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Customer Engineering Manual of Instruction

56 Card Verifier

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56 Card Verifier

MINOR REVISION (September 1962)

This edition, 223-6026-6, obsoletes 223-6026-5, and all earlier editions. Significant changes have been made throughout the manual, and this new edition should be reviewed in its entirety.

Contents

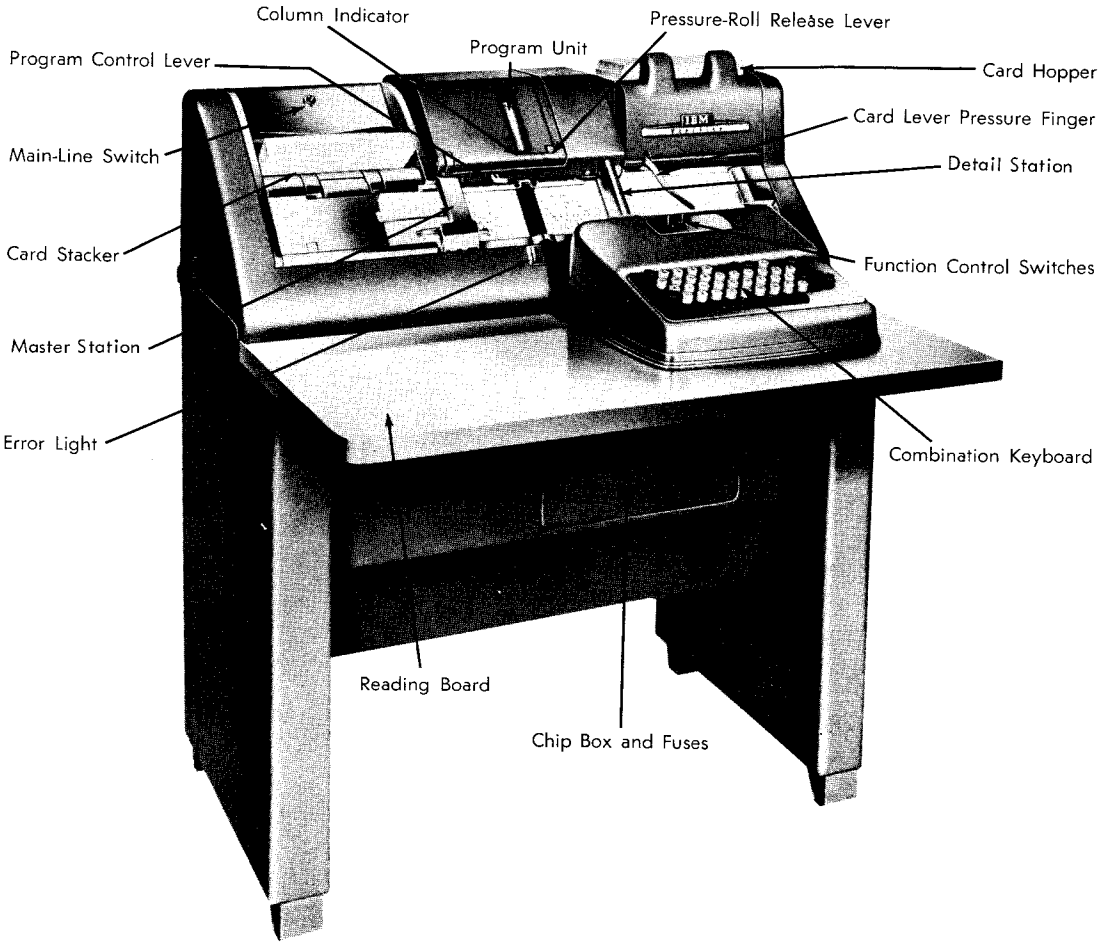


Figure 1. IBM 56 Card Verifier

The main function of the IBM 56 Card Verifier (Figure 1) is to compare a character that is punched in a column and another character that is either keyed by the operator or read from a master card. A program drum can contain a prepunched card that controls machine operation.

This manual describes mechanical and electrical principles, circuits, and relays for this machine. Detailed operating principles of the machine are found in IBM *56 Reference Manual* (Form A24-1018).

