance between adjacent print positions (hammers) is called a *print scan*. This distance is 0.100".

The distance between adjacent typefaces along the type chain is called the *type span*. Nominal type span is 50% greater (0.150") than the print span, but actual type span is about 0.1505". This slight increase over the nominal length of the type span is due to the motion of the chain. The chain moves about 0.001" in 11.1 μs. This 11.1 μs period is the basic timing interval around which the operation of the printer is designed. It represents the print selection time (option to print) allowed by the printer for storage investigation, and for checking to determine whether an aligned character should print.

Nearly two aphamerical type arrays are required to span the entire print line. If the printer is to print all A's (or the same character in all print positions) and if position 1 has just printed, position 73 is the next position to print. After print position 1 receives a print time allocation to print the A in the first type array, one option to print occurs before the C in the first type array becomes aligned for printing in print position four; two options occur before the E in the first type array becomes aligned for printing in print position 7; and twenty-four options occur before the A in the second type array becomes aligned for printing in print position 73.

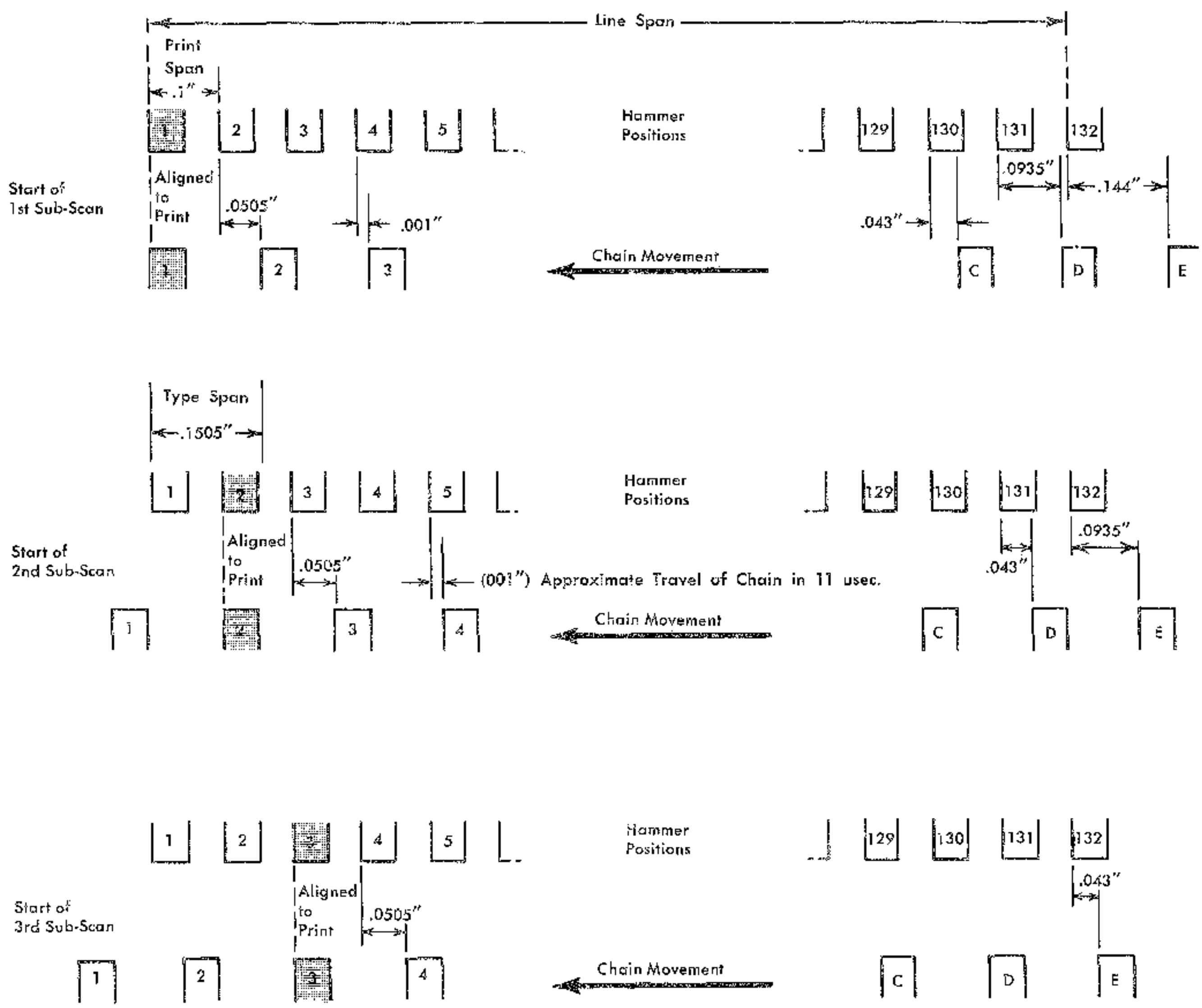


Figure 29. Schematic of Type Movement in relation to Print Hammers

Hammer Unit to Type-Chain Movement Relationship

- **The hammer unit to type-chain movement relationship results in a progressive pattern of printing options.**
- **Based on the hammer unit to type-chain size relationships, this pattern produces two definite printing sequences.**
- **The sequence of hammer firing is every third hammer.**
- **The sequence of typeface selection is every second character.**

The movement of the chain, and the sizes and spacings of the typefaces and print hammers, produce a constantly changing relationship. This progressive relationship gives every hammer an opportunity or option, to print every character in the array.

These relationships of size, spacing, and chain motion are part of the physical design of the printing mechanism. They produce a sequence of printing which is: every third hammer, every second type character.

Before the development of these sequences can be explained, these timing references should be understood:

1. The time required for the type to move one-half of a print span is called a *sub scan.* The time required for three subscans is called a *print scan.* The first subscan starts when a type is aligned with the first print position. The second subscan starts when a type is aligned with the second print position. The third subscan starts when a type is aligned with the third print position. A print scan consists of a first, second, and third subscan.

2. During each subscan, one-third of the hammers, each in progressive sequence, are optioned to some character in the type array at 11 μs intervals. At the end of a print scan, each of the hammers will have been optioned to a character in the type array.

3. With the standard alphamerical type array, at the end of 48 print scans, all of the hammers will have been optioned to a complete type array. Therefore, 48 print scans are required to print a line.

4. With the optional numerical print feature, at the end of 16 print scans, all the hammers will have been optioned to a complete type array. Thus, 16 print scans are required to print a line.

5. Printing is started only at the beginning of a first subscan. During printing, the subscans are identified and the print scans are counted (by the system).

6. For the printing rate of 600 lines per minute, a sub scan is 555 μs, a print scan is 1665 μs, and a print line is about 80 ms. For the printing rate of 1285 lines per minute with the numerical print feature, the subscan and print scan durations are the same as for the standard machine. However, a print line is about 27 ms. At either printing speed, the type is moving at 90.3″ per second. During a subscan, 484 μs are required to provide an option to print for the 44 positions scanned (44 times 11 = 484). Normally a clock in the system is started at the beginning of each subscan. It is stopped in each subscan after all 44 positions scanned (for 132-position print line) have had an option to print. This allows the system and the printer chain to be resynchronized for each subscan. By this means, any slight difference in the relation of the hammer unit to the type array is corrected for each subscan.

Description

The chain, moving at 90.3″ per second, travels about about .001″ in 11 μs. Using this data and the relationship of print span to type span, we can plot a theoretical location of type in relation to hammers. Actual locations may differ slightly, but we can reconcile any actual differences after each subscan by resynchronizing the system to the chain.

The schematic shows the relation of the chain to the hammers at three specific points in time. These reference points are the beginning of each subscan for one entire print scan. For this discussion, assume an alphamerical (standard 48-character) chain and 132 print positions.

Note: The sizes and spacings are exaggerated in the illustration. Actually the print positions are adjacent, and the dimensions are theoretically as indicated.

	Print Option	Cumulative Chain Movement	Storage Location Addressed	Character Optioned if Present	Hammer Position
First Sub-Scan	1st	.000″	201	1	1
	2nd	.001″	204	3	4
	3rd	.002″	207	5	7
	44th	.043″	330	C	130
Re-Sync		(Add .0075″)			
Second Sub-Scan	45th	.0505″	202	2	2
	46th	.0515″	205	4	5
	47th	.0525″	208	6	8
	88th	.0935″	331	D	131
Re-Sync		(Add .0075″)			
Third Sub-Scan	89th	.101″	203	3	3
	90th	.102″	206	5	6
	91st	.103″	209	7	9
	132nd	.144″	332	E	132

Figure 30. Chain Movement (One Print Scan)

Figure 30 presents an analysis of chain movement for one complete print scan (three subscans). The additional chain movement (that is, movement in excess of .001″) between subscans represents the interval of time that the system is waiting for the printer. This movement amounts to about .0075″ and represents about the difference between the 555 μs interval of print subscan (PSS) pulses and the 484 μs subscan time.

Assume the storage positions of the system (that are optioned to print) are 201-332, inclusive.

Note: This is a hypothetical situation, and no specific characters are assumed to be in storage. Figure 30 shows what character *could* print at a specific time if it *were* in storage.

To summarize: In order to print one line of information, each hammer must be given the option to print all 48 (or 16) characters. It takes three subscans to have all 132 hammers optioned to print one character. Three subscans are called one print scan. It takes 48 print scans (16 with the optional numerical feature) to make one print line. It takes 144 subscans (48 with the numerical feature) to make one print line. It takes 6,336 print options (2,112 with the numerical feature) to print a line of information.

Type Arrangement

The standard alphamerical type chain contains five identical type arrays of 48 characters each. The optional numerical type chain contains fifteen identical type arrays of 16 characters each. Within each array, the characters are grouped in sequence by the modified BCD character bit values. This arrangement facilitates identification of characters as the type becomes aligned with the various print positions.

Within the array there are two type characters per slug, and the slugs are fastened to a steel tape to form an endless chain one character high and 240 characters long (Figure 31). The type and tape move continuously along the print line from the highest-numbered print position (132nd) toward the lowest-numbered print position (1st). The type is exposed to the hammers along the print line.

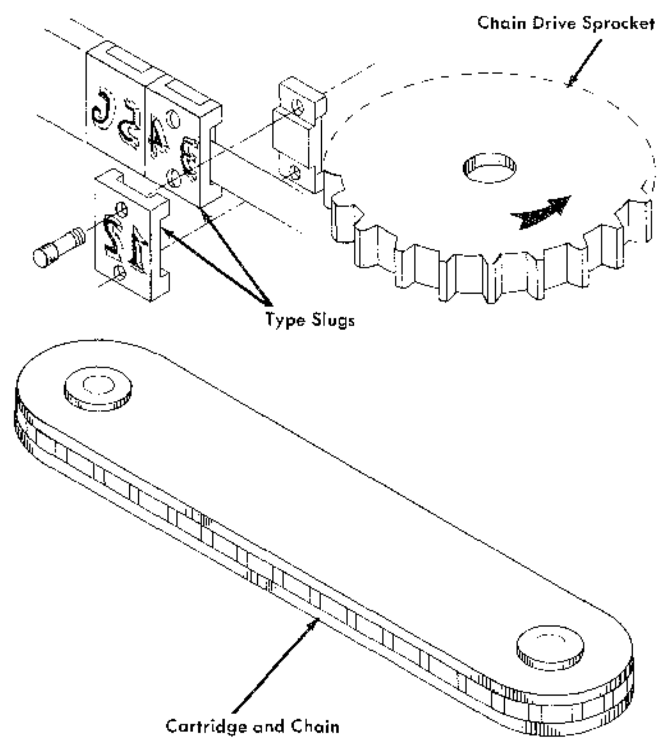


Figure 31. Schematic of Chain, Cartridge, and Slugs

Electrical Principles of Printing

- **The print control circuits in the system must match the mechanical operation of the printer.**
- **The chain timing pulses are the only coordinating signals supplied by the printer. All other print control signals must be developed by the system.**
- **Based on these signals, the system fires the hammers in the printer.**

This section deals only with the circuit requirements of the printer. Each system meets these requirements in its own way. The number and names of counters, registers, or other devices used to meet these requirements, varies with the type of system. In general, the methods used by the different systems are similar.

The circuitry required of the system must take into account the inherent sequences of the printer design: every third hammer, every second type-character.

Three things must be known to print intelligible information:

1. *What character can print.* The specific type-character within the array that is aligned with some hammer, ready to print.
2. *Where the character can print.* The number of the specific print-hammer position with which the type-character is aligned.
3. *If the character should print (compare equal).* Is this aligned character the same as the character in storage that should print in this position?

This first two requirements involve a method of keeping track of the print-hammer to type-character relationship. The third, at any given print time, requires some sort of comparison between the character that is aligned to print and the character in storage that should print in this position. This is known as print compare. When these characters match, the result is a compare equal.

Compare equal is a necessary condition for firing the print hammer. The only clue provided by the printer to the system regarding the status of these relationships is a constant series of chain timing pulses. With only these pulses to go on, the system circuitry must provide for the correct timed firing of the print-hammers.

Timing Pulse Generation

- **A magnetic disk keyed to the type-chain drive generates timing pulses.**
- **These pulses identify the start of a subscan, when some type character is aligned with print positions 1, 2, or 3.**
- **They are known as print subscan (PSS) pulses.**

Description

Timing pulse generation is accomplished by a magnetic disk, a read head, read-head sense amplifiers, and appropriate circuits within the system.

A single-track, nickel-cobalt-plated disk is used for timing. Scribed slots divide the disk into magnetic areas. A head senses the external magnetic flux produced by the 144 equally spaced slots around the circumference of the disk. The slots identify the start of the subscans within a print line. The disk in the Model 2 makes one revolution, at 750 rpm, while one alphamerical or three numerical type arrays pass a given print position.

The read head has a laminated core and is positioned radially about 0.003" from the periphery of the disk. This can be adjusted to get the desired output. As each slot passes the read head, the change in flux in the core produces a small voltage (50 to 150 millivolts) in a sense winding on one of the core legs. This voltage is amplified, and a timing pulse is generated at zero crossover, the point where the output waveform crosses 0V. These pulses are known as print subscan pulses. They identify the precise time that some character on the chain is aligned to print with hammers 1, 2, or 3.

Home Position

An additional slot (145th) halfway between the 144th and the 1st identifies the next pulse as the first pulse, or home position. The type chain is timed in the machine so character 1 is aligned to print in the first print position when home position occurs. Thus, when the printer is running, the 1 is always aligned to print in the first print position at home position.

When the disk and type have been stopped, it is possible that the disk may be in such a position that, on restarting, the 145th and the first (rather than the 144th and the 145th) slots may be interpreted by the machine as identifying the home position. To avoid this error the print operation should be delayed by the system until the disk has made at least two revolutions.

Pulse Amplifier

Figures 32 and 33 show the circuits of the two sense-amplifier SMS cards in logic 01.08.1. The input to the amplifier is approximately sinusoidal and changes from maximum positive to maximum negative in 100 μs. A compensated push-pull circuit minimizes the effect of noise from high current surges in the rest of the machine. Figures 34, 35, and 36 are scope pictures of the read-head, sense-amp 1, and sense-amp 2 outputs respectively. The push-pull output of the sense amplifier normally drives a differential amplifier in the system, which produces a U line output from an emitter follower. The output shifts to a +U line at zero crossover. The amplifiers amplify and square off the shape of the pulses. Either the rising or the falling edges of the waveforms can be used by the system.

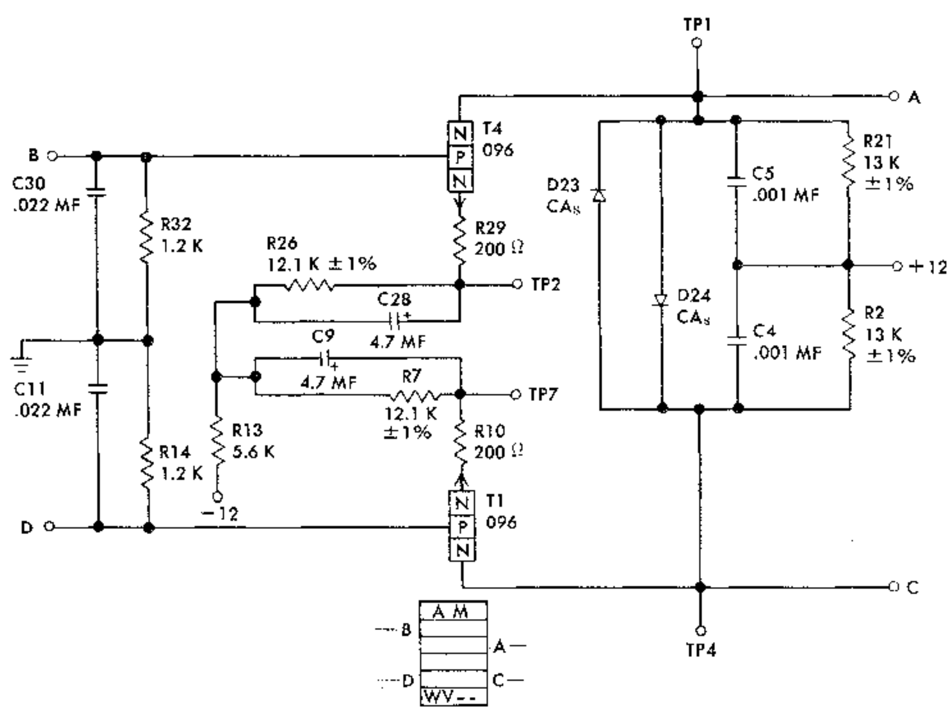


Figure 32. Alloy Sense Amplifier (Stage 1)

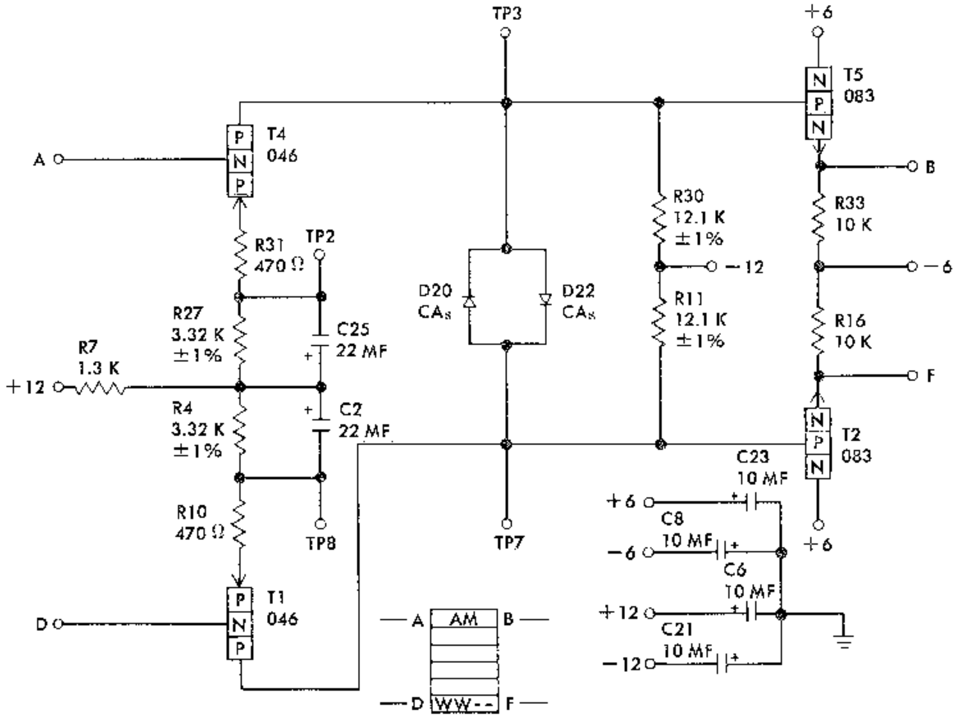


Figure 33. Alloy Sense Amplifier (Stage 2)

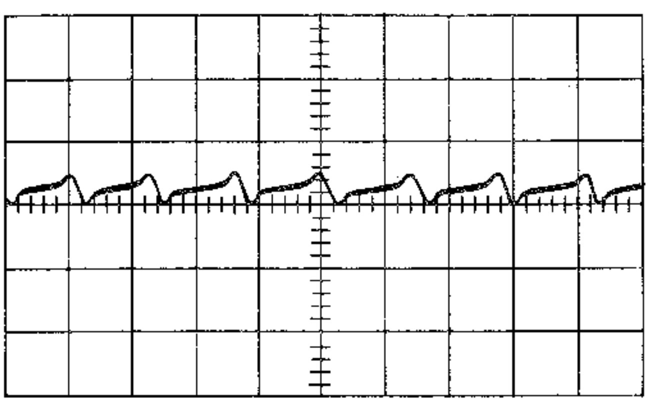


Figure 34. Read-Head Output

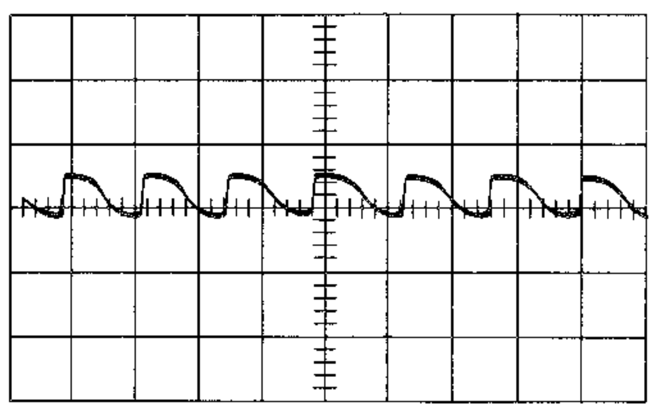


Figure 35. Stage 1 Amplifier Output

Circuit Requirements of the Printer

- **The control circuits in the system must fit the mechanical operation of the printer.**
- **They must meet the requirements imposed by this operation, and fire the hammers.**

The system must provide a way to keep track of the characters in the chain as they become aligned to print. It must fire the hammers only when the desired characters are aligned with them to print. Each system does these things in its own way. No attempt is made to describe any particular method. These methods are a function of the system, and are described in the system manuals.