Removal and adjustment procedures and preventative maintenance instruction are published in IBM *24 Base Machines, CE Reference Manual,* (Form 225-6535). To avoid duplication, this information is excluded from the instruction manual. A copy of the reference manual accompanies all machines that leave the factory.

The IBM 56 derives many of its mechanical features from the IBM 24 and 26, which it closely resembles. A knowledge of the card punch is helpful in studying the verifier, but not required because the common features of both machines are discussed here. Special emphasis is given to the circuits that apply to verification.

Program Unit

An important feature of the IBM 56 is its flexibility in controlling automatic verification and skipping. The machine accepts instruction from a program card to:

1. cause auto-verification over designated fields.
2. skip columns or fields that are not to be verified.
3. permit manual verification from the keyboard of either alphabetic or numerical punching.
4. shift the keyboard for automatic operation.

The program card is a standard IBM card in which various code punches have been placed to control machine operation. The program card is fastened around the program drum (Figure 2) and installed in the program unit. The program drum is designed to revolve clockwise (column one to column eighty of the program card) as cards move through the detail station. At the same time the program drum advances column by column, the codes in the program card are sensed electrically and relayed as instructions to the machine.

For example, a 12-hole must be punched in every column except the first (left-hand position) of every field to be skipped, automatically verified, or manually verified. These 12's serve to continue to the end of a field any skip or automatic verification started within that field. Several consecutive fields to be automatically skipped or verified as one field should be programmed as a single field. A single-column field should not be programmed with a 12-code.

The 12's are punched in the program card for manually verified fields to cause occasional skipping or semi-automatic verification. These functions are started by pressing a key and are carried across the field by the 12's. This type of skipping is similar to an X-level skip on other IBM card punches or card verifiers. The semi-automatic verification is useful in the case of two or more cards punched with the same information.

An 11-hole punched in the first column of any field automatically starts the skip, which is continued over that field by the 12's punched in the remaining columns of the field. If a single column is to be automatically skipped, punch it with an 11. This coding operates in conjunction with an automatic skip-and-verify switch, which must be ON to start the skipping automatically.

A zero punched in the first column of any field starts automatic verification, which is continued over that field by the 12's punched in the remaining columns of the field. If a single column is to be automatically verified, punch it with a zero. This coding operates in conjunction with an automatic skip-and-verify switch, which must be ON to make the zero coding effective.

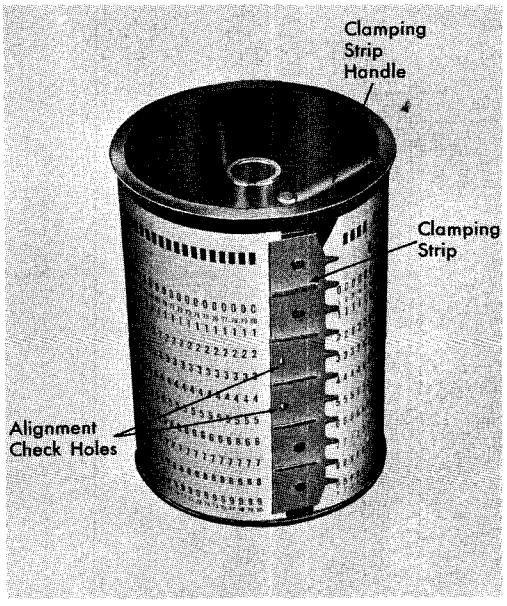


Figure 2. Program Drum

When the program card is in the machine and the starwheels are lowered, the combination keyboard is normally in numerical shift: pressing any one of the two-purpose keys causes a figure to be verified. To verify a letter, the combination keyboard must be shifted for alphabetic verification. This shifting is caused by a 1 in the program card in each column of the alphabetic field.

The four basic program codes are:

Code	*Function*
12	Field Definition
11	Start Automatic Skip
0	Start Automatic Verification
1	Alphabetic Shift

The other digit rows in the program card control functions that are explained under *Optional Features*. Do not use a program card that has a cut upper-right corner. The cut may interfere with the OK notching, which indicates that the card is correct.

Keyboards

The IBM 56 can be equipped with either a numerical (Figure 3) or a combination keyboard (Figure 4). The combination keyboard includes numbers, letters, and eleven special characters. Refer to Figure 5 for punch codes. When selective-feature keys are not used, they can be blocked by rubber washers beneath the key tops. Field conversion without exchanging keyboards is thus made practical.