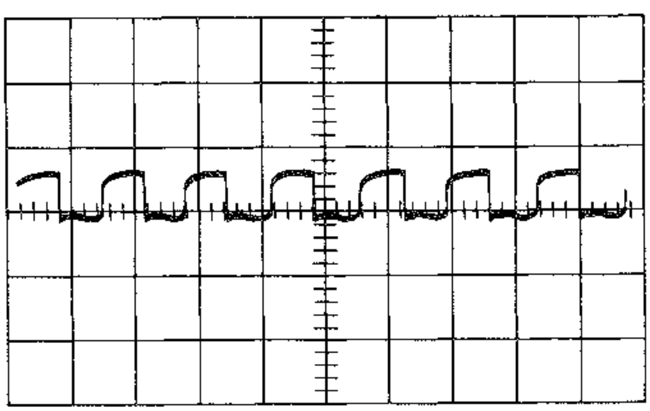
To help the reader understand some of the problems involved, however, a brief generalized description is presented of a typical method of meeting the requirements of the printer.

Circuit Objectives

Five circuit objectives are required by the printer of the system. Three involve a means of keeping track of the printing sequences. The fourth requires verification of the character to be printed, and the fifth controls actual hammer firing. In addition, the home pulse is used to indicate to the system when the digit 1 in the chain is aligned to print with hammer position 1.

Identification of the Specific Print Position with which a Character is Aligned

A counter, ring, or other device can be used by the system to identify the print subscan in progress at any instant. This device has different names and forms, depending upon the type of system. It contains positions, latches, triggers or other elements corresponding to each of the three subscans within the print scan. Thus, at the start of any subscan, the device identifies which of the first three print positions has a type character aligned with it for printing. This device is not concerned with the identity of the character. It is controlled by the PSS pulses emitted by the timing disk and read head.



VERT DEF : .05 Volts/Div (X10 Attenuator Probe)
HORZ DEF : 400 μs/Div
SYNC : Internal dc plus
TEST POINT : SA-2 Pin B
LOGIC : 01.08.1
COMMENT : Short Ground Lead
Connected to dc Ground, Pin J

Figure 36. Stage 2 Amplifier Output

Identification of the Type Aligned with a Print Position during any Subscan while Printing

During printing (once the first character eligible to be printed during a subscan has been identified), alternate characters within the type array become eligible to print in sequence at intervals corresponding to the storage cycle of the system. This progression continues until all of the 44 hammers to be selected during the subscan have had the option of firing. Some type of comparing circuits normally identifies the type character that is eligible to print at each print option. These circuits take various forms: counters, character generators, etc., depending upon the system. They must be able effectively to advance by two, when printing, so as to keep track of the alternate characters in the chain as they are optioned.

The placement of characters in the array in the ascending order of bit values lends itself to a counting arrangement. This arrangement, by counting by 2's, can identify the corresponding characters of the array by their modified BCD code values.

Identification of the Print Position Aligned with a Character during any Subscan while Printing

Printing is initiated only at the start of a print scan (on subscan 1). Therefore, the first position that has an option to print this is print position 1 followed by every third print position until subscan 1 is completed. Then print position 2 has an option to print followed by every third position until subscan 2 is completed. Next, print position 3 has an option to print followed by every third position until subscan 3 is completed. These three subscans constitute the first print scan. On following print scans, this order of scanning is repeated.

The information to be printed is placed in storage locations that can be scanned in the manner described. Circuits in the system control the selection of these storage positions until 49 (17 with numerical feature) print scans have been completed. Printing does not occur on the 49th (or 17th) scan but this print scan is necessary to complete checks made while printing. Thus, the print position that aligns with the type in position to be printed is identified during any sub-scan while printing.

Note: Because there is a known starting place, a known starting time, and a known scan pattern, the system circuits can identify the print position that has a type aligned with it at any given time.

Comparison of Character in Type Array to Character to Be Printed

To print the correct character in any position, the system circuits must detect when the type character aligned to a print position is the same as the character from the corresponding (print) storage position.

This can be accomplished by a system of bit registers or a compare matrix. The objective is to compare the bits of the character in the storage printing position with the bits in the device that is keeping track of the character aligned to print. If the bit structure of the two characters is the same, the hammer driver for that position is impulsed, and the character is printed.

Hammer Firing

The same addressing scheme that selects storage positions can be used to select hammer drivers in the driver matrix. A driver can be selected, but it is not fired unless an equal-compare condition exists. Because the chain is moving when printing occurs, all hammers must impact in the same amount of time. Variations in impact times produce print misalignment. The critical nature of this may be seen when you consider the fact that 1.52 ms (1520 μs) is needed for the hammer to hit the paper, and in 11 μs the type moves 0.001″ on the Model 2.

The hammer drivers in the system should produce a timed hammer-magnet impulse for about 1.1 to 1.5 milliseconds. About 5 amps are required to fire a hammer. The specific type of driver (switch core, latch, etc.) is discussed in the manual of instruction for the system to which the printer is attached.

Type Synchronization Check

The position of the type is checked by the system once during each passage of an alphamerical type array past print position 1. During this passage, print position 1 will have a type aligned with it 48 times. One of these times is identified as the home position. The type array is placed into the machine so that a 1 is aligned to print in position 1 at home position.

The circuits to keep track of the type must indicate that a 1 is aligned to print in print position 1 at home position. Any other indication is in error.

Hydraulic Carriage

General Information

- **The hydraulic carriage controls the passage of forms through the printer.**
- **It is a mechanical unit controlled electronically by the system.**
- **A control-tape unit provides communication between the carriage and the system.**

The carriage is an integral part of the printer. It is a hydraulically operated device that spaces and skips paper forms through the printer in response to commands from the system. The carriage can operate at two speeds: high and low. The system determines which speed is used. Spacing is always done at low speed.

Spacing is the line-by-line advancement of the forms. Any number of spaces can be taken, depending upon the programming and space-control circuitry of the system. Six or eight lines per inch can be printed, depending on the setting of the manual clutch and line selection knob. The carriage operates at a maximum speed of 35″ of paper per second at slow speed. At high speed, this rate is 75″ of paper per second.

Skipping is the smooth uninterrupted flow of paper through the printer. It is regulated by the carriage tape unit and the control circuits in the system. The amount of skip is limited only by the length of the control tape used. The maximum length of the carriage control tape is 22″ (132 spaces).

Physical Description

- **The carriage is a boxlike unit bolted to the right side casting of the printer.**
- **It is filled with hydraulic fluid in which the carriage drive mechanisms are submerged.**
- **A blower cools the unit with a constant stream of air.**
- **The carriage includes the pin-feed forms tractors and the stacking rolls.**

The carriage is bolted to the right side casting directly above its drive motor.

Figure 37 is an overall picture showing the carriage and forms tractors and their relative positions. In this picture the T-casting and print mechanisms are not yet installed.

The control-tape unit, blower forms tractors and associated mechanisms can be seen. These, together with the hydraulic unit, drive motor, and magnetic emitter, are the principal parts of the carriage. They are described in the next section.

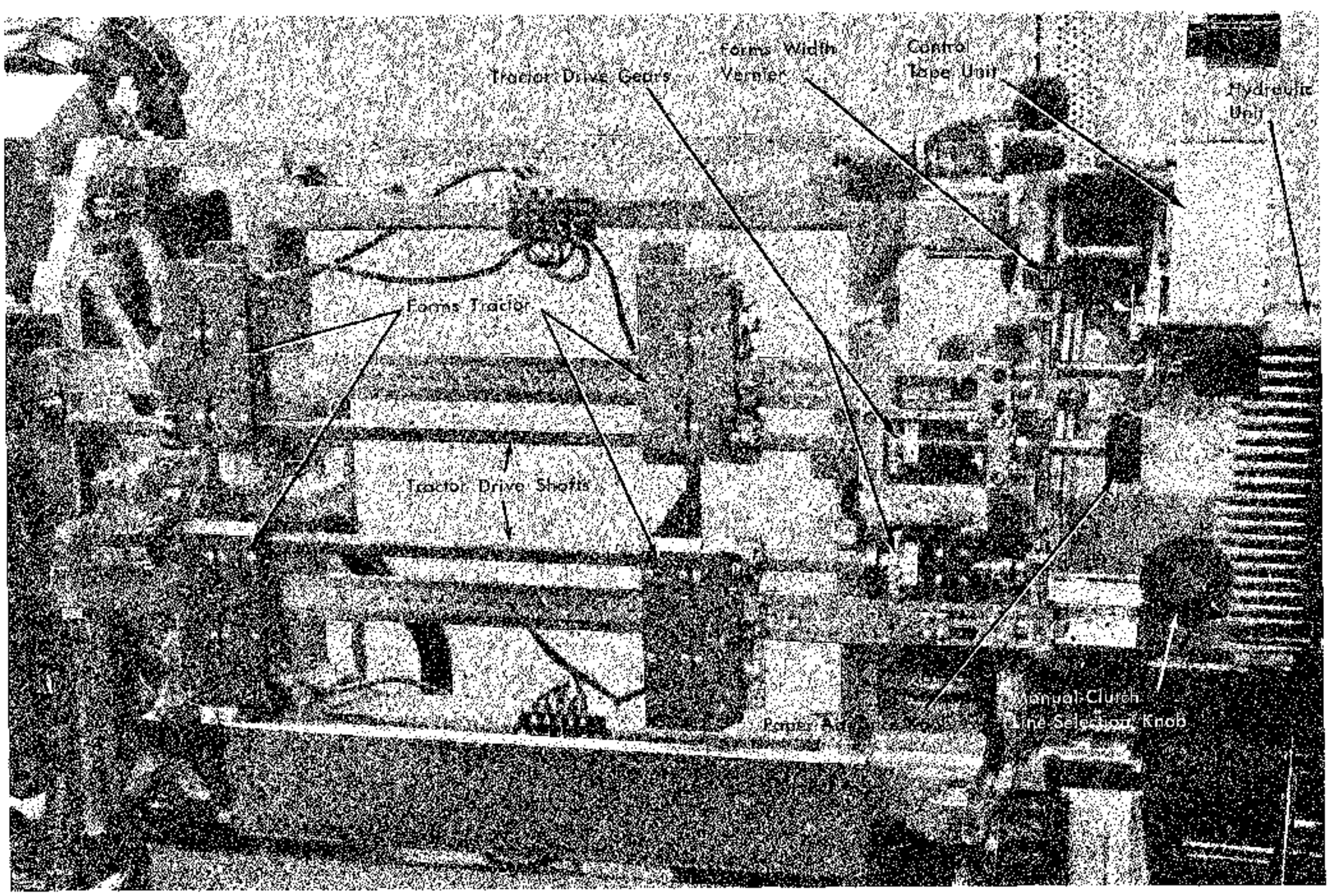


Figure 37. Hydraulic Carriage and Forms-Tractor Drive

Functional Units

Hydraulic Unit (Figure 38)

- **The hydraulic unit drives the forms tractors, control-tape unit, and the magnetic emitter.**
- **It is operated by valves controlled by the system.**

This unit is a self-contained, sealed mechanism that supplies the motion required for feeding forms automatically. Two input shafts, an output shaft, and control wires extend from this unit. Contained within the unit are the following items:

1. Hydraulic fluid oil (one gallon).
2. Space pump, driven by one input shaft.
3. Skip pump, driven by the other input shaft.
4. Hydraulic motor, integral with the output shaft.
5. Detent wheel and hydraulically operated, spring-returned detent to position the hydraulic motor at rest.
6. Space control valve, to open or block ports and control oil flow from the space pump to the hydraulic motor.
7. Skip (eject) control valve, to open or block ports and control oil flow from the skip pump to the hydraulic motor.
8. Space magnet which positions the space valve.
9. Skip magnet, which positions the skip valve.
10. Fine-mesh plastic filter, to screen particles over 0.002" from the oil flow to pumps and motor.
11. Alnico magnet, to trap magnetic material that passes through the filter.

The unit is on the upper right end of the printer above the carriage drive motor.

Drive Motor

- **The drive motor runs continuously whenever power is on.**
- **All carriage motion depends on the carriage drive motor.**

The carriage drive motor is a ¾ hp, 1750 rpm, 208V, 3-phase motor. Its shaft turns counterclockwise, when viewed from the pulley end of the motor, and drives two hydraulic pumps inside the hydraulic unit. The drive is transmitted through a timing belt.

The motor is on the right end of the printer below the hydraulic unit.

Caution: When installing or relocating equipment to a new power source, be sure the direction of drive motor rotation is correct before running the motor continuously. Because this is a three-phase motor, its direction of rotation may change when it is connected to a new power source. Serious damage may occur in the hydraulic unit if the pumps are permitted to run in the reverse direction for more than the few moments necessary to test the direction of rotation.

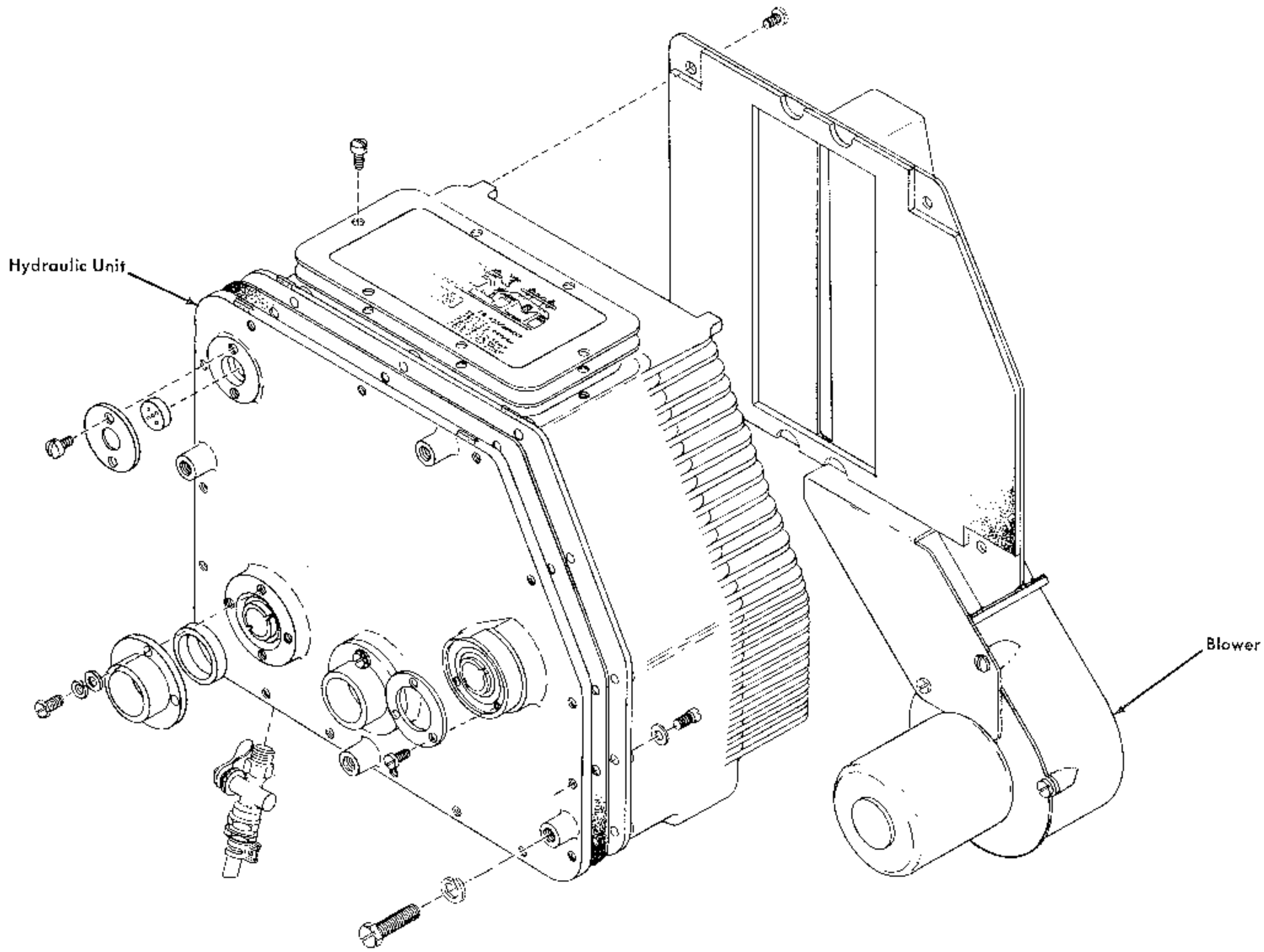


Figure 38. Hydraulic Drive Unit

Magnetic Emitter (Figure 39)

- **The magnetic emitter provides timing pulses for the carriage.**

A magnetic emitter furnishes carriage timing pulses. The emitter is known as the *E-1 emitter*, and its output as the *E-1 pulses*. A paddlewheel-shaped emitter rotor is mounted on the hydraulic motor shaft. This rotor, or emitter wheel, turns whenever the hydraulic motor shaft turns. Twelve equally spaced vanes on the emitter wheel pass close to a transducer.

The transducer is on an arm that can pivot about the axis of the emitter wheel, and so vary the instant of passage (timing). The transducer consists of a coil of wire wrapped around a permanent magnet. As the iron vanes of the rotor pass the head, they vary the flux of the magnet and induce small voltages in the coil. The waveform and amplitude of the transducer voltage is shown in Figure 40. These voltages are amplified by a small SMS card on the unit to produce final E-1 pulses of about 12V in amplitude. These pulses control skipping and spacing by the carriage. One pulse is produced for each space taken.

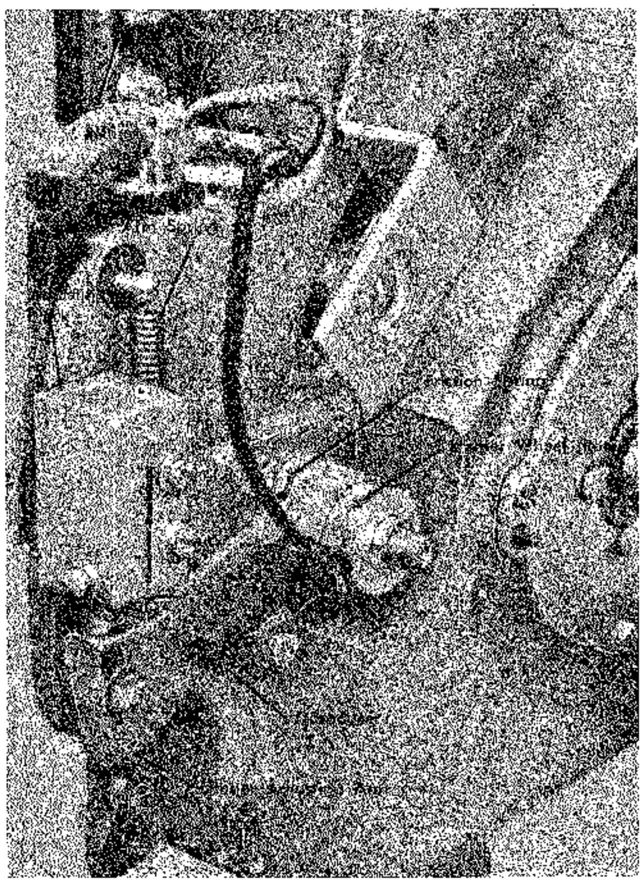


Figure 39. E-1 Magnetic Emitter

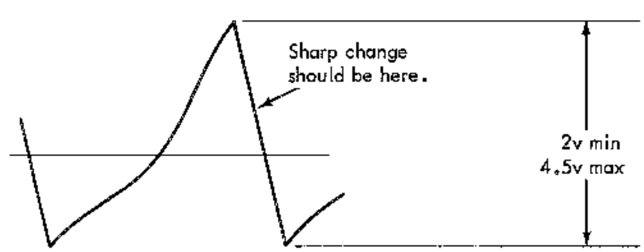


Figure 40. E-1 Pulse Waveform

Control-Tape Unit

- **Skipping and overflow of the carriage is controlled by the control-tape unit.**
- **The control tape is formed into an endless loop and fed through the unit by a pin-feed sprocket.**
- **Punched holes in the tape are sensed by two sets of brushes to provide control impulses to the system.**

The skipping and overflow functions of the carriage are controlled by the control-tape unit. This unit notifies the system when the forms have advanced to a position indicated by instructions from the system. It also indicates to the system when an overflow condition develops, that is, when the end of the form has been reached. Spacing and skipping operations start in response to signals sent from the system. The control-tape signals the system when the end of these operations occurs.