The IBM 56 machines equipped with the combination keyboard remain in alphabetic shift during verification without program control. When the program-control lever is turned ON (starwheels lowered), the keyboard is in numerical shift for all columns except those programmed for alphabetic shift.

Some features that have to do with verification set these keyboards apart from those used with the IBM 24 and IBM 26:

Figure 3. Numerical Keyboard

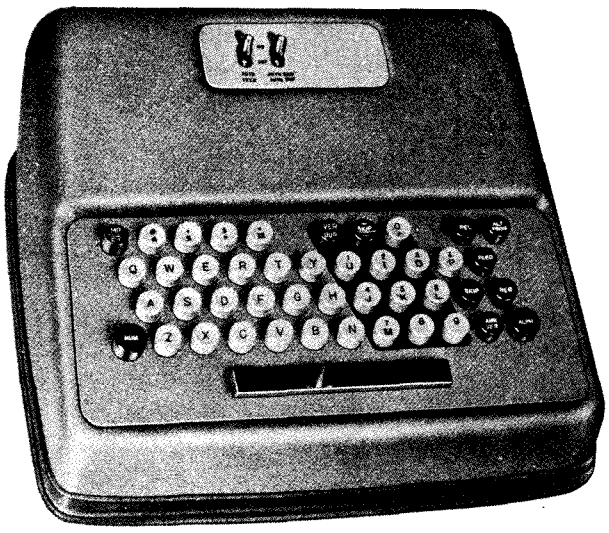


Figure 4. Combination Keyboard

LOWER PUNCH	ZONE			
	12	11	0	N
1	A	J	/	I
2	B	K	S	2
3	C	L	T	3
4	D	M	U	4
5	E	N	V	5
6	F	O	W	6
7	G	P	X	7
8	H	Q	Y	8
9	I	R	Z	9
8-3	.	$	,	#
8-4	␣	*	%	@
Blank	&	-	0	

Figure 5. Punching Codes

Multiple-Punch/Error-Reset (MP/ER) Key: Pressing this key causes verification of multiple punched columns. The same key is used to reset the machine and cause additional trials when an error occurs, or when the feed key is pressed by mistake.

Verify Key: In the absence of field definition in the program card, pressing the verify key causes single column auto-verification as long as the key is held down. In a field defined in the program card, pressing the verify key causes auto-verification for the remainder of that field.

Dash-Skip Key: When the keyboard is in numerical shift, pressing this key verifies an X and causes skipping. If the keyboard is in alphabetic shift when the dash-skip key is pressed, an X-punch is verified but no skipping occurs.

Skip Key: The machine does not skip from punched columns unless it is programmed to do so automatically. Pressing the skip key results in a verify cycle that reads the column of operation. If the column is blank, a skip follows. If it is punched, a normal error condition occurs and the keyboard locks. Press MP/ER to reset the keyboard. Once an error is indicated and the machine is reset, pressing the skip key causes the card to be error-notched (on the second error trial) before skipping.

Release (REL) Key: Before card-lever relay two is energized, pressing REL causes any card registered to be passed through its station beyond column eighty at 12 ms per column. This condition exists when the machine is turned OFF after a card is registered. Neither OK-notching nor error-notching occurs.

During a normal run, pressing REL causes the machine to follow the program controls and pick up auto-verification fields if the auto-skip/auto-verify switch is ON. Blank columns of the program card cause automatic space cycles until the field-definition punches are read in the program card, at which time skipping occurs.

When the starwheels are raised, with relay 2 up, and REL is pressed, the card automatically spaces out at 50 ms per column.

A released card is not OK notched. A latch-type relay is picked up in parallel with the release relay, which suppresses notching. The latch relay is latch-tripped on the next card-feed cycle.

An error sensed during auto-verification on a release is treated as a normal error: it cancels the release. When the error condition is cleared, REL can again be pressed.

Error Light

An error light notifies the operator that a difference has been sensed between the master card and the detail card, or between a punch in the detail card and the key that was operated for that column.

The error light is designed to remain ON until the error condition is rectified, or until the column in error is notched. Pressing MP/ER does not put out the error light, but it does condition relays that cause error-trial cycles. This key can be pressed any number of times between trial cycles.

At the first indication of an error, during manual or automatic verification, the error light goes ON and the keyboard locks.

Follow this procedure:

1. Free the keyboard by pressing MP/ER. This conditions the machine for the second trial. The error light remains ON.
2. Make the second trial verification. If the second attempt is correct, the error light goes out and verification can continue. If not, the keyboard locks again.
3. Reset the keyboard by again pressing MP/ER.
4. Make the third trial verification. If the third attempt is correct, the error light goes out, and verification can be resumed. If the third trial is incorrect, the column in error is notched. Error notching automatically eliminates OK check notching for that card, because the card is incorrect.

Visibility of Card Columns

On this machine, the operator can see all card columns up to, but not including, the error column. The operator can locate the error column by noting the last column correctly verified or by consulting the column indicator, which points to the error column.

Automatic Feeding

When the auto-feed switch is ON, each correctly verified card is OK-notched. A new card feeds from the hopper as the card already in the detail station is registered.

Should any column of the card be error-notched, automatic feeding is suppressed, and it will be necessary to press FEED to feed the next card.

Any card that passes through the machine and is not OK-notched suppresses automatic feeding. The feed key must always be pressed after pressing REL.

Movable Column Indicator

The IBM 56 has a movable column indicator. The machine escapes from column to column before it verifies, until an error occurs. When an error occurs, escapement is suspended. Normally, the indicator points to the number of the column to be keyed next. When an error is indicated, the error column must be keyed again. Therefore, the indicator moves back one column to show which column has the error condition. The indicator operates in parallel with the error light. It remains shifted for errors until the column is found correct or until the error column is notched.

Figure 6 presents a graphic view of the card-column relationship after registration. If column one is to be verified, escapement carries the detail card to column one before verification. As soon as column one is verified, the indicator points to column two. If there is an error in column one, the pointer returns to column one until the condition is cleared, then goes on to column two automatically. The cards remain in the same relationship during all operations.

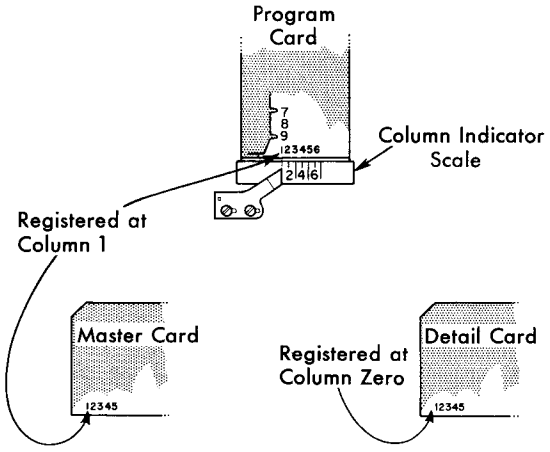


Figure 6. Column Orientation

The IBM 56 is built on the IBM 24 base. Many mechanical features of the two machines are identical. A front view of the IBM 56 with covers removed is shown in Figure 7a. The error light is found in place of the backspace button. The verifying and notching mechanisms occupy the position of the die and stripper on the IBM 24. Figure 7b is a rear view showing unit locations.

A view of the tube panel and relays is shown in Figure 8a. The relays are in the lower right-hand corner looking from the back. Older machines have a terminal panel as shown in Figure 8b.

Figure 9 shows the path of card transportation. Two card-feed cycles are required to move a card from the hopper to register position in the detail station. On the first feed cycle the card moves from the hopper through steps 1 and 2. On the second card feed cycle the card moves to steps 3 and 4, where it is held in register position between a smooth feed wheel and a pressure roll.

The program drum comes to rest at column one after each card-feed cycle. The most recently completed detail card moves into the master station and is registered in column one. The new detail card is registered in column zero. The three units maintain this relationship throughout each card operation.

The mechanisms that move the card into position and through the machine are described in the following pages. A knowledge of card movement is important to the study of the verifying unit.