To do this, the control-tape unit has two sets of brushes and two contact rolls. The two sets of brushes are separated by a distance of seven spaces. Each set contains 13 brushes: twelve read the holes in the tape, while the thirteenth provides common return. The reading brushes sense holes prepunched by the operator in any of twelve channels in the tape. To insert and remove the control tape, unlatch the brushes by pulling forward on the latch (Figure 41). A pressure-friction pivot holds the brushes off the rolls when unlatched. If not latched in place, a microswitch interlock so notifies the system.

A pin-feed sprocket driven by the hydraulic mechanism is part of the control-tape unit. It moves in step with the paper forms. The pins in the sprocket engage feed holes punched along the center of the control-tape, and advance it past the two sets of brushes. A large adjustable idler hub takes up any slack in the tape which forms an endless loop.

The first set of brushes encountered by the advancing tape is called the *slow brushes.* They read the tape, and change from high- to low-speed skipping in preparation for stopping the forms. Stopping occurs when channel holes in the tape are sensed by the second set. This set is known as the *stop brushes.*

Both the slow and the stop brushes are held by clamps in nonconductive brush blocks. The contact rolls are free-spinning on their exis. When the brushes are raised, (Figure 42), the contact rolls are isolated, and are not part of any circuits. When the brushes are latched and insulated on an unpunched section of the control tape, only the common (return) brushes contact the contact rolls. They ride outside of the edge of the tape on a bare section of the rolls. When any of the punched channel holes pass under the brushes, a circuit is completed from the brush that is in the hole, through the contact roll, to the common brush. The brushes, in turn, are all connected to the system through the signal cables.

The control tape is made of paper or plastic. It is a printed form ruled along its length with 12 parallel lines, one for each channel or punching position. Each of these channels is read by the corresponding slow or stop reading brush. 132 lines are ruled across the tape, each line corresponding to a single space of the carriage.

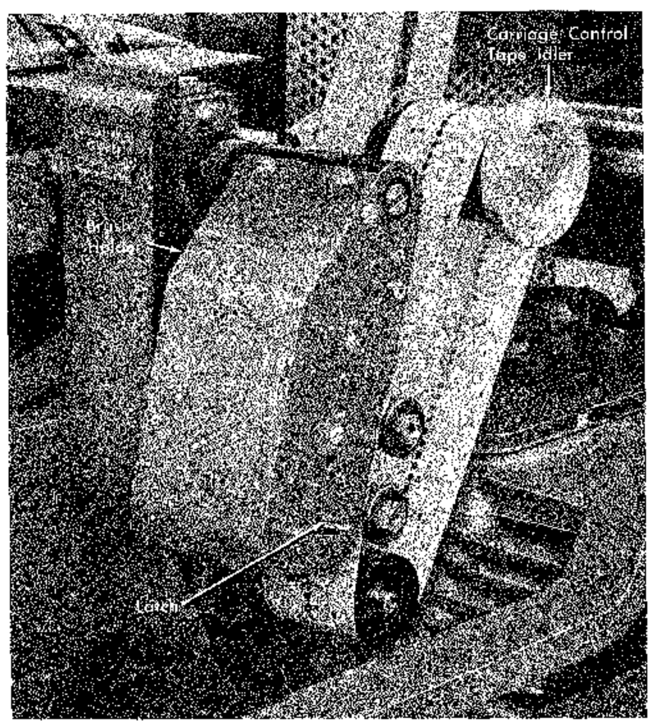


Figure 41. Carriage-Control Tape Unit

The operator, using a special punch, punches signal holes in the tape in different channels and at different spacing positions on the tape. These holes indicate different conditions to the system, and correspond to the various positions of the paper forms. Examples of these signals are: location of first and last printed lines, headings, end of sheet, etc. Each condition is represented by a hole in a different channel. Some channel designations are preassigned by the system.

You can use the control tape full length, or cut it to any convenient length, corresponding to the length of the paper forms. Then, paste the end to the beginning to form an endless loop. The end must coincide with a starting line printed on the tape. Place the tape on the unit with the brushes in a raised position. The feed holes must be meshed with the pins in the feed sprocket. Then, close the brushes and adjust the idler hub to remove excessive slack in the tape.

Because skipping to different sections of the form is controlled by the program and by holes punched in the carriage tape, forms can be designed to permit printing in practically any desired arrangement. The carriage can control continuous forms up to 22″ in length, with 6-lines-per-inch spacing, or up to 16½″ with 8-lines-per-inch spacing. The minimum length is 1″. For efficient stacking of forms, the recommended maximum length is 17″.

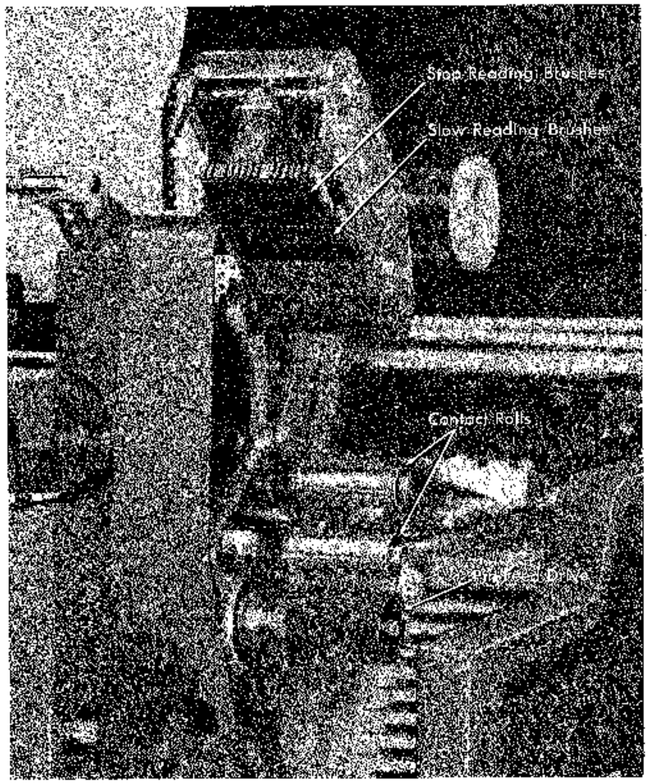


Figure 42. Control-Tape Unit (with Brushes Raised)

Forms Tractors and Shafts

- **Four pin-feed forms tractors feed the paper through the printer.**
- **They are driven through two square shafts by the hydraulic unit.**
- **Hinged doors keep the forms on the tractor pins.**

Paper forms, while printing, must be advanced through the machine. To do this, four forms tractors are used. Two are above the print line, and two below the print line. They are driven by two square horizontal drive shafts. Shaft movement is supplied by the hydraulic motor through gearing that is selected by the manual clutch and line selection knob. The forms tractor and drive shafts are mounted at the front of the printer above and below the hammer unit and type cartridge.

The tractor consists of an endless chain of feeding pins attached to a timing belt. When the T-casting is opened, a hinged door on each tractor permits insertion of the forms. The marginal perforations in the paper engage the pins to provide feeding of the forms. The tractor doors are held shut by spring tension. This tension overcomes any tendency of the forms to come off the pins. As the paper advances, it leaves the pins when they pull away to follow the direction of the tractor idler pulley.

IBM recommends that the forms used with this machine be designed for compatibility. Refer customers to the IBM sales representative for details. IBM also recommends that customers note on the forms order that the forms are for use with the IBM 1403 Printer.

The maximum-width form that can be used with the 1403 is 18¾" from edge to edge. If the maximum-width form is used, the first print position cannot be printed any closer than 2⅝" to the left outside edge. Nor can the 132nd print position be printed any closer than ⅝" to the right outside edge. The overall length of a printed line is 13.2".

Minimum form width is 3" between pin-feed centers. Pin-feed centers are ¼" in from the form edge.

When a 16¾" form is used, the printed line (13.2" overall length) can be located any place on the form within ⅝" from either edge.

When only 100 print positions are used (1403 Models 1 and 4), the right margin will be increased 3.2".

Stacker (Figure 43)

- **The stacker refolds the forms on the paper cart after they are printed.**
- **Either power or gravity stacking can be used.**

The stacker consists of a set of feed rolls and a paper folding guide. As the forms are printed, they move upwards, and over the curved forms guide at the top. From there they move downward at the rear, drawn by gravity until they reach the continually running stacker rolls. These rolls pull the forms down by friction. This action can be nullified by the stacker-spring lift bar to permit optional gravity stacking.

The forms pass between two sections of an adjustable guide on their way to the stacker rolls. This guide can be raised and lowered by a handle called the *paper guide control*. The handle moves vertically along a printed scale graduated (for convenience of the operator) from 0 through 6. The guide has a counterbalance negator spring to keep it at any setting of the scale. The lower edge of the guide assists the folding of the paper when set at the proper level. As the pile of stacked paper rises, the level of the guide may have to be adjusted.

Blower

A blower cools the hydraulic unit. It is bolted to the side of the unit. The blower rotor and blower motor form an integral part of the blower. They are suspended below and to the front of the hydraulic unit.

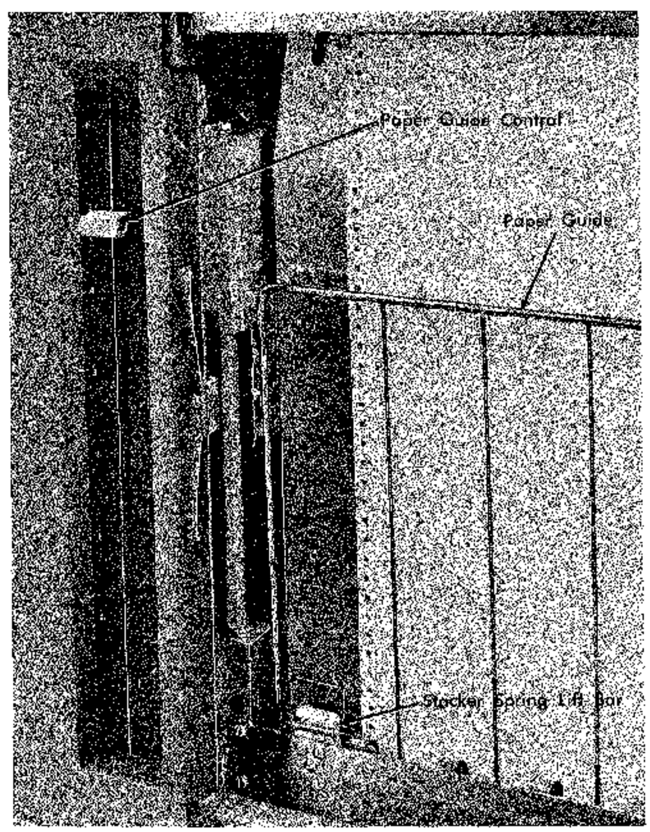


Figure 43. Forms Stacker

Manual Carriage Controls

- Manual carriage controls permit proper positioning of the forms.

Description

This section discusses only the controls that are used specifically for carriage functions.

Forms Tractor Positioning

The forms tractors are mounted on two stationary rectangular guide bars; one above, and one below the print line. Two forms tractors are on the upper guide bar, and two are on the lower guide bar. Slots cut into the upper and lower edges of these stationary guide bars are used to position the left forms tractors. The front of each guide bar is recessed. Into this recess fits a movable slide. Holes in the face of these slides are used to position the right-hand forms tractors. Thus, the left-hand forms tractors lock to the stationary guide bars, and the right-hand forms tractors lock to the movable slides.

Forms Width Vernier

This vernier insures tractor alignment to the pin-feed holes in the form. Turning the vernier knob slightly moves both right forms tractors along the print line.

Paper Advance Knob

This knob is fastened to the right end of the drive shaft for the upper-forms-tractors. When the manual-clutch-and-line-selection knob is in one of its two disengaged positions, the paper advance knob can move the forms up or down in increments of one line space.

Manual-Clutch-and-Line-Selection Knob

This knob can be set to one of four positions. The two middle positions are disengaged positions. Each of the disengaged positions has a manual detent with a lines-per-inch spacing that corresponds to the adjacent engaged position. The extreme right-detented position is the setting for a spacing of 6 lines per inch. The extreme left-detented position is the setting for a spacing of 8 lines per inch.

This control is at the right front of the printer.

Rear-Forms-Guide Operating Lever (Paper Guide Control)

This lever is used to raise or lower the rear forms guide.

Stacker-Spring Lift Bar

This lever lifts the stacker roll springs away from the rolls to permit gravity-stacking of the forms.

Electrical Carriage Controls and Lights

- Electrical controls permit the manual initiation of electrically performed operations.
- The lights indicate the current status of various conditions within the printer.

Description

The various switches for carriage control are on the panel at the left front of the printer. The system may not require the carriage to have or use all of these controls.

The interlock lights and carriage start and stop indicators are on the printer indicator panel at the lower right front of the printer.

Carriage Space Key

This key is used during manual control to space the carriage once each time the key is pressed. The number of spaces taken each time the key is pressed may differ in different systems to which the printer is connected, and may be under control of the carriage mode switch. The circuits for this control are contained within the system.

Pressing the carriage space key causes the +6V to shift from the −T space-key line to the +U space-key line (01.06.1). When this key is pressed and released, it stops the printer usage meter.

Carriage Restore Key

This key is used during manual control to cause the carriage to skip to a hole in channel 1 of the carriage tape. A hole in channel 1 normally locates the starting position on the form. The circuits for this control are contained within the system.

The carriage restore switch (01.06.1) causes +6V to shift from the −T restore-key line to the +U restore-key line. When this key is pressed and released, it stops the printer usage meter.

Carriage Stop Key

Pressing this key stops the carriage operation and turns ON the forms check light.

The carriage stop key switch (01.06.1) causes the +T forms-check or carriage-stop line to shift from +6V to floating.

End-of-Forms Light

This light shows an end-of-forms condition or a break in the form at the lower or upper left-hand tractor.

The +U end-of-forms-indicator line (01.06.1) lights the light under control of the system. The light returns to −12V.

Forms Check Light

This light indicates a forms malfunction in the forms tractor or that the carriage stop key has been operated.

The +U forms-check-indicator line (01.06.1) lights the light under control of the system. The light returns to −12V.

Brush Interlock Light

BRUSH INLK indicates that the carriage-control-tape brush frame is raised. If both the brush interlock and the shift interlock contacts (01.07.1) are operated, only the brush interlock light will indicate. The brush interlock contact is actuated when the frame is locked in place.

Shift Interlock Light

SHIFT INLK indicates that the 6-8 line clutch is not properly engaged or properly detented. The shift interlock contact (01.07.1) is actuated when the shift mechanism is not detented. The operation of this and the brush interlock contact control the carriage interlock line to the system.

High-Speed Start Light

HS START indicates that the high-speed (skip) start magnet is energized. It is controlled by the high-speed-start-indicate line (01.07.1) from the system.

Low-Speed Start Light

LS START indicates that the low-speed (space) start magnet is energized. It is controlled by the low-speed-start-indicate line (01.07.1) from the system.

High-Speed Stop Light

HS STOP indicates that the high-speed (skip) stop magnet is energized. It is controlled by the high-speed-stop-indicate line (01.07.1) from the system.

Low-Speed Stop Light

LS STOP indicates that the low-speed (space) magnet is energized. It is controlled by the low-speed-stop-indicate line (01.07.1) from the system.

Theory of Operation (Hydraulic Carriage)

Mechanical Principles of the Carriage

Hydraulic Unit

- **The hydraulic unit runs continuously when machine power is on.**
- **It contains a hydraulic motor driven by either a skip (high-speed) pump, or a space (low-speed) pump, or both.**
- **The hydraulic motor operates the output shaft.**
- **These pumps run continuously. Their output to the hydraulic motor is regulated by valves.**
- **The valves are operated by magnets controlled by the system.**

Within this sealed unit, two hydraulic pumps operate continuously as long as power is supplied by a timing belt from the carriage drive motor. The skip (eject) pump operates at a slightly greater speed than the space pump. Two valves, the space control valve and the skip (eject) control valve, control oil flow to the hydraulic motor. Whenever the hydraulic motor is not operating, it is detented. The detent is seated by spring tension.

The detent wheel is inside the unit on the hydraulic motor output shaft. The output shaft supplies motion to the forms tractors.

When oil is flowing through the hydraulic motor to drive it, back pressure must be built up to overcome spring tension on the detent. Back-pressure-regulating needle valves beyond the hydraulic motor are adjusted to provide enough back pressure to lift the detent.

These needle valves are in the lines leading to the ports opened by the transfer of the control valves to the start (run) position.

Figures 44 and 45 show the oil flow passages, check valves, space and skip valves, and other hydraulic unit components.