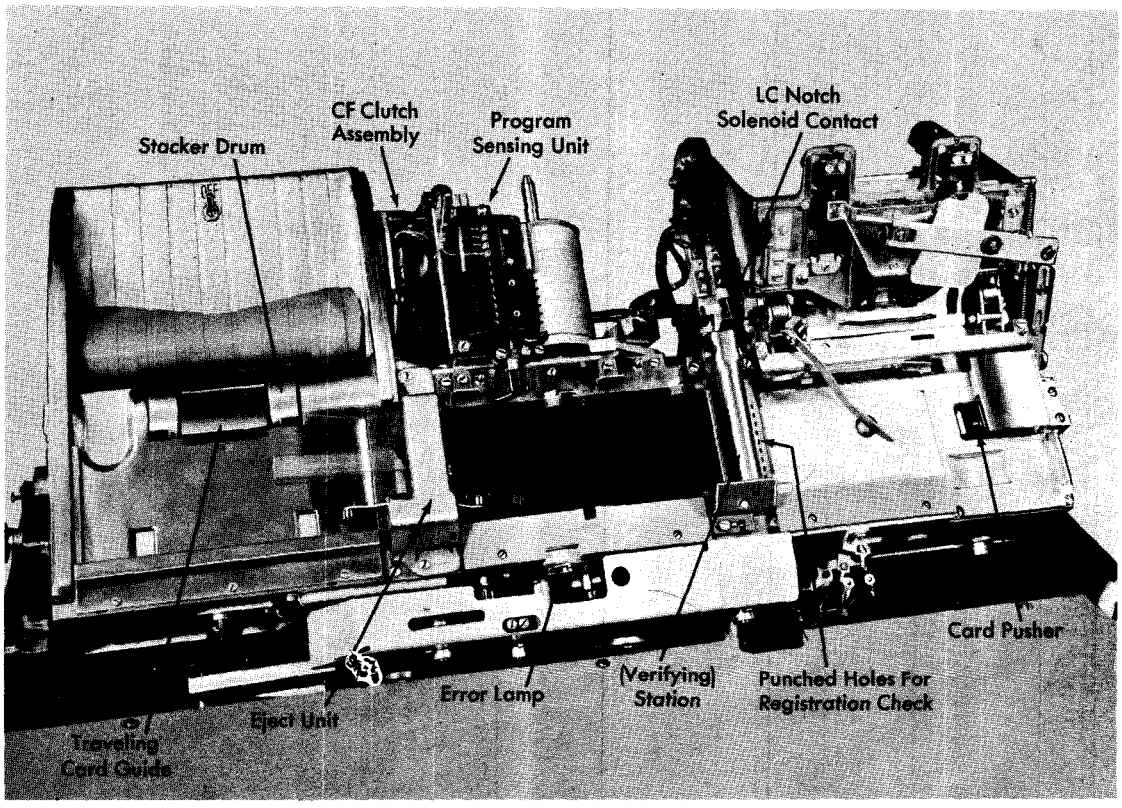


Figure 7a. Card Verifier (Front View — Old Style)

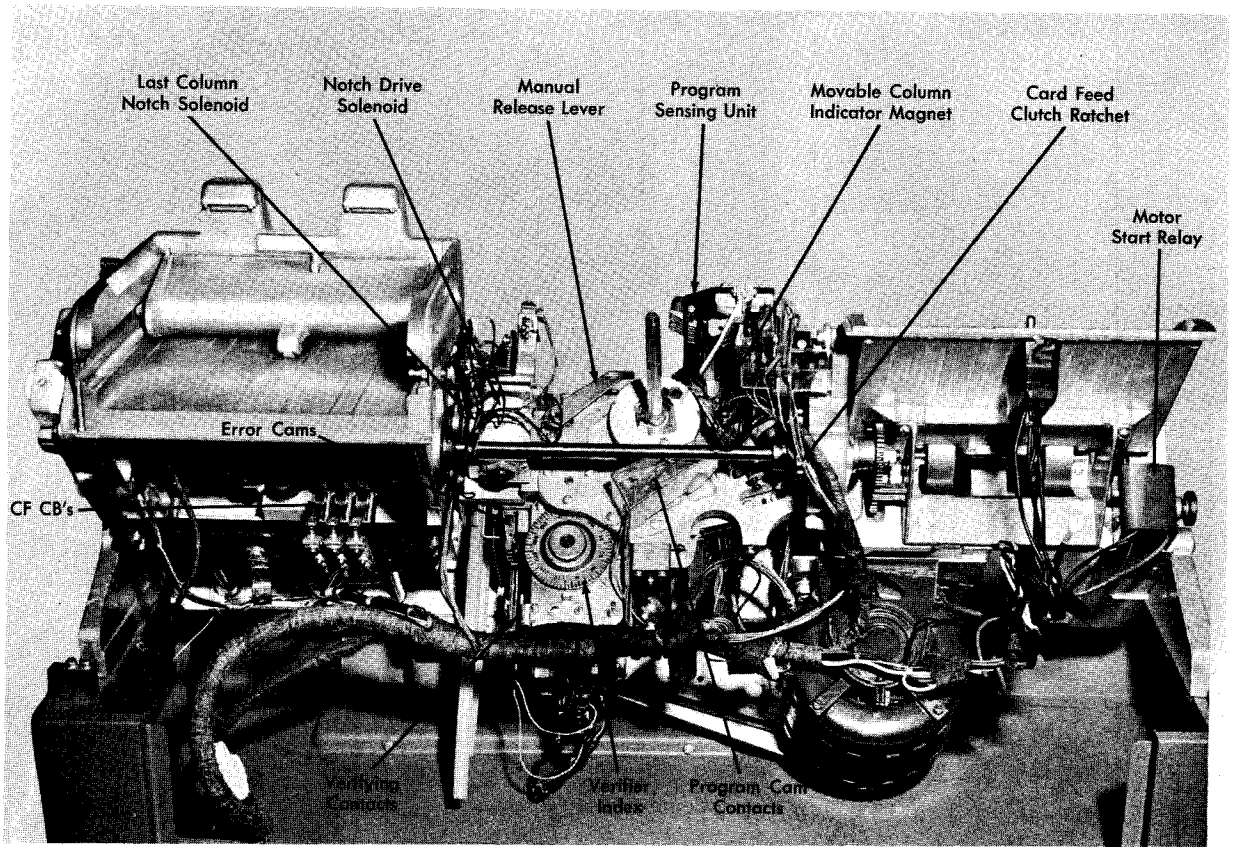


Figure 7b. Card Verifier (Rear View — New Style)