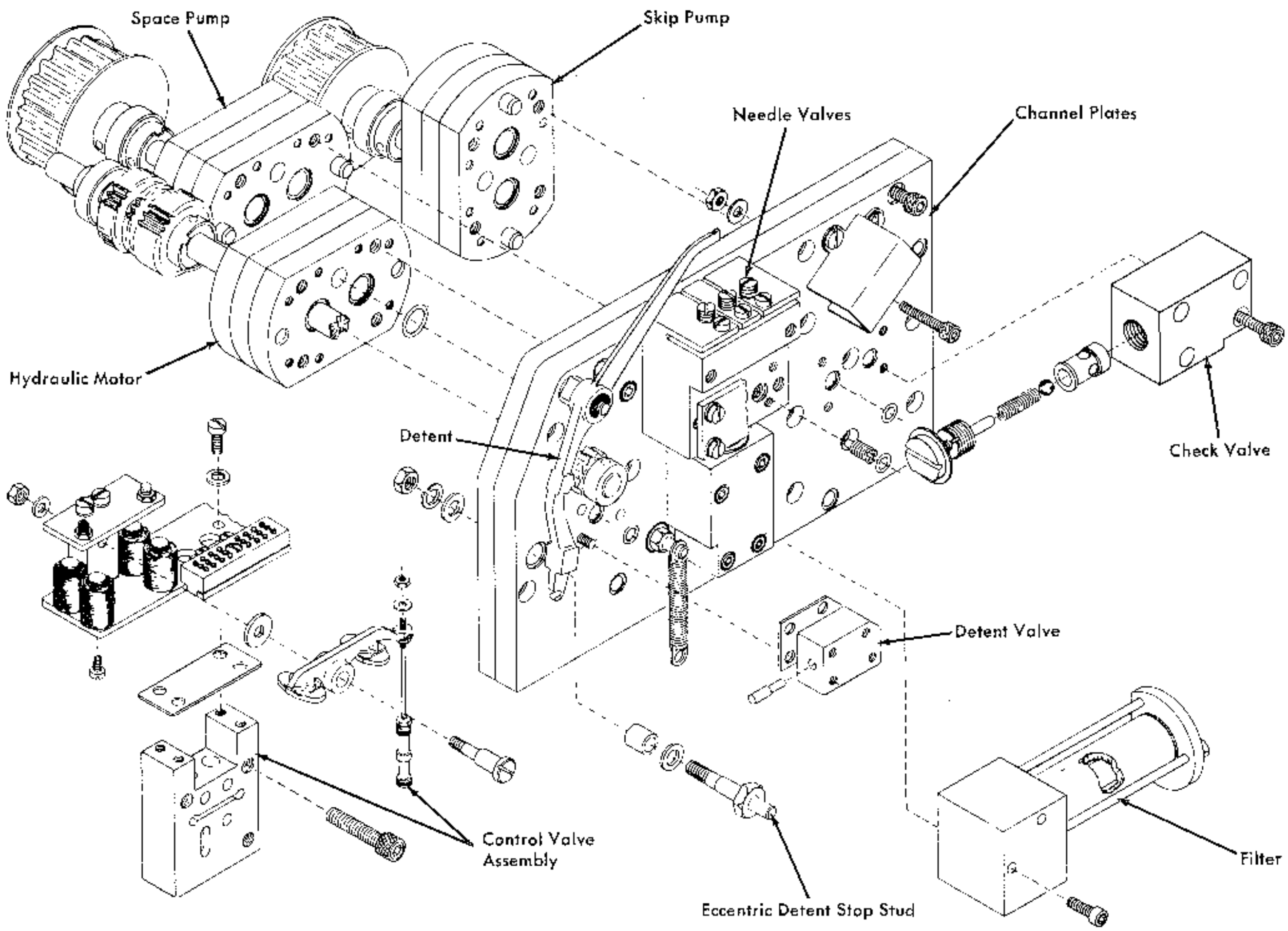


Figure 44. Exploded View of Hydraulic Drive Unit

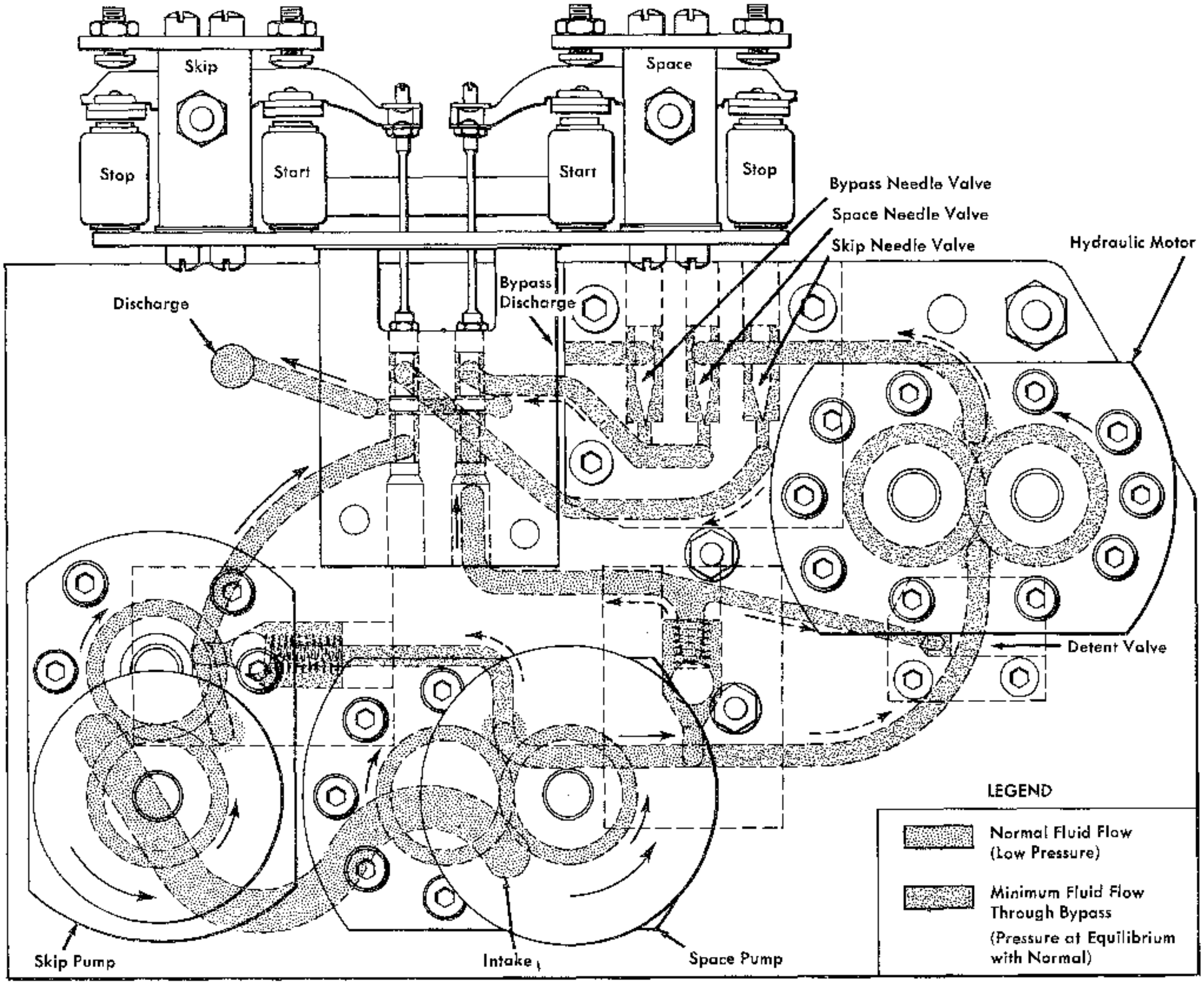


Figure 45. Phantom View of Hydraulic Unit Oil Flow (No Space — No Skip)

No Space—No Skip (Figure 46)

- When not spacing or not skipping, the space and skip STOP magnets must be energized.
- With these magnets energized, the hydraulic fluid bypasses the hydraulic motor.
- This is done by ports in the space and skip valves.

With neither control valve transferred, the space pump picks up oil from the reservoir and forces it up to, but not through, the hydraulic motor, through the space-pump check valve; through a port (that is open when the space control valve is in the stop position); and then back to the reservoir. At the same time, the skip pump picks up oil from the reservoir and forces it up to, but not through, the skip-pump check valve; through a port (that is open when the skip control valve is in the stop position); and then back to the reservoir.

Note that either the start or stop magnet, for both the space control valve and the skip control valve, must be energized at all times when the hydraulic pumps are running. If none of the magnets are energized, the control valves can float and block the ports, preventing oil flow. This blocking action causes an excessive load on the carriage drive motor, and fuses will blow.

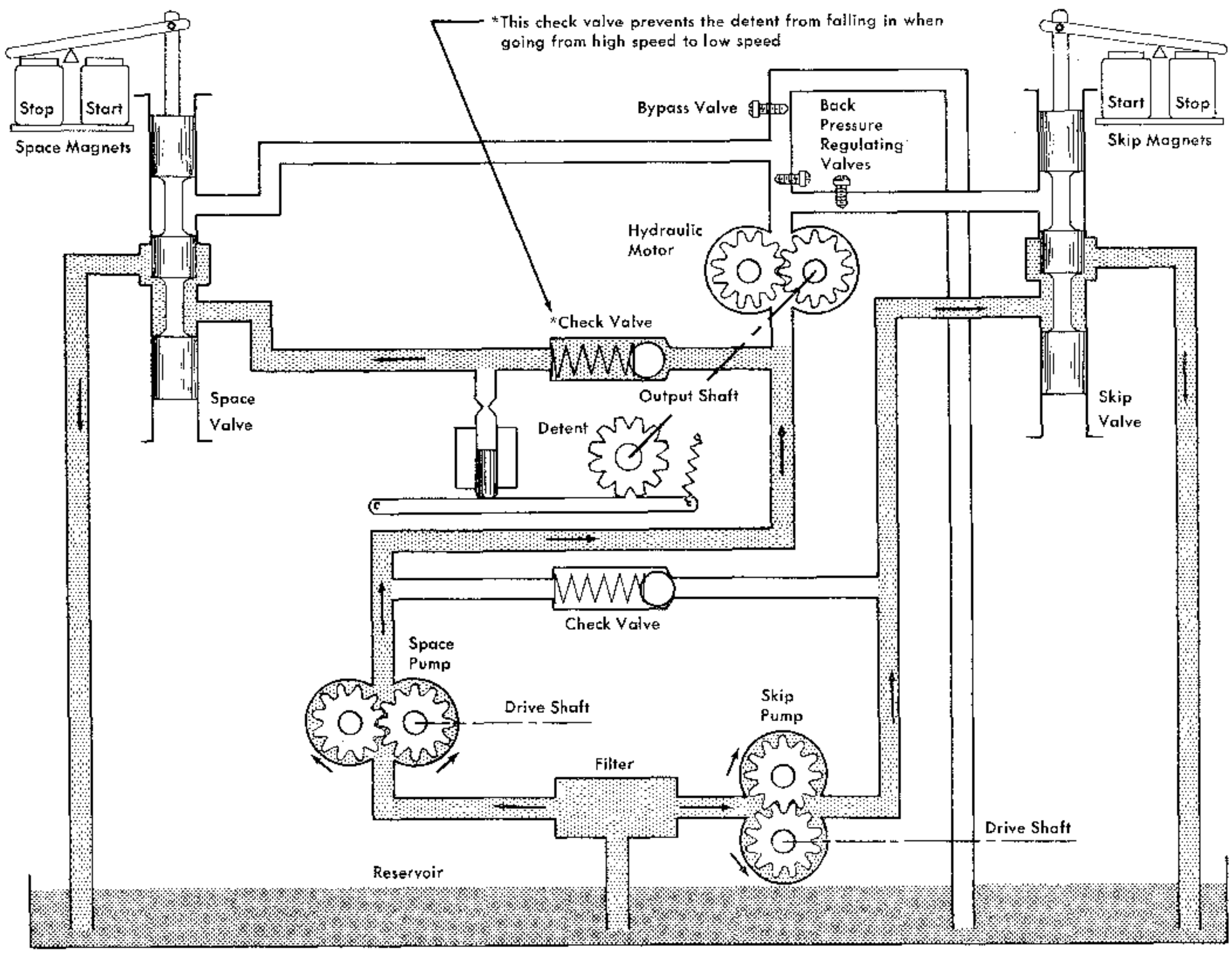


Figure 46. Hydraulic Unit Oil Flow Schematic (No Space — No Skip)

Space or Slow-Speed Skip (Figure 47)

- **In slow speed operations, the hydraulic motor is driven by the space pump.**

With the space control valve transferred (space-start control-magnet energized), the space pump picks up oil from the reservoir and forces it through the hydraulic motor; through the port opened by the transfer of the space-control valve; and then back to the reservoir. This action turns the hydraulic motor at slow speed. The oil flow from the skip pump is unchanged from the no-space or no-skip condition. One of the gears in the hydraulic motor is integral with the output shaft. The detent wheel is on the same shaft. The forms tractors start to move about 3 ms after the start pulse is received. An additional 7 to 10 ms are required before the forms tractors are moving at space speed.

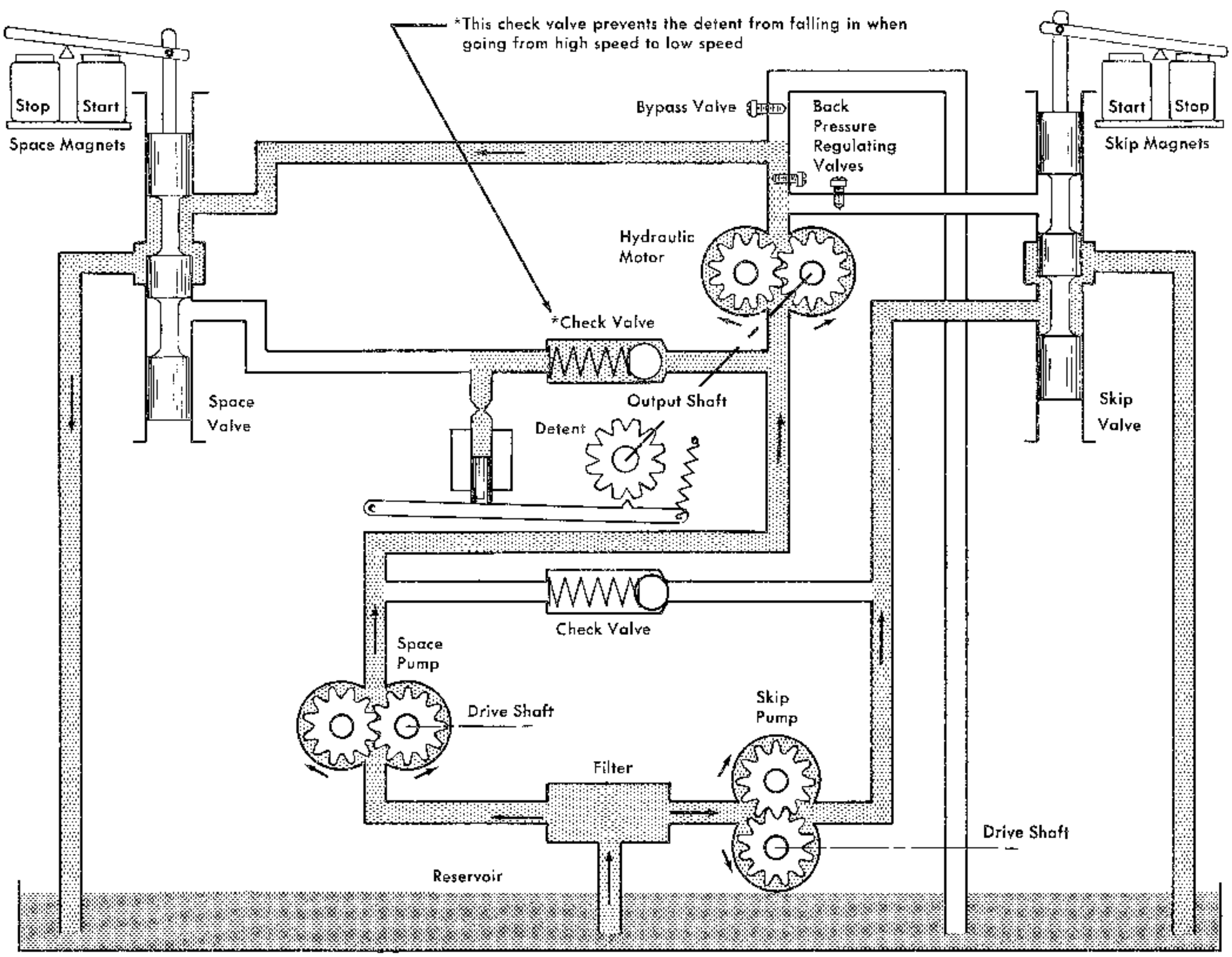


Figure 47. Hydraulic Unit Oil Flow Schematic (Space or Slow-Speed Skip)

High-Speed Skip (Figure 48)

- **In high-speed operations, the hydraulic motor is driven by both the space and the skip pumps.**

With both the space-control and the skip-control valves transferred by both start magnets (when energized), the space pump picks up oil from the reservoir and forces it through the hydraulic motor, through the ports opened by the transfer of both control valves, and then back to the reservoir. The skip pump picks up oil from the reservoir and forces it through the skip-pump check valve, through the hydraulic motor, through the opened ports, and then back to the reservoir.

The two pumps both force oil through the hydraulic motor and revolve it at about twice the speed it has with only the space-control valve transferred.

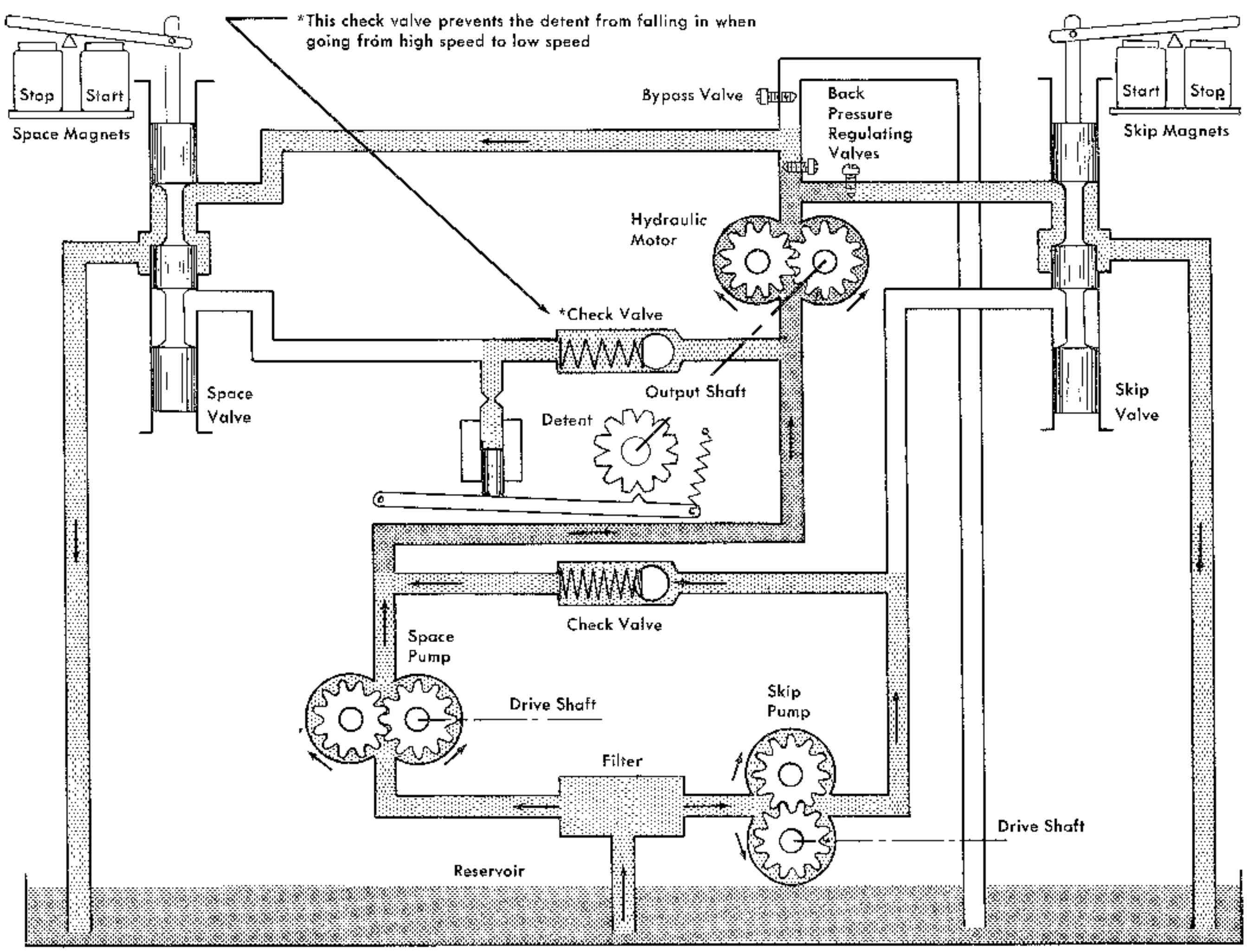


Figure 48. Hydraulic Unit Oil Flow Schematic (High-Speed Skip)

Slowdown from High-Speed Skip

- **Slowdown is accomplished by simply closing the skip-control valve and allowing the space pump to drive the hydraulic motor.**

When the slowdown signal is received from the tape brushes, the skip stop magnet is energized. This action restores the skip control valve to the stop position and changes the hydraulic motor speed to slow. See *Space or Slow-Speed Skip* for oil flow.

Stopping from Space or Skip (Bypass Operation, Figure 49)

- **Stopping is accomplished by closing both the space and skip control valves.**
- **Stopping requires correct adjustment of the bypass valve.**

When the space-stop control magnet is energized, it restores the space-control valve to the stop position. This action closes the port beyond the hydraulic motor, opens the port ahead of the motor, and stops the flow of oil through the motor. Because of the momentum of the carriage, back pressure is built up between the closed port and the hydraulic motor. A bypass is connected between this point and the reservoir to relieve the back pressure. Otherwise, the hydraulic motor might be forced to turn backward. Adjust the bypass orifice in this line to stop the motor in such a position that the detent will drop into a tooth on the detent wheel.

When both stop magnets are energized and both control valves are in their stop position, the pressure in the system is not enough to overcome the detent spring tension, and the detent is held engaged in the detent wheel.

Electrical Principles of the Carriage

Space Magnets

- **The start and stop space magnets operate the control valve to the space pump.**
- **They are energized by signals from the system.**
- **Either the start or the stop space magnet must be energized at all times.**

The space magnets operate the space control valve. A common armature, with a central pivot between the magnets, is connected directly to the valve stem. The central pivot results in a rocker action in such a way that when the armature is attracted by one magnet, it is pulled away from the other. The magnets have two coils each (wired in parallel) and are known as the *space start* and *stop* magnets. When the start magnet is energized, the armature pushes the valve down. When the stop magnet is energized, the valve is pulled up. One of the magnets must be energized at all times when power is on the machine. Both magnets should never be energized together.

Skip Magnets

- **The skip magnets operate the high speed skip pump valve.**
- **Either the start or stop skip magnets must be energized at all times.**

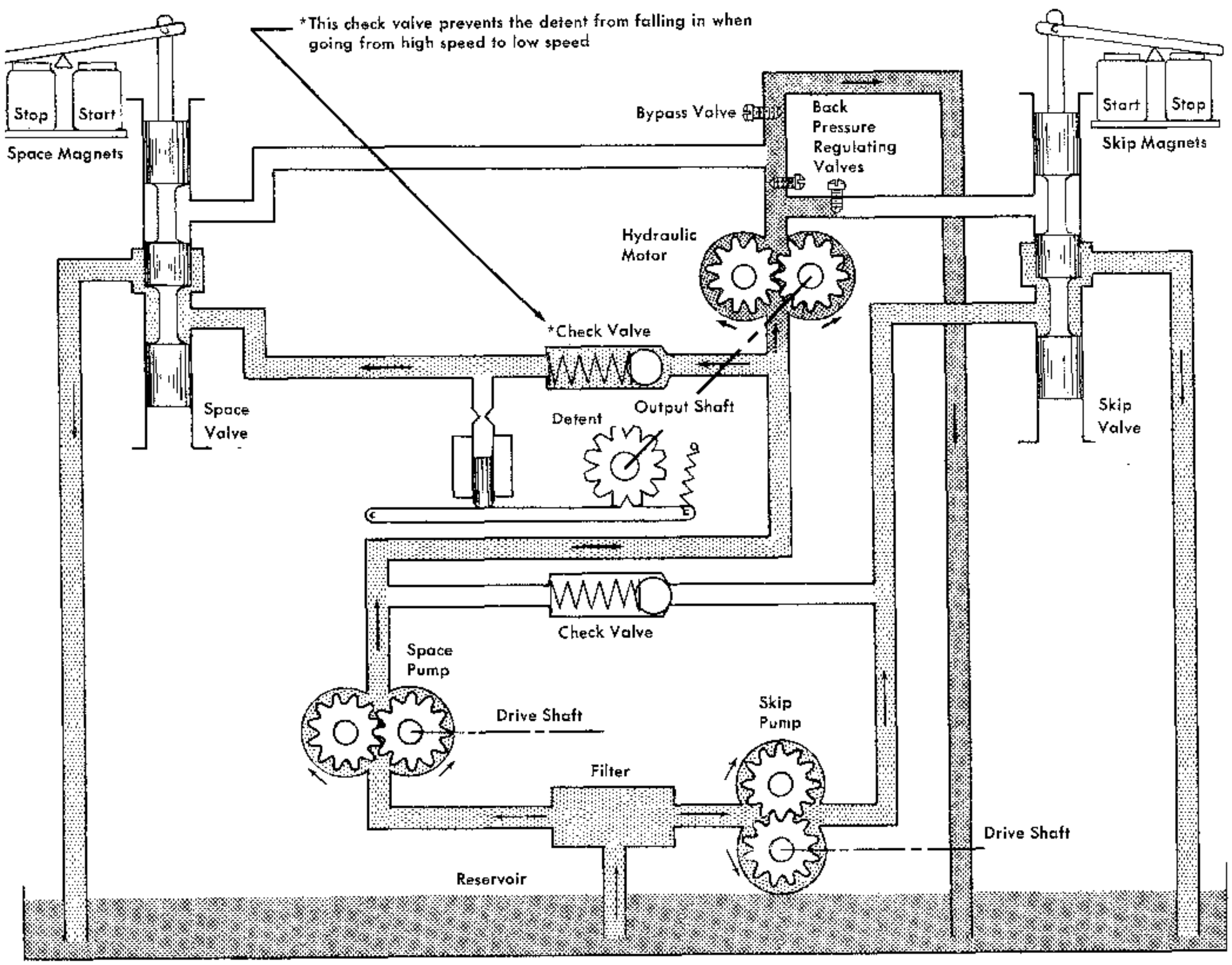


Figure 49. Hydraulic Unit Oil Flow Schematic (Bypass Operation)

The skip magnets operate the skip control valve. The arrangement of the armature and magnets is the same as that of the space magnets except that their physical positioning is reversed. Each magnet has two coils wired in parallel. Except for the rare occasion where the carriage operates at single speed (for instance, when used with the 1401 Model A), one of these magnets must be energized at all times when power is on the machine. Both should never be energized together.

The start magnet pushes down the skip valve, while the stop magnet pulls it up. When the carriage is to run at high speed, the skip-start magnet is energized along with the space-start magnet. The carriage starts skipping at high speed only if the length of the skip is over eight spaces. This is controlled by the seven-space separation between the slow and the stop control-tape brushes.

Eight spaces before the end of a high-speed skip, the carriage receives an impulse to slow down. This impulse energizes the skip-stop magnet, while the space start magnet remains energized. This allows carriage-skipping to proceed from high to low speed in preparation for the stop. Normally, the carriage should always slow down before a stop. Stopping directly from high speed is permissible, however, in the case of emergency, such as form jams, etc.

E-1 Magnetic Emitter (See Figure 39)

- **The output pulses of this emitter are used for all but single-space carriage operations.**

The E-1 emitter is used in the spacing and skipping circuits. In older machines the output of this emitter is called *E-1 brush* in the wiring diagrams, as previously this emitter did have a brush and commutator. The E-1 emitter is used with the control-tape brushes during skipping to provide timed pulses. It is also used for all spacing except the single space. For single spacing and single-line skipping, a single-shot is used. This may vary with different systems and control units. In some control units, three single-shots are used with the single-space single-shot to control single, double, and triple spacing, as well as single-line skipping.

Tape Drive and Tape Brushes

- **The control-tape and brushes control all carriage skipping and overflow operations.**

The carriage control tape and the tape brushes are used for skipping and overflowing.

The stop brushes with E-1 are used to stop all skipping, and the stop brush in channel 12 or 9 may be used to sense an overflow.

The slow brushes return the carriage to slow speed when skipping. With the dual-speed feature of the carriage, skips of nine spaces or longer start at high speed. Eight spaces before the end of such a high-speed skip, a slow brush makes through a hole in the carriage tape. The slow brush, which slows down the high-speed skip, is in the same channel as the stop brush. The slow brush is encountered seven spaces ahead of the stop brush.

Power and Signal Requirements

Printer Power and Signal Lines

- **All printer power is furnished by the system.**
- **Two shoe connectors receive signal cables from the system.**
- **These cables provide paths for input and output signals.**
- **A 13-pin receptacle accepts the power cable from the system.**

Printer Power Connector

A 13-position power connector (PP-1) is at the left side (bottom) of the printer. This connector (00.03.1) supplies the ac power for the motors and service outlet and the −60V dc power for the carriage control magnets.

Signal Connectors

Two connectors (SC-1 and SC-2) provide for exchange of control signals and hammer circuits between the printer and the system. These connectors are at the left side of the printer. The front connector (SC-1, 00.02.1) is used for odd-numbered hammers, the rear connector (SC-2, 00.02.2), for even-numbered hammers.

Input Lines

All power is received from the system. The lines to the hammer magnets come from hammer drivers in the system. A line to a microswitch operated by the T-casting lock lever comes from the system. Input lines go to the various switches (START, STOP, CHECK RESET, etc.) located on the printer. These circuits are discussed individually in the section *Electrical Printer Controls and Lights.*

Output Lines

The printer sends an amplified head signal from its disk to the system. These signals indicate the alignment of some character with one of the first three print positions, or indicate when a 1 is aligned with print position 1.

A microswitch operated by the T-casting lock lever controls an output line to the system, and indicates whether the type array is in printing position. Other output lines are controlled by the various switches on the printer.

Carriage Power and Signal Lines

- **All carriage power must be supplied by the system.**
- **Input signal lines from the system control the space and skip magnets.**
- **Output lines to the system transmit signals from the magnetic emitter, control-tape unit, and interlock switches.**

Carriage Power Requirements

Power must be supplied for the carriage motor and for the carriage blower motor through the power connector on the IBM 1403 Printer. Three-phase power at 208-230V and 2.6 amps is required by the carriage motor. Single-phase power at 208-230V and .40 to .44 amp is required for the blower motor.

Input Lines

The lines to the space start and space stop magnets, and those to the skip (eject) start and skip (eject) stop magnets come from the system (02.01.1). Input lines go to various switches on the printer (01.06.1). All power is received from the system.

Output Lines

A line from the E-1 magnetic emitter emits a signal to the system when one of the vanes on the rotor passes the read-head (02.01.1). This line goes to the system, and is tapped off to the E-1 test point on the CE indicator panel. It is called the *E-1 sync point* and is used for oscilloscope synchronization in carriage troubleshooting. This pulse comes once for every carriage space taken at either high or low speed.

Each of the control-tape brushes (slow brushes, 02.02.1; and stop brushes, 02.03.1), emits a signal to the system when it contacts the roll through a hole in the tape. The manual-clutch-and-line-selection-knob microswitch controls an interlock line (01.07.1), which prevents operation in any but the four detented positions.

Two forms-stop microswitches, one in the upper left and another in the lower left forms tractors, control an interlock line (01.07.1) to indicate whether forms are in place. Jam microswitches, incorporated in each forms tractor, control an interlock line (01.07.1) to indicate a paper jam.

A tape brush microswitch, operated by the tape brush assembly lock, controls an interlock line (01.07.1) to indicate whether the tape brushes are in position. Output lines leave from various switches located on the printer (01.06.1).

Process Meter

- **The process meter records printer usage time.**

All printers are equipped with a process meter. This meter will record time if the system processing unit is recording, and if a first print instruction has been received by the printer from the system. A stop condition is established when the printer space key or restore key is manually operated and released, or when the system processing meter stops recording. However, as long as the space or restore key is held down, the meter will record time, provided the system processing unit meter is also recording time. The printer meter stops when the space or restore key is released.

Once started, the printer meter starts and stops with the system start and stop keys, regardless of the program function, provided no printer stop condition occurs.

Testing the Circuit

Enter the following program in address 444:

2B449B445 _

This will print one line and branch to a loop, which will keep the process M (−U) line active, although the printer will not continue to print. Operate the system start and stop keys. Note that the printer meter starts and stops under control of the system start and stop keys although no printing is taking place.

With the printer meter running (because the program is operating in a branch loop), press the space key and hold it down. The printer meter should not stop recording. Release the space key and the printer meter should stop. Restart the program at address 444, and make sure that the restore key, when operated and released, stops the printer meter while the system meter continues to run.

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IBM 1403 Printer (Model 3)

General Information

- **The Model 3 printer is a high-speed type-train printer. It can print 1100 lpm.**
- **It uses the IBM 1416 Train Cartridge and a new design hammer unit.**
- **A new style mechanism corrects ribbon skew in both winding directions.**
- **Electromagnetic acoustical dampeners minimize noise caused by the printer's high speed.**

The IBM 1403 Model 3 printer is very similar to the Model 2. Certain distinctive changes and refinements have been made. These are covered in this section of the manual. Information on the Model 2 printer is given in the *IBM 1403 Printer (Models 1, 2, 4, 5, and 6)* section of this manual. Only those differences peculiar to the Model 3 are presented in this section.

The Model 3 printer is a high-speed output medium adaptable to a variety of data processing systems. In appearance and operation it closely resembles the other models except that it can print and single-space 1,100 lines of alphamerical information per minute. This high speed is possible with the IBM 1416 Train Cartridge used by the Model 3. To complement this cartridge, the Model 3 uses a hammer unit of new design. Both of these units are described in this section. The Model 3 uses the same hydraulic carriage as the other models.

The machine is designed to operate at a basic cycle time of 5 μs. This timing must be matched by the using system. For this reason, buffer storage is a requirement of the Model 3.

Standard features of the Model 3 printer include:

1. 132 print positions.
2. IBM 1416 Train Cartridge.
3. Ribbon stop feature.
4. Motor-driven ribbon-skew correction device.

The method of printing (Figure 50) remains basically the same as in the other 1403 models. The main difference is in the use of the type-train cartridge and the new style hammer unit.

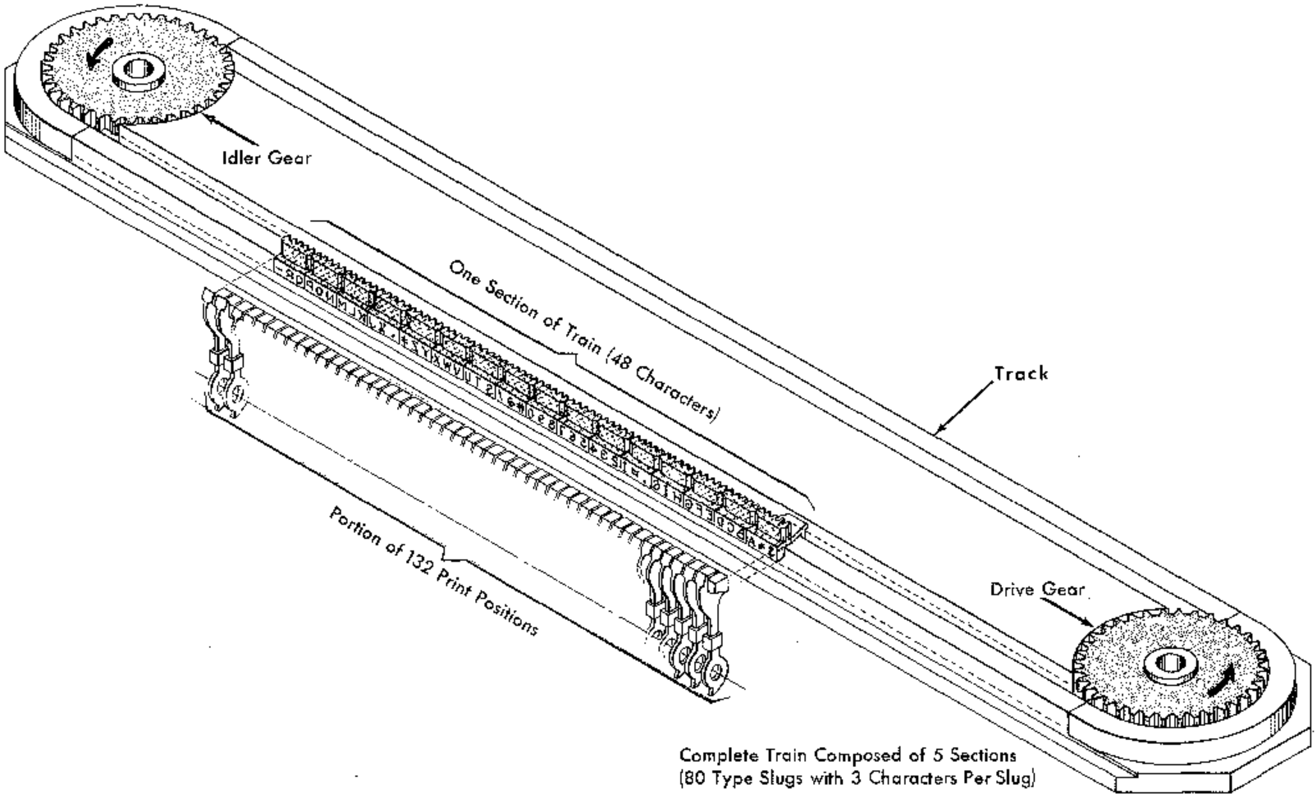

Figure 50. IBM 1403 Model 3 (Type-Train and Hammer Schematic)

Functional Units (Model 3)

Hammer Unit

- **The hammer unit is designed to match the high-speed operation of the type-train.**
- **The hammers are driven by pushrods when the print magnets are energized.**
- **Impression control is obtained by a cam-operated actuating bar in the hammer unit.**

Description

The hammer unit (Figure 51) consists of two banks of 66 magnet assemblies that operate through pushrods to actuate the hammers. The magnet-assembly mounting plates can be rotated on pivots at each end to provide access to the individual magnet-assembly mounting screws. You can get at the mounting screws without opening the unit. The unit is positioned in the translator frame by adjustable stops. These stops insure the proper relationship between the hammer unit and the type-train. A blower at the rear of the unit forces air through a tapered slot to cool the magnet coils. The unit can be pulled back for servicing on the standard CE service rails.

Hammer-Magnet Assembly (Figure 51)

The upper bank of 66 hammer magnets is directly over the lower bank. The armature tips operate in the pushrod assemblies to fire the hammers.

All magnet assemblies are identical and have a rating of 60V at 4.6 amps and a seal time of 1.175 ms. The coils snap into place on the yoke and are retained on the yoke by a latch which is part of the plastic bobbin. A backstop on each magnet is adjustable for proper armature-to-core gap. A polyurethane-strip residual threads between the armature and cores of each bank of magnet assemblies. The residual cushions the impact of the armature against the core, and assures that the armature does not stick to the core when the magnet is de-energized.

Pushrod Assembly

The pushrods transfer the motion of the hammer-magnet armature to the hammers. They are contained in their own assemblies directly in back of the hammers. There are two pushrod sizes: one is about 1⅞″ long, the other about 3½″ long. The 11 pushrod assemblies each contain 12 pushrods: six short and six long.

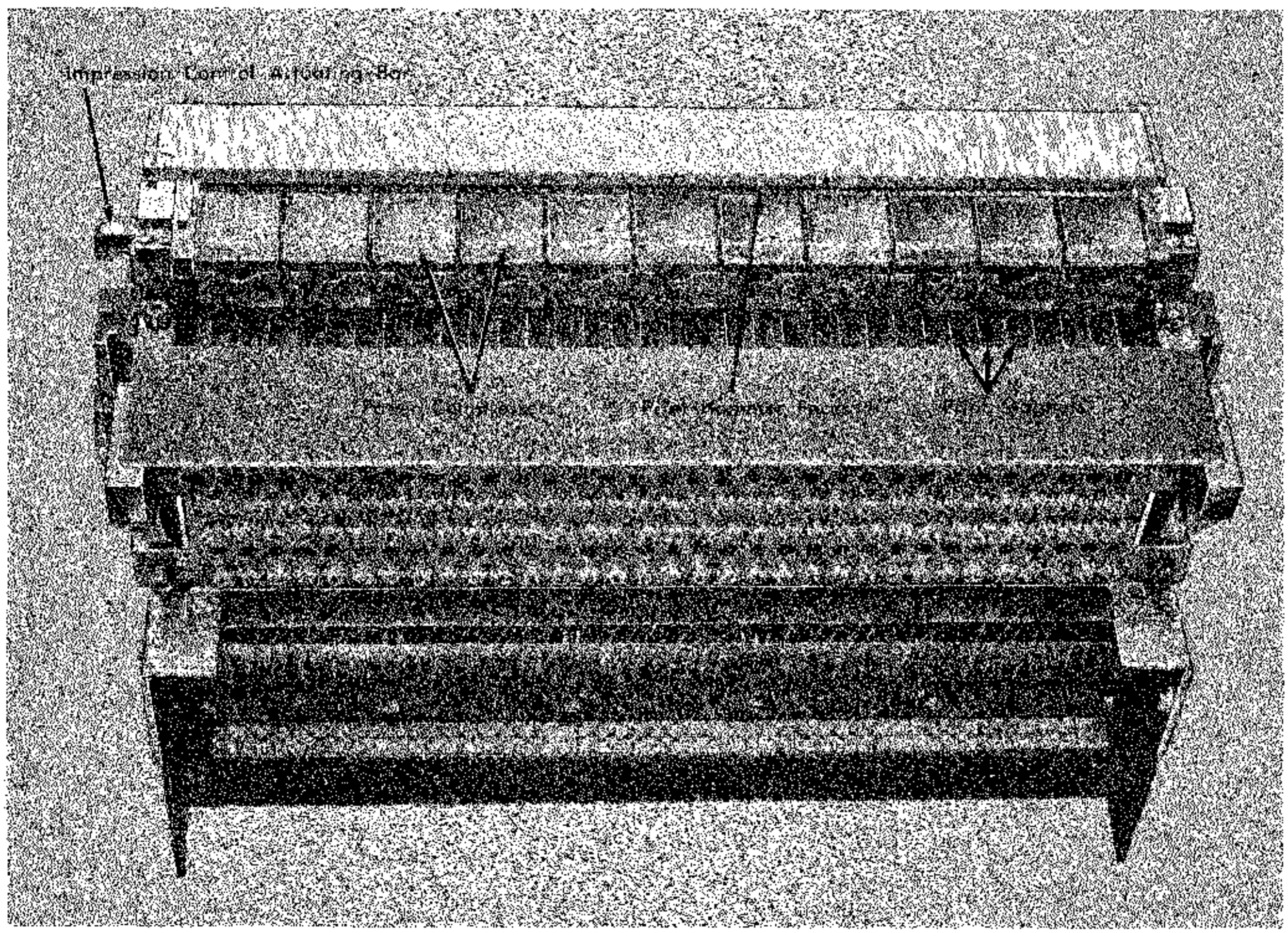

Figure 51. IBM 1403 Model 3 (Hammer Unit)

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Hammers and Impression Control

The hammers (Figure 52) are mounted in 11 groups of 12 hammers each to make up a row of 132 hammers. The energy of the hammer is controlled by the impression control bar pad. As the hammer travels toward the print line, the projection at the top of the hammer contacts the impression control pad, which is compressed by the hammer and thus absorbs part of its energy. The operator adjusts the position of the impression control assembly. Refer to *Print Density Control.*

As the print density control is turned, a cam operates against the end of the actuating bar and moves this bar laterally. This motion moves the wedges, on which the impression control bar is mounted, either to the front or rear. Figure 53 shows the actuating bar, operating cam, cam drive shaft, and operating knob.

Forms Compressors

At the bottom of each of the 11 hammer blocks is a form compressor. Its function is to push the form toward the type train. An adjusting setscrew is provided for each of the 11 compressors. Figure 53 shows the relative position of the forms compressors just below the print hammer faces.

Cable Connectors and Thermistors

Signals are brought to the hammer unit through pluggable SMS paddle cards. The thermistors for the hammer magnets are on these paddle cards. Leads from the individual hammer magnets connect to the SMS terminal block through slip-on connectors.

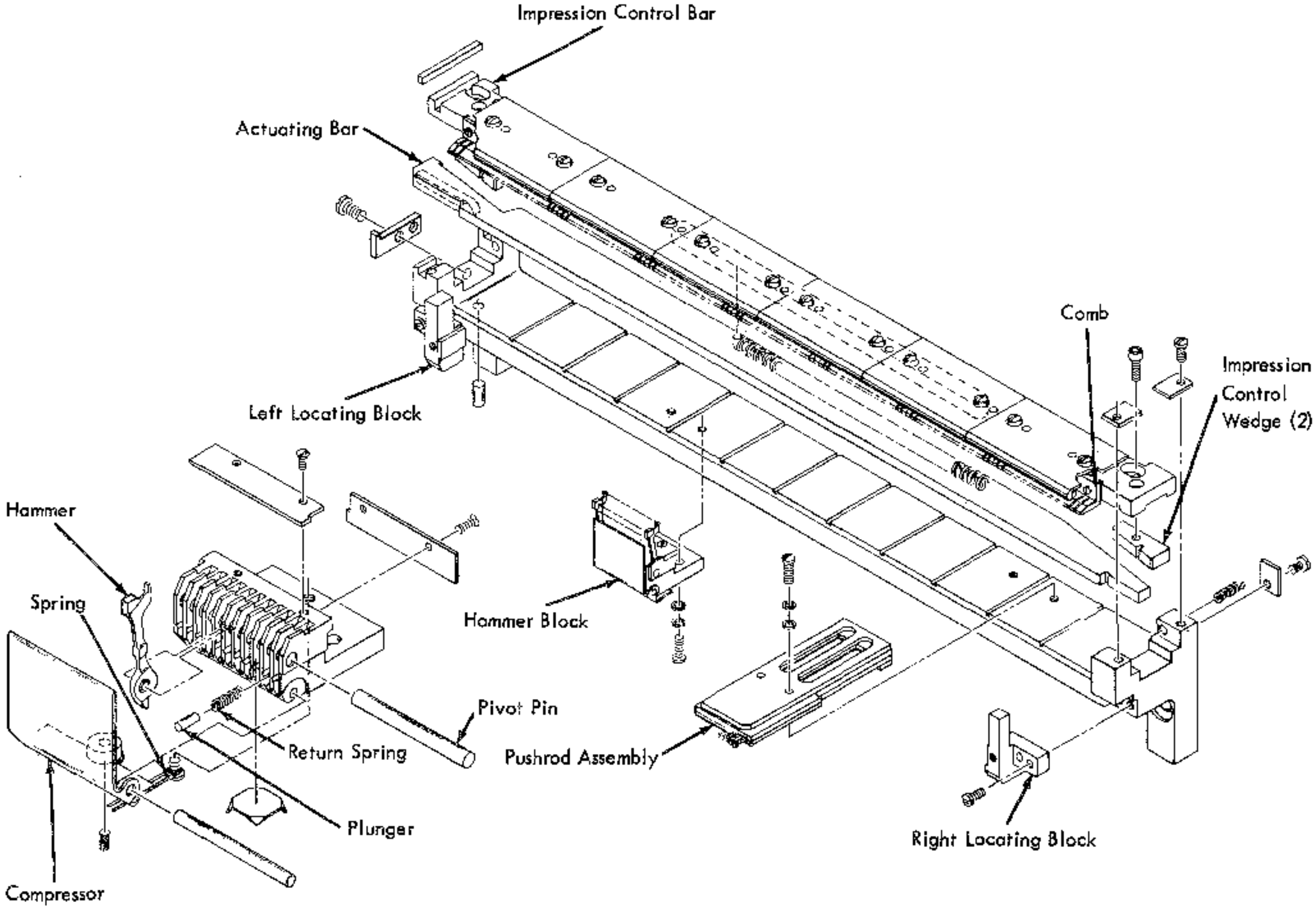

Figure 52. Hammer Unit Mounting Bar Assembly

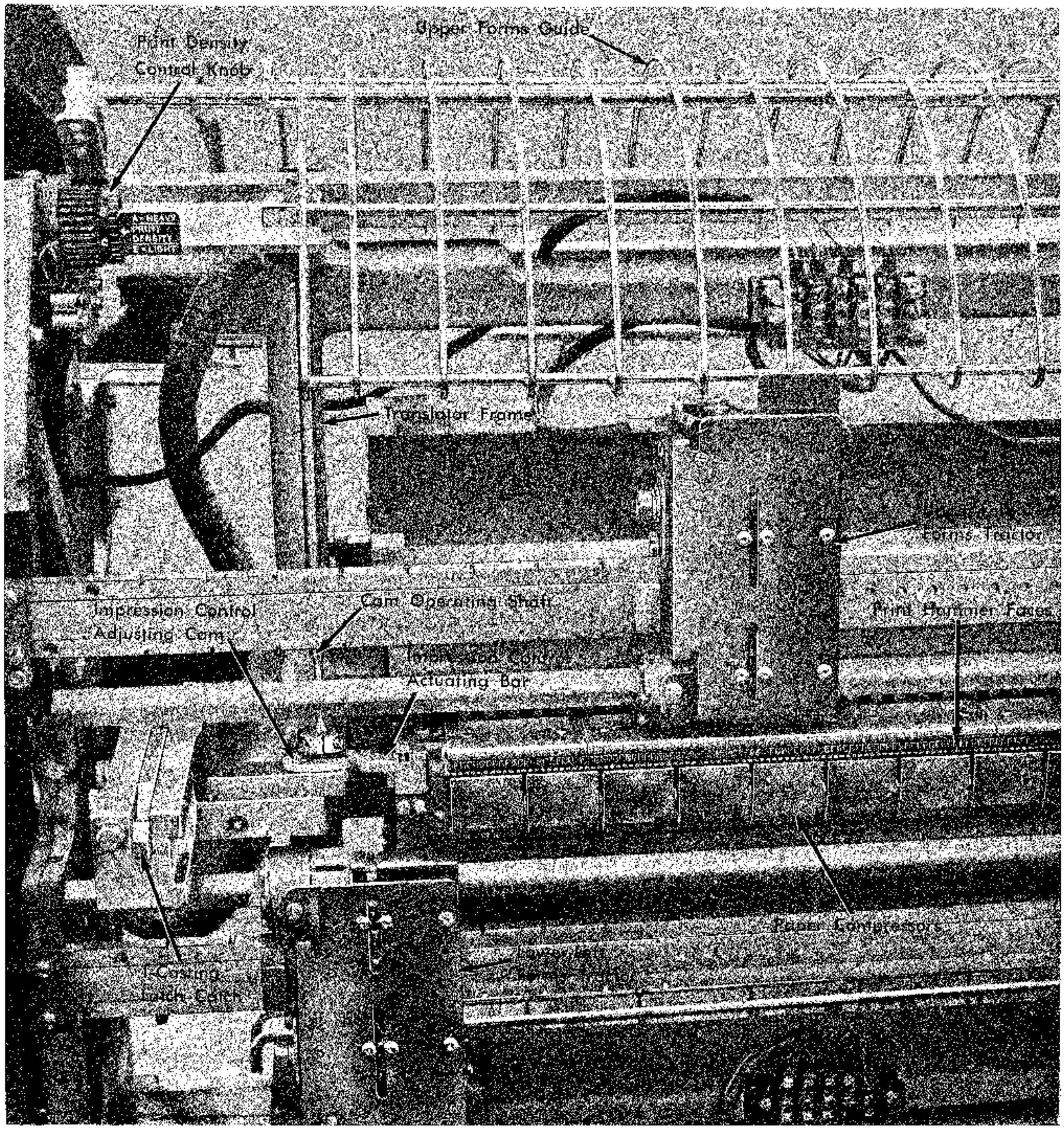

Figure 53. IBM 1403 Model 3 (Print Density Control)

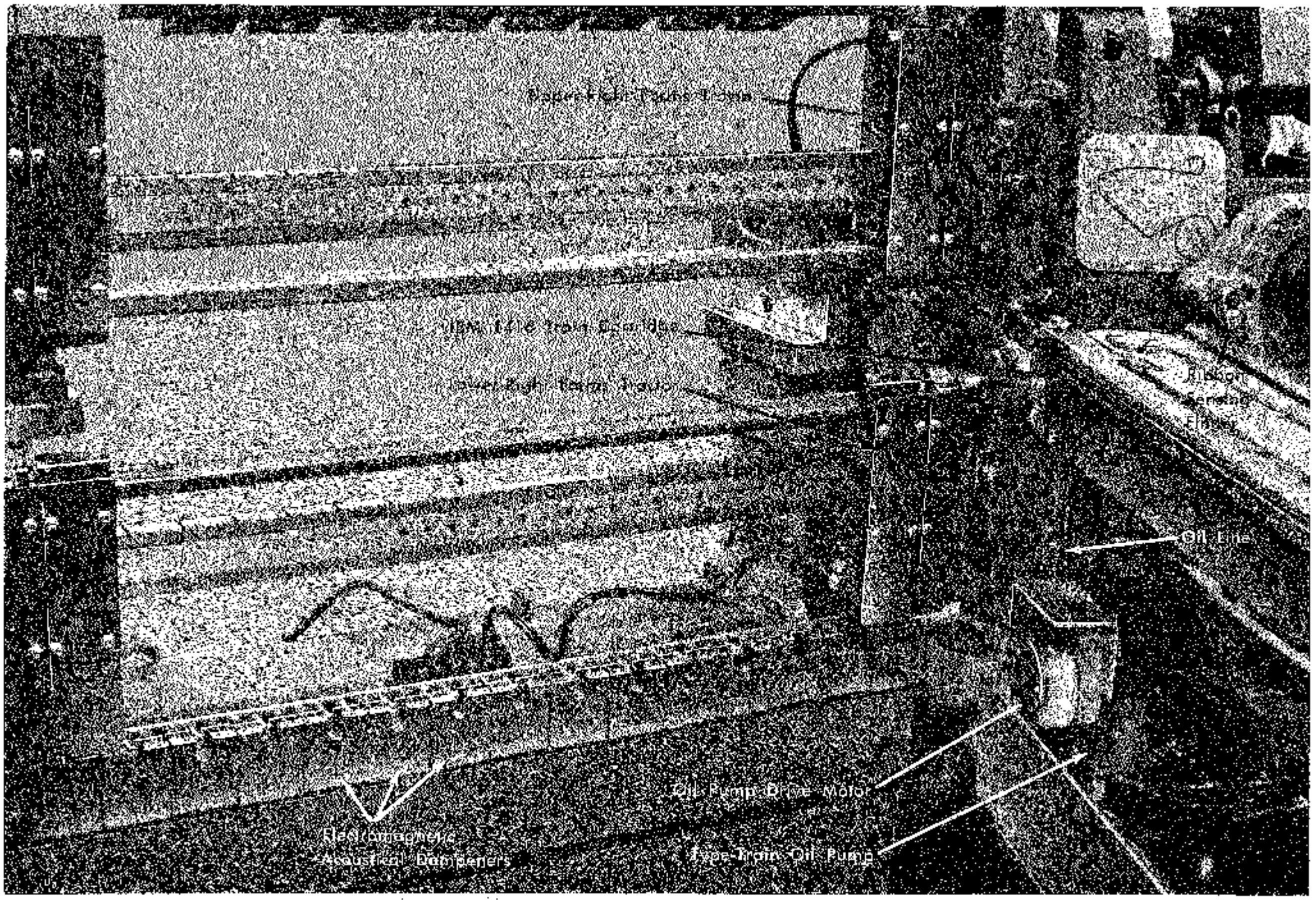

Figure 54. IBM 1403 Model 3 (T-Casting Open, Hammer Unit Removed)

Electromagnetic Acoustical Dampeners (Figure 54)

To minimize noise created by the high-speed operation of the printer, a set of electromagnetic acoustical dampeners is provided. These are 15 flat plates attached to coils to form electromagnets. They are on the translator frame below the hammer unit. The magnets are free-floating on their mounting studs. When printing, these magnets are energized momentarily by circuits in the system. When energized, they attract themselves strongly to a striker plate on the swing-pan. This action grips the forms firmly and blocks the passage of an acoustical shock wave down the length of the paper.

The magnets are wired in five sets of three. The three coils in each set are in series, while all five sets are in parallel (01.08.3).

Timing Disk, Transducer, and Type-Train Motor

- **These three components were changed to meet the high-speed requirements of the Model 3 printer.**

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Timing Disk

The timing disk, or drum, is part of the gear that drives the type-train. It is similar to the disk used in the other models except that in the Model 3, the disk is not magnetized. It has the same scribed slots about its circumference as the magnetized disks in the other models. The speed of the disk is 1714 rpm.

Transducer

A transducer (sense head) is used in the Model 3 to go with the nonmagnetic timing disk. The transducer is a variable reluctance head containing a permanent magnet and a coil. The slots in the timing disk pass very close to the head. As they pass they vary the flux of the magnet. This change in flux generates a tiny voltage in the coil. The voltage is amplified by two SMS cards in the printer. The output pulses are sent to the system. The transducer head-to-disk clearance of .001″ to .002″ is set at the factory for maximum output. No operator adjustment is provided for moving the sense head about the disk as in the other models. This (print timing dial) was an adjustment of timing provided on the other models to compensate for varying hammer-flight times due to forms thickness variations. In the Model 3 the timing of the pulses is fixed, but can be shifted, if necessary, by customer engineer. Variation in form thickness is compensated for by the forms thickness lever.

Type-Train Drive Motor

A larger and heavier motor is used on the Model 3 to drive the type train (Figure 55). Unlike the other models, the Model 3 motor is mounted vertically instead of on an angle. It is attached directly to the movable base on the T-casting, and moves in and out with the type train when the forms thickness lever is operated. The motor is a 3600 rpm synchronous hysteresis type rated at 1/8 hp. A pinion gear on the motor shaft drives the type train through an idler gear.

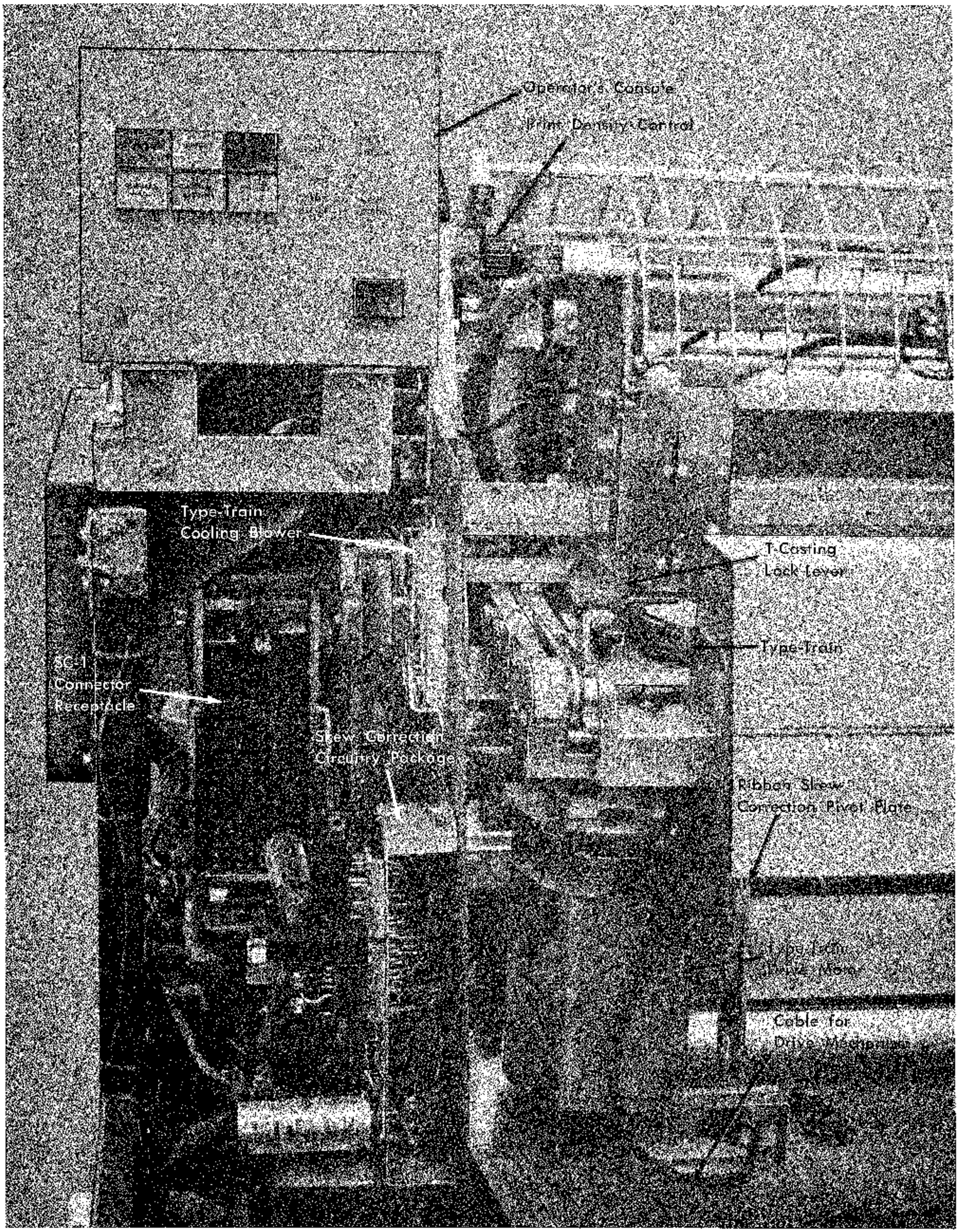

Figure 55. IBM 1403 Model 3 (Left Front, Skew Correction Device Out)

IBM 1416 Train Cartridge (Figure 56)

- **The IBM 1416 Train Cartridge is an interchangeable high-speed type-train unit.**
- **It contains 80 type slugs with three type characters on each.**
- **The individual slugs push each other around a track in the cartridge.**
- **The type slugs are propelled by a drive gear at the left end of the cartridge.**
- **They move 206" per second.**
- **Individual slugs can be removed.**

Description

The IBM 1416 Train Cartridge is standard equipment on the Model 3 printer. It has an upper-, center-, and baseplate, a drive gear at one end, and an idler gear at the other. The type train rides a track that is part of the baseplate. The idler and drive gears are fastened to the upper plate. The drive gear is driven by a horizontal key fastened to the timing disk gear. The cartridge, drive and timing disk gears, as well as the drive motor, are all mounted on the movable base. The upper and center plates have a slot in them through which individual slugs can be removed. To remove a slug, you have only to remove a block held by a single screw. The cartridge does not have to be dismantled.

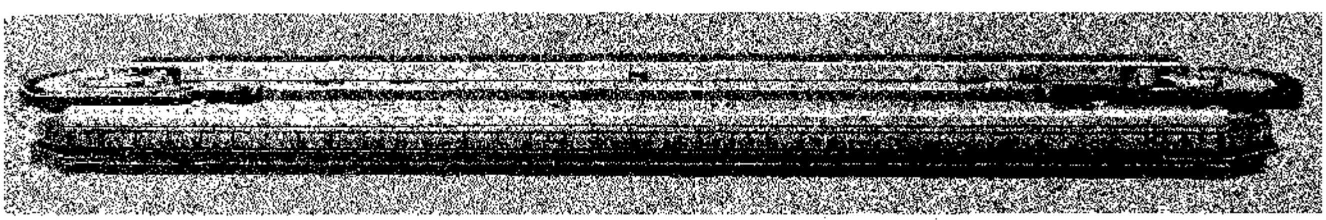

Figure 56. IBM 1416 Train Cartridge

Type Slugs (Figure 57)

The type slugs are made of sintered steel and are case hardened. Each slug has three type characters engraved and coined on its outer surface. The type stands out from the slug in three-dimensional relief. Six gear teeth are formed on top of the backside of each slug while a channel is formed underneath for straddling the guide track. A felt pad is embedded in a groove in the baseplate, for lubrication of the slugs. The slugs are completely separate and are not connected to one another. A type complement of 80 slugs completely fills the track. The drive and idler gears engage the teeth in the slugs at each end of the track. As the drive gear turns, it propels the meshed slugs around the curved end portion of the track until they disengage from the gear. Subsequent slugs, likewise propelled, then push these slugs, in turn, along the track. Since the train is endless, this process maintains a constant rotary motion, as the slugs push each other around the track at 206″ per second.

Type-Train Lubrication System

Because of its high speed, the type train requires proper lubrication at all times. A special lubricating oil (part 856381) is used. This oil is fed by a pump to a felt pad in a groove in the lower cartridge plate. Figure 58 shows this motor-driven pump which supplies the lubrication. The pump supplies a measured quantity of oil every two hours of running time to both the gear bearings, and to the track via the felt pad.

Cartridge Blower

When the train is operating, considerable heat is generated by its high speed. Unless dissipated, cartridge heat could rise high enough to break down ordinary lubricants and cause failures. A blower cools the cartridge. It is on a plate facing the left end of the cartridge. This blower blows a constant stream of air across the cartridge, preventing overheating.

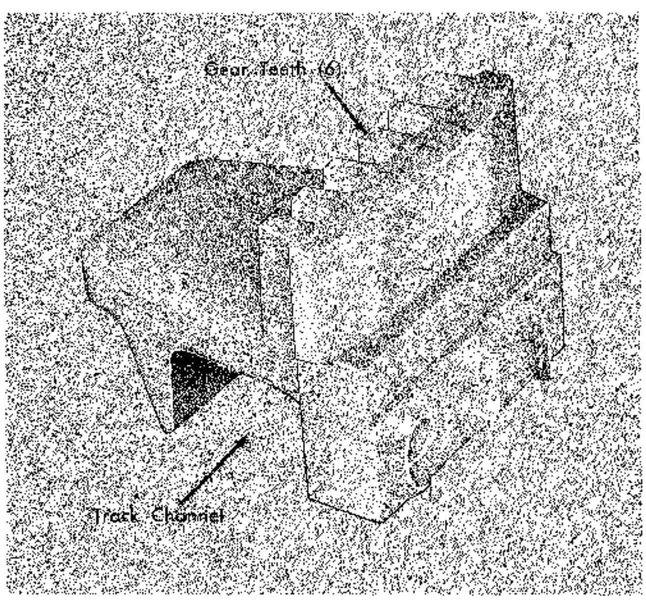

Figure 57. Train Cartridge Type Slug

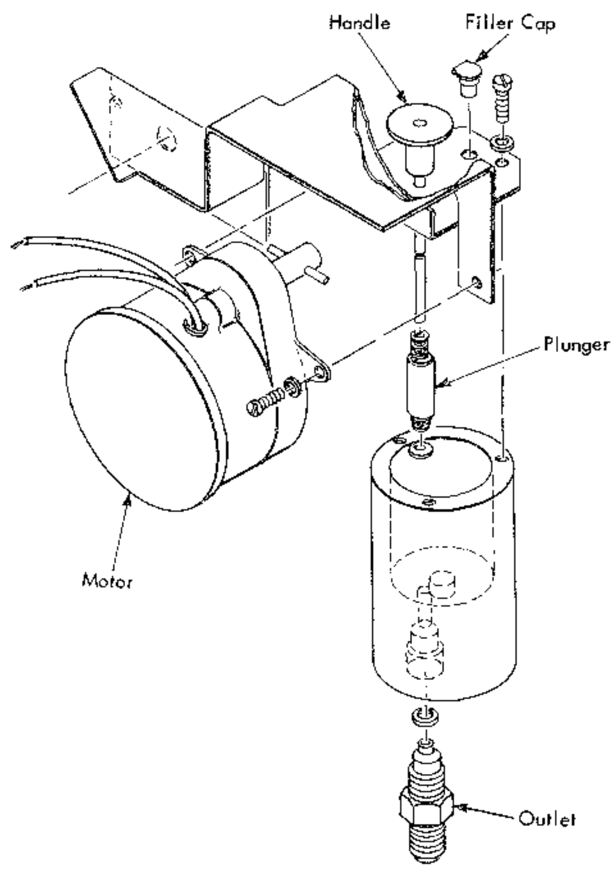

Figure 58. Type-Train Lubricator

Ribbon Mechanisms

- **Mechanisms are provided for ribbon feeding and skew correction.**

Ribbon Feed

- **The ribbon feed winds the ribbon during printing.**

The Model 3 printer uses the same ribbon-feeding mechanism as the other models except that it has a ribbon stop feature. Unlike the other models, whose ribbons wind continuously, the Model 3 ribbon stops winding when not printing. Circuitry effects this stoppage by opening the ribbon-feed clutch circuits if one second elapses without printing (01.08.1). Ribbon winding resumes with the next print operation, and stops one second later unless another print operation takes place before that time.

Ribbon Skew Correction

- **Skew-correction takes place regardless of ribbon winding direction.**

The ribbon is checked on the Model 3 for skew in both winding directions. Skew is due to the counterclockwise motion of the type train. It is a tendency of the ribbon to pull to the left and wind crooked on the spool. The sense finger that rides on the right edge of the ribbon near the upper spool to test for this condition is the same as on the Model 2. Here the similarity ends. The skew correction wheel has been replaced with a powered mechanism. This mechanism works in conjunction with the ribbon feed gears to sense the direction of winding. Correction is effected by shifting the left end of the ribbon spools to obtain correct winding.

Description

The position of the right edge of the ribbon is sensed near the upper right ribbon spool. This is the same mechanism as in the Model 2 printer. Every revolution of the drive gear, a roller on the gear lifts a sense arm and lets it drop. A sense finger hangs from a pivot at the upper end of this arm. When the arm drops, the sense finger lands on a spot where the edge of the ribbon should be if it is winding correctly. If this is the case, the motion of the ribbon moves this finger out of vertical alignment with its pivot, and both the finger and the sense arm drop. The correct winding of the ribbon opens a normally closed contact by allowing the sense arm to drop.

If the ribbon has moved to the left of its normal position (skew condition), the finger lands instead on the ribbon guide plate. With no moving ribbon beneath it to upset its alignment, the sensing finger remains upright and prevents the arm from dropping. The normally closed contact remains closed to start the skew-correction action.

The skew-correction mechanism (Figure 59) consists of a pivot plate on which the left-hand ribbon-

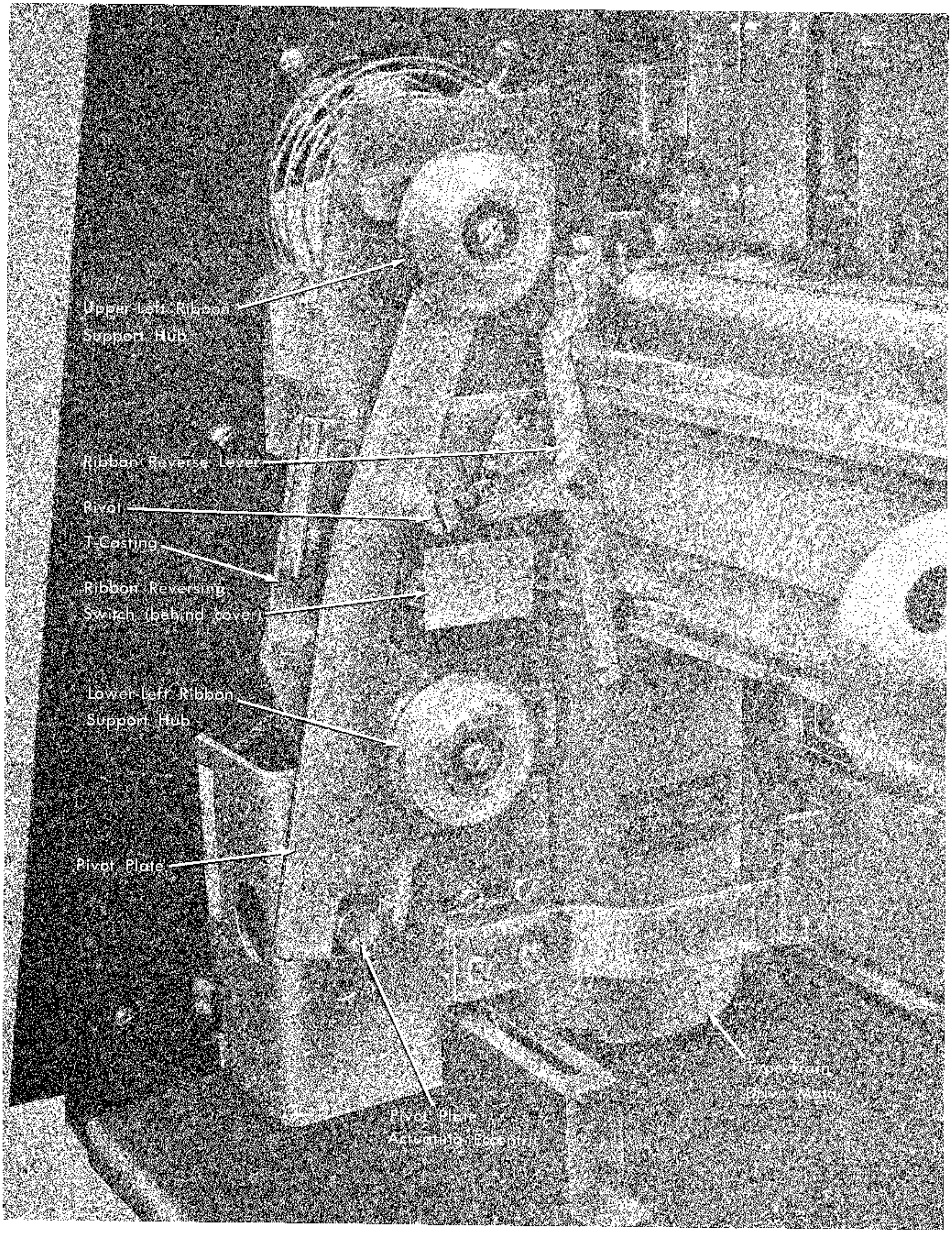

Figure 59. Ribbon Skew-Correction Mechanism

spool hubs are mounted. These hubs are not driven, but are free-spinning idlers. The plate pivots about a central stud between the two hubs. The amount of travel of the pivot plate is limited by the amount of eccentricity of its operating cam. This cam fits into a slot in the lower end of the pivot plate. The cam rotates one half a revolution each time corrective action is started.

During this half revolution, the lower end of the pivot plate moves in or out. The left-hand ribbon-spool hubs move in opposite directions. When the upper hub moves closer to the printer, the lower hub moves away from it. When the lower hub moves closer to the printer, the upper hub moves away.

Figure 60 shows the relative positions of the ribbon spool axes and the print line, both when correcting and not correcting. The axes of the ribbon spools always remain parallel to each other, but with respect to the print line, they shift as shown. This action overcomes skew and winds the ribbon squarely on the spool.

The skew-correction mechanism is operated by its own drive (Figure 61). A unitized motor and reduction drive assembly is fastened to the outside of a U-shaped bracket. Within the bracket are included two microswitches, a capacitor and resistor combination, and a roll-pin collar. The roll-pin collar is mounted on an extension of the reduction drive output shaft. The shaft is connected to the extension by a flexible coupling to insure bind-free alignment. The roll-pin collar has a roll pin inserted on each side, 180° apart. The shaft can rotate in one direction only. Two normally closed

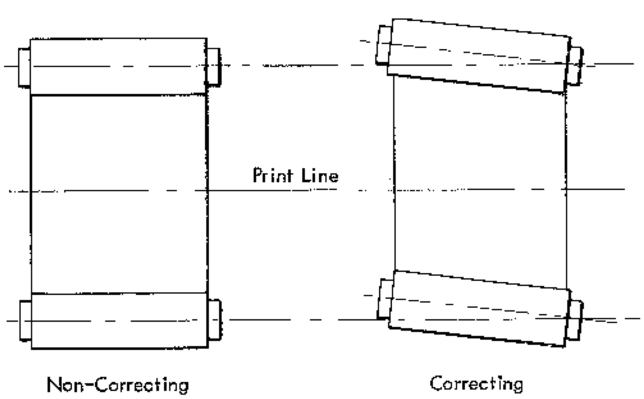

Figure 60. Skew-Correction Action

microswitches are mounted inside the wall of the bracket close to the roll pins. When corrective action is called for, the motor turns the shaft until one of the roll pins operates its respective microswitch, to open the circuit, and stop the drive motor.

On the outboard end of the shaft (not visible in the figure) is the eccentric cam that operates the pivot plate. This cam rotates 180° in each corrective operation, alternately shifting the ribbon first to one side of center, then to the other.

Circuit Objectives (Figure 62)

The position of the sense lever governs the operation of the correction mechanism and its circuitry. If the sense lever contact is open, it indicates that no corrective action is required, and the correction circuits remain inactive.

If the right edge of the ribbon is to the left of the sense lever, the lever does not drop. This indicates skew is occurring, and the sense-lever contact remains closed. As soon as the gear contact makes, it picks relay A. The A-1 contact point transfers and completes a circuit to contact B-2.

The condition of B-2 is determined by the direction of ribbon winding. Relay B is connected in parallel with the lower ribbon-clutch magnet, and thus picks whenever the ribbon is winding onto the lower spool. Each of the B-2 nonoperating contacts is connected to one side of its respective microswitch. Since the roll pins are 180° apart, one of these switches is normally closed while the opposite roll pin holds the other open. The other sides of the switches are connected together (commoned) and are in series with the skew-correction motor.

After a closed S1 or S2 is selected by the relays, the motor will run and the eccentric will move the pivot plate until the selected switch is opened by a roll pin. By this time the other switch is closed. When the line to this switch is selected, the motor will run again, and the pivot plate will return to its original position. Thus, the motor and shaft will always home in on the selected switch and stop when it opens. Because the switches are 180° apart, the system has two home positions. The eccentric shaft is set so these home positions correspond to the two extreme positions of the pivot plate.

Note that the motor switch selected will change when the condition of either relay A or B is changed. Figure 63 summarizes these conditions.

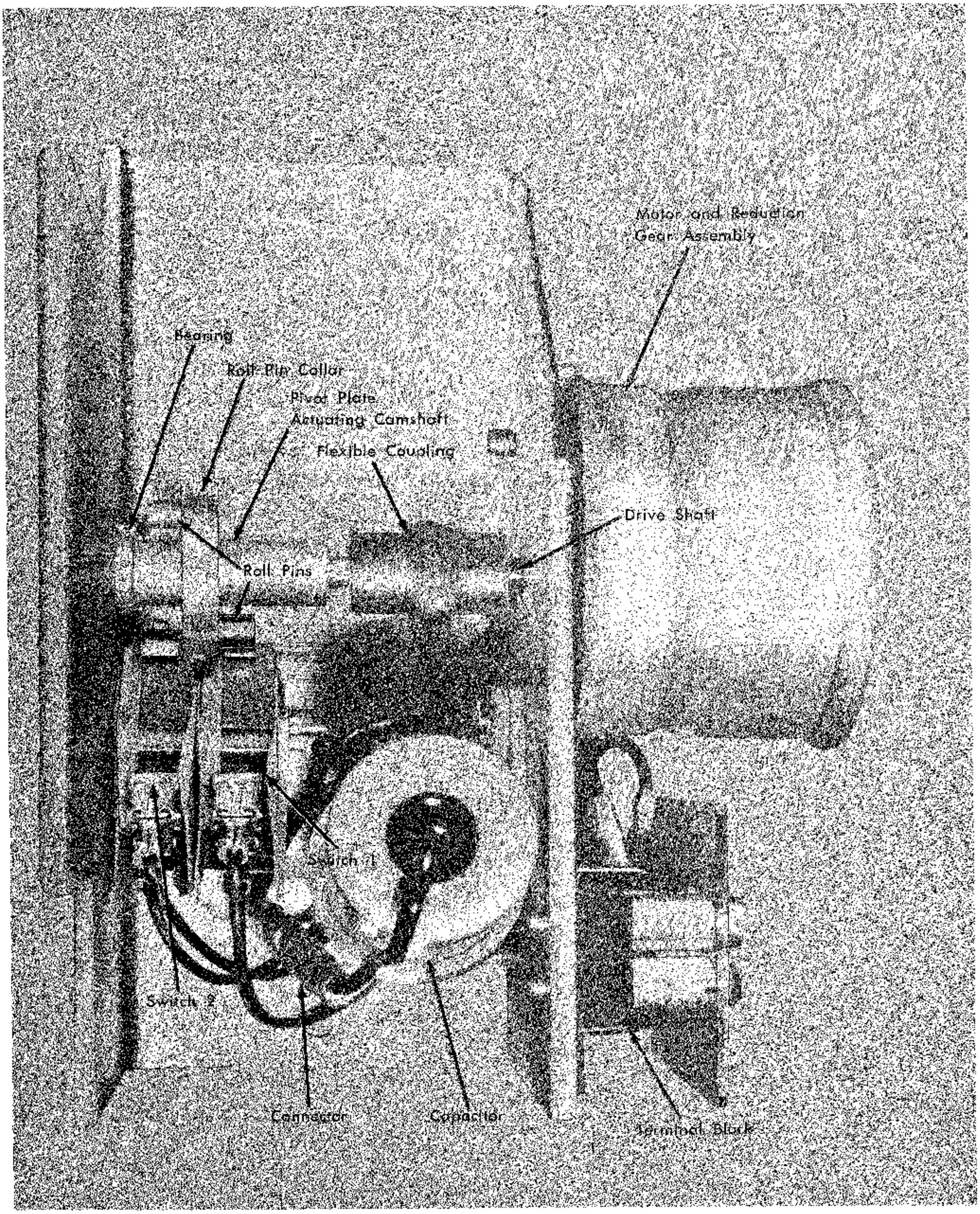

Figure 61. Skew-Correction Drive

Mechanical Principles of Operation

- **Printing in the Model 3 is accomplished by momentarily pressing the paper and ribbon against the continuously moving type faces.**
- **The pressing is done by a new hammer unit to go with the high-speed type train.**
- **Print impression is controlled in the hammer unit.**
- **Hammer travel is kept constant by the forms thickness lever. The print timing dial and mechanism have been eliminated.**
- **All other mechanical operations are the same as in other models.**

Printing is done by the hammer unit and the type train. The train spans the entire 132-position print line formed by the horizontal row of hammers. When a hammer (print) magnet is energized, it attracts its corresponding armature. The armature, as it moves toward the magnet, operates against its pushrod. The pushrod, in turn, is in contact with the hammer, and drives it forward. The hammer carries the paper and ribbon with it and quickly drives them against the moving type face on the train slug.

Figure 64 is a cross section of the printing mechanism of the Model 3 printer. All the principle components are shown. The hammers are kept in alignment by guide combs. You can keep the spacing constant between the hammer faces and the typefaces by compensating for the thickness of the forms with the forms thickness lever. This lever shifts the position of the movable base on the T-casting.

To provide for proper print density, an adjustable impression control pad is built into the hammer unit. This pad is on a bar positioned by wedges through the print density control knob. The hammer strikes this resilient pad, which absorbs part of the energy. Then, as the hammer strikes the type slugs, it rebounds. This action quickly restores the hammers for the next operation. No print-timing dial is used.

All other mechanical operation of the Model 3 printer is similar to that of the other models.

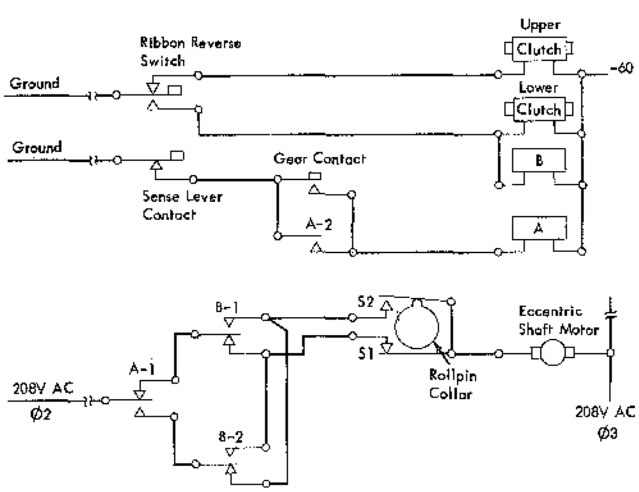

Figure 62. Skew-Correction Circuits

	Relay B not Energized (Ribbon winding on Upper Spool)	Relay B Energized (Ribbon winding on Lower Spool)
Relay A Energized (Ribbon to Left, Sense Lever Up, Sense Lever Contact Closed).	Top of Pivot Plate to Rear, Switch S2 selected.*	Top of Pivot Plate to Front, Switch S1 selected.*
Relay A not Energized (Ribbon to Right, Sense Lever Down, Sense Lever Contact Open).	Top of Pivot Plate to Front, Switch S1 selected.*	Top of Pivot Plate to Rear, Switch S2 selected.*

* To start 180° turn of Eccentric Shaft

Figure 63. Relay A and Relay B Conditions

Electrical Principles of Operation

- **The electrical principles of printing are the same in the Model 3 as in the other models.**
- **The higher speed of the Model 3 requires a 5-microsecond processing cycle.**

Except for the higher speed of operation, differences in the Model 3 electrical operation are few. The faster motion of the chain requires a repetition rate of about 5 μs per printing pulse. Systems that have this cycle rate can use the Model 3 directly. Other systems must use a print buffer having a 5 μs clock.

The principles of operation are the same in the Model 3 as in other models. These principles are not affected by the change in speed or by the slight differences of design in the timing disk and sense head of the Model 3.

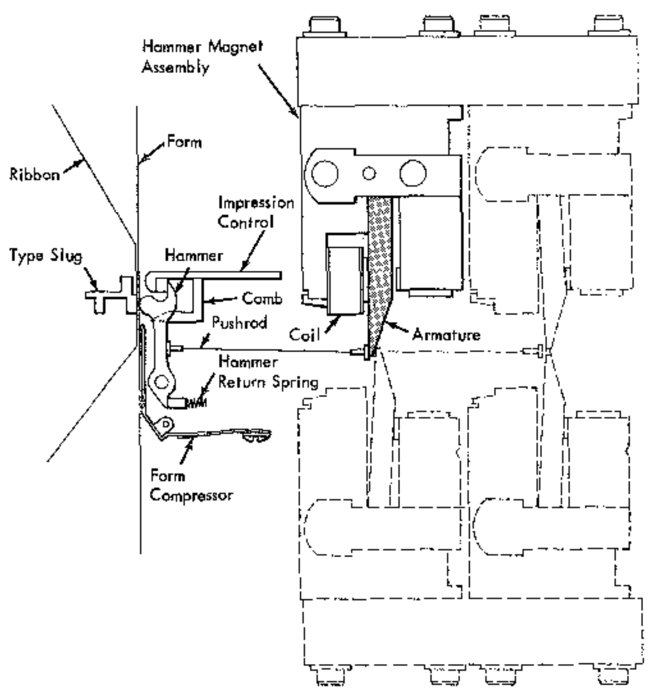

Figure 64. Cross Section of the IBM 1403 Printer Model 3

Just as in the other models, these three factors must be known in order to print intelligible information:

1. Specific type character that is aligned to print with some hammer.
2. Specific hammer position that is aligned.
3. Character in storage that is supposed to print in this position.

Again, just as in the other models, the only print information sent to the system is that supplied by the timing disk and transducer. The slugs in the train follow a definite sequence just as in the chain printer. The timing disk emits pulses in synchronism with the type movement. The system of subscans and print scans is the same. Only the frequency of the disk (print subscan) pulses is different. In the Model 3 the frequency is higher, due to its increased speed.

Identification of print positions and aligned type must be made within the system, with only the print subscan (PSS) pulses and the home pulse (supplied by the printer) to go on. Each system has its own method of doing this. Therefore, the names and arrangements of devices used in the systems may vary, and no attempt is made to describe them here. These items are functions of the various systems and are described in their respective customer engineering manuals of instruction.

The electrical principles of operation of the hydraulic carriage are identical in all models of the 1403.

- The Model 3 differs from the other models in two manual controls:
  Print density control.
  Forms thickness lever.
- Individual levers can be latched for gravity stacking.

With the exception of print density control and the forms-thickness lever, all of the manual controls for the Model 3 are the same as for the Model 2. The print timing dial of the Model 2 is not used in the Model 3.

Print Density Control

The print-density control knob on the Model 3 is on the upper left side of the print frame. Its function eliminates the need for a print-timing control on the Model 2. As the knob is turned, it moves the hammer impression control bar and pad closer or farther from the type train. Thus, the energy of the hammer at impact may be controlled. The timing is not affected when changing density as in the Model 2.

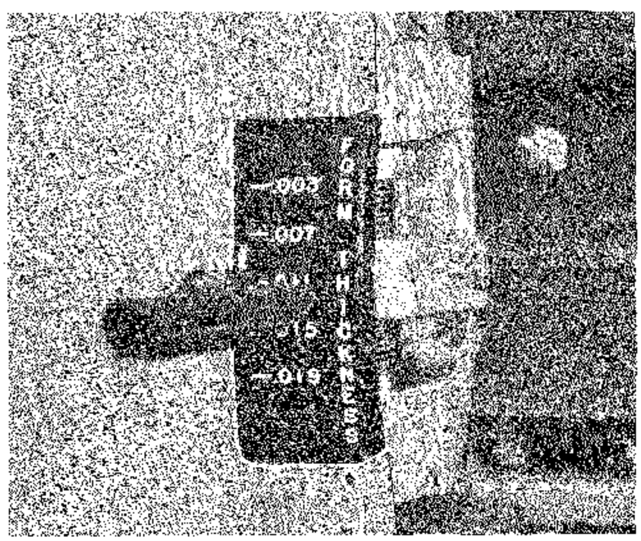

Figure 65. Forms Thickness Lever

Forms Thickness Lever (Figure 65)

This control is at the right end of the ribbon cover on the main casting (the same as the print-density lever on the Model 2). The lever permits manual adjustment for various forms thicknesses, both single and multiple copy.

The lever moves the train cartridge toward or away from the hammer unit in the same way that the Model 2 print-density lever operates. The adjustment range is calibrated from .003″ minimum to .019″ maximum.

Although the lever is labeled in increments of .004″, the operator may choose any setting required, either at the labeled points or in between. Proper setting ensures that the hammer faces are parallel to the typefaces at impact.

The forms-thickness lever, together with the print-density control, eliminates the need for the print-timing dial and its associated chart. These items are not found on the Model 3.

Stacker

The forms stacker is the same as it is on the other models. It is included under *Manual Controls* because it has new manually operated gravity stacking latches. The individual latch levers can be seen in Figure 66. When lifted up, these levers can latch in place to hold their individual pressure rolls away from the friction powered stacker rolls. This permits the forms to stack by gravity rather than under power of the rolls.

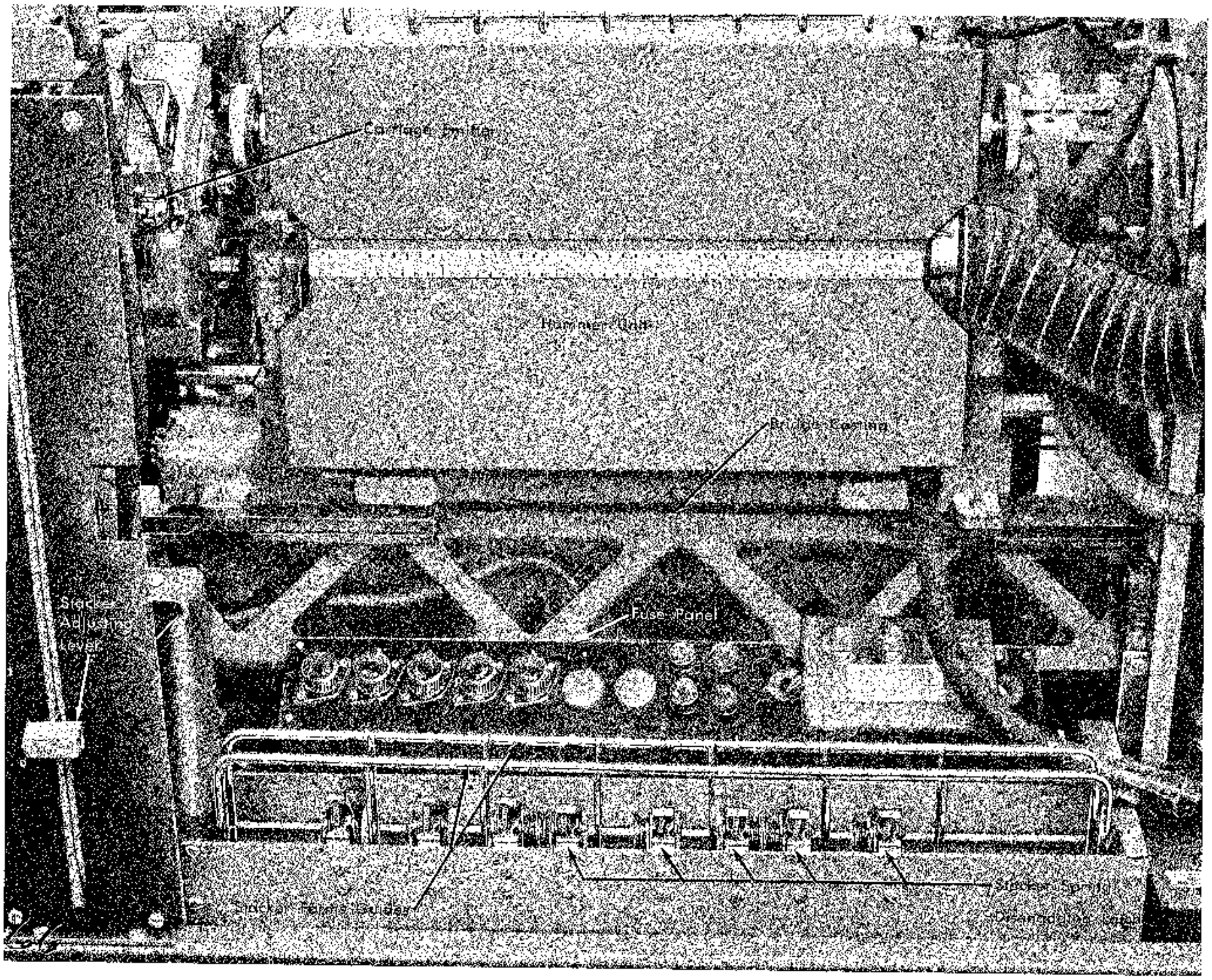

Figure 66. IBM 1403 Model 3 (Rear View)

Summary of Model Differences

- Significant printer differences between the Models 2 and 3 are summarized as follows:

Model 2 Printers	Model 3 Printers
Use the type-chain cartridge with 120 type slugs	Use the IBM 1416 Train Cartridge with 80 type slugs.
Each slug has 2 type characters.	Each slug has 3 type characters.
Chain moves about 90" per second.	Train moves about 206" per second.
Chain moves about .001" in 11.1 μs.	Train moves about .001" in 5 μs.
Have medium size chain drive motor mounted on angle, attached to T-casting.	Have large size train drive motor mounted vertically, attached to movable base.
Use magnetized timing disk.	Use nonmagnetized timing disk.
Have print density control that adjusts the movable base on the T-casting.	Have forms-thickness-control that adjusts the movable base on the T-casting.
Print density is controlled by positioning movable base on T-casting.	Print density is controlled by impression control bar in hammer unit.
Have print timing dial and mechanism.	Have no print timing dial or mechanism.
Have detachable guide wire on ribbon shield.	Have no guide wire on ribbon shield.
Have two different kinds of print-magnet armature assemblies.	Have only one kind of print-magnet armature assembly.
Print armatures operate print hammer directly (without pushrods).	Print armatures operate print hammers through two sizes of pushrods.
Have paper guards on lower forms tractors with roll pin stop in left-hand translator frame slide.	Have no paper guards on lower forms tractors. Roll pin and guards have been replaced by a new design lower ribbon shield.
Have common stacker-spring lift-bar for gravity stacking.	Have individual latching levers for gravity stacking.
Ribbon skew corrected in one winding direction only by an idling correction wheel.	Ribbon skew corrected in either winding direction by a motor-driven correction mechanism.
Ribbon winds continuously.	Ribbon winds only during printing operation.

In all but the Model 3, the impression control pad is set in the hammer unit and serves to absorb hammer energy as the chain is moved further away by the print-density-control lever. The print timing dial and mechanism is operated to advance the timing of the chain PSS pulses to compensate for the changes of chain position made by the print-density-control lever.

In the Model 3, the optimum distance from the hammer is kept constant by correcting for the amount of thickness of the forms used (forms thickness lever). Since the distance the hammer travels (and correspondingly, its time of flight) is fixed, there is no print timing dial or mechanism. Print density is regulated by varying the position of the impression control pad (within the hammer unit) with respect to the position of the hammer at its point of impact.

General Information

- The 1403 Model N-1 printer uses the same basic operating units as the 1403 Model 3 printer.
- The covers are different. The N-1 top cover operates electrically.
- A new method of cooling and forms stacking is used.
- Some location changes have been made.
- Manual single-cycle operations have been eliminated.

The IBM 1403 Model N-1 Printer uses the IBM 1416 Train Cartridge. It can print at 1100 lpm. The printer and hydraulic tape-controlled carriage are the same as those used in the 1403 Model 3.

A system of hush covers minimizes the noise of its high speed. These covers are acoustically insulated and replace the electromagnetic dampeners in the Model 3. The large top cover with the window is electrically operated. It operates automatically, opening at the end of a printing operation, or when a condition arises that requires operator intervention. Push button switches to raise and lower the cover are provided front and back. Those in front are on the operator's console at the top left of the machine. The rear switches are with the start, stop, and carriage restore switches in the left rear cover.

The back of the machine has three hinged covers: a large center cover, with a smaller one at each side. The hinged side covers are held closed by permanent magnets attached to them. The large center cover contains the stacker.

The stacker is built into the large hinged rear center cover. The stacker swings open with the cover for servicing. The stacker rolls are self-powered by a small motor. The stacker rolls and motor assembly can be raised or lowered in a manner similar to the forms stacker guide in the 1403. As the paper stacks, it piles up on a horizontal metal grill that can be adjusted to suit the length of the form.

A single blower, through a system of ducts and hoses, cools the entire printer. This large blower is at the bottom of the right side of the machine. It draws air in through a large filter and distributes it to the type train, hammer unit, and hydraulic unit.

The main switch and fuse panel are in a box inside the left side cover. The power cable receptacle is on the underside of this box. Alongside the box, side by side, and to the rear, are the SC-1, and SC-2 signal-cable-shoe receptacles.

The two SMS amplifier cards for the train timing disk are near the right rear of the printer.

All the standard and optional features of the 1403 Model 3 printer apply to the N-1. The manual single-cycle operation has been placed under control of the start key. The single-cycle key and switch have been eliminated.

Special Features

Auxiliary Ribbon Feeding Feature

- **This is a ribbon-skew correction device for plastic ribbons.**
- **Correction for skew is made as required, regardless of direction of ribbon winding.**

To provide improved print quality, a plastic (polyester or nylon) ribbon is used. Such ribbons require the use of this feature.

This feature closely resembles the skew-correction device that is standard on the 1403 Model 3 and the N-1. In operation, it is the same but some physical differences exist. For instance, the pivot plate drive is slightly different, and optical, rather than mechanical, sensing of ribbon alignment is used. In other respects it is the same, and it can also be used with fabric ribbons. For more details on the operation, see the description in the section *IBM 1403 (Model 3): Ribbon Skew Correction.*

Interchangeable Chain Cartridge Adapter Feature

- **This feature gives a variety of type styles to the printer.**
- **It is standard on the 1403 Models 3 and N-1.**

This feature permits the operator to insert an interchangeable chain cartridge (Figure 67) with different type font, style, or special character arrangement.

The change can be made quickly without special tools. Printer operation remains unchanged. Two interchangeable cartridges are supplied: one replacing the standard permanent chain, and one additional cartridge.

A cartridge interlock switch (01.07.1) opens unless the cartridge is correctly locked in position in the machine. This switch is in series with the gate interlock switch.

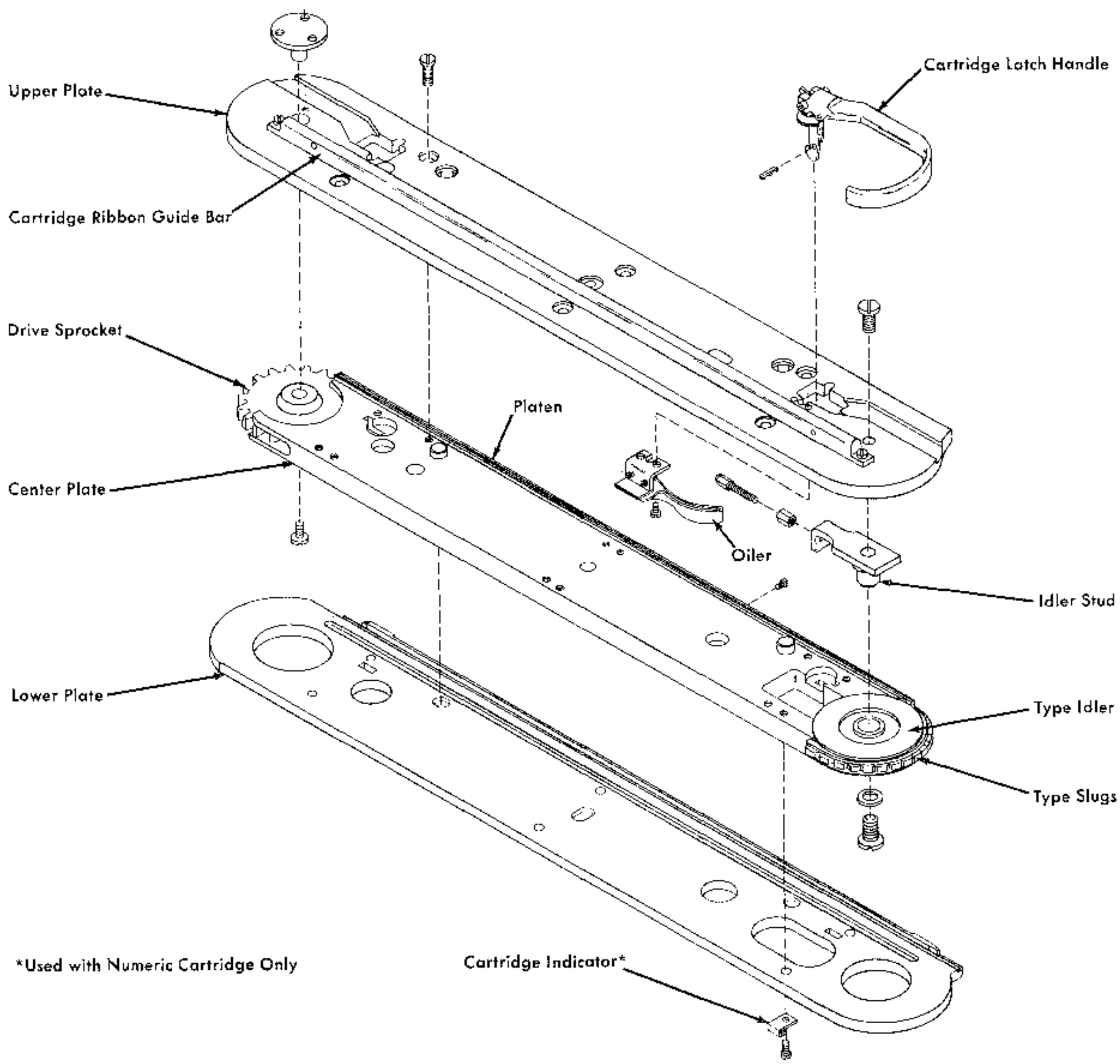

Figure 67. Interchangeable Type-Cartridge Assembly.

Numerical Print Feature

- **This feature allows the operator to change from alphamerical to numerical operation at will.**
- **It permits printing speeds up to 1,285 lpm, depending on the operation.**

Machines with the numerical print feature have the interchangeable cartridge. The numerical print feature is available only as a factory-installed option on printer Models 1 and 2.

With this feature, the operator can switch from the alphamerical to the numerical mode by changing the chain cartridge.

To change from one mode to another, it is only necessary to remove one chain cartridge and replace it with the other. When a numeric chain cartridge is placed in the printer, the corresponding mode is selected automatically by the −T numeric line (01.07.1, *Numerical Printer System Diagram).*

When the printer is operating in numeric mode, standard carriage operation and checking remains the same except that an alphabetic character causes a print check error.

The chain has ten numeric and six symbol characters arranged in 15 identical arrays.

This feature is not available on printers used with the 1401 Model A system, or with System/360. The interchangeable chain cartridge adapter described in the *Interchangeable Chain Cartridge Adapter Feature* section is a prerequisite for the numeric print feature.

Preferred Character Set Feature

- **This feature permits printing speeds up to 1,400 lpm.**

Preferred character set (PCS) is a special feature available only on Model 3 and N-1 printers used with the 1460 system or System/360. It allows higher printing speeds than usual by a special arrangement of selected, or preferred, characters in the type train. The speed of operation depends upon the frequency of printing of the characters most common in the train.

This feature requires the IBM 1416 train cartridge with the preferred character set print train. For use with either the 1460 or System/360, the preferred character set adapter feature must be installed in the printer control circuitry. A special PCS transducer is added to the printer with this feature. The home pulse output must fall within the home select gate provided by the control circuits.

Selective Tape Listing Feature

- **This feature suspends normal carriage operation, and allows printing on individual narrow paper tapes.**

The selective tape listing feature allows printing on individual paper tapes. These tapes can be 1.5″ wide or 3.1″ wide. Four 3.1″ tapes or eight 1.5″ tapes can be used. They can be in combinations if the wider tape uses positions 1-2, 3-4, 5-6, or 7-8. The tapes are not fed by the standard carriage, which is disconnected when this feature is used. Instead, they are fed individually by magnetic feeders under program control. No forms-skipping is possible when using this feature.

To use the feature, the operator inserts a tape guide plate. Inserting the tape guide plate causes an interlock switch to disable the standard carriage-control circuits and activate the tape-feeding circuits.

This feature is limited to use on printer Models 1, 2, and 3 with 1420, 1460, System/360 and the 1401 (except Models A and D). It can be used with either the alphameric chain or Numerical Print Feature on Models 1 or 2. On the Model 3 it can be used with either the alphamerical train or preferred character set feature.

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