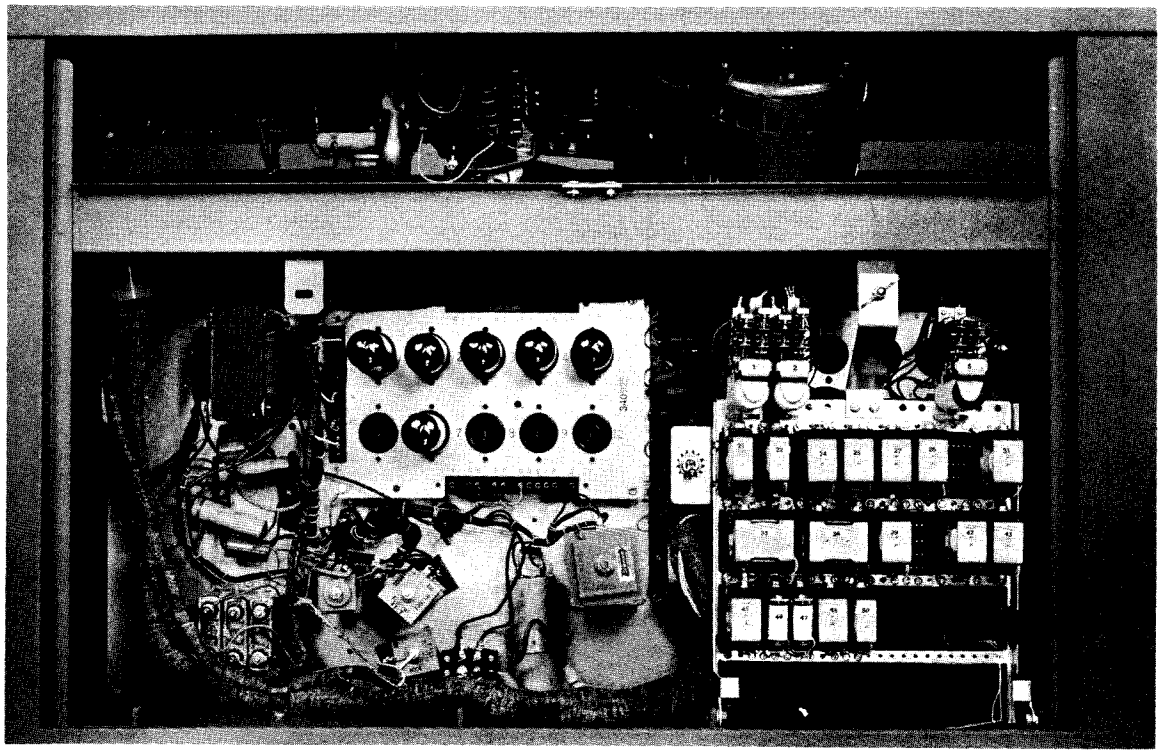


Figure 8a. Tube Panel and Relays

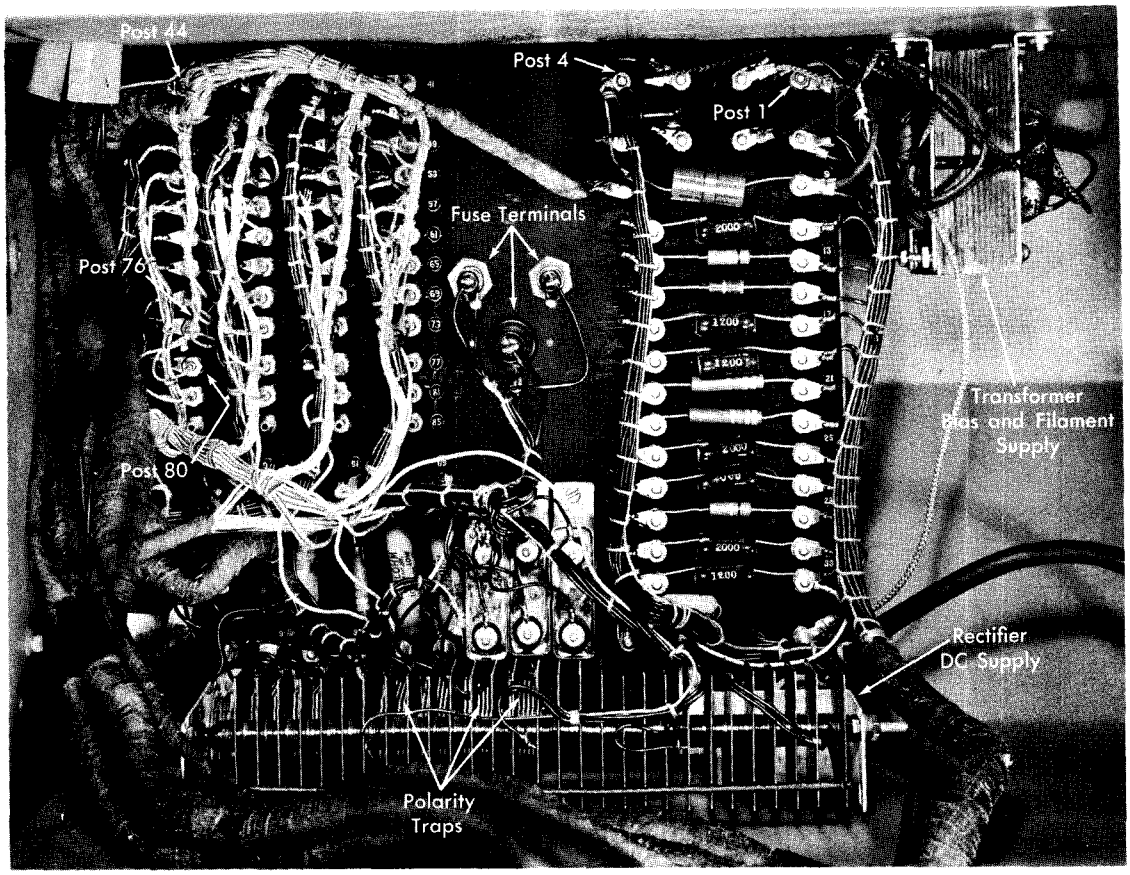


Figure 8b. Terminal Panel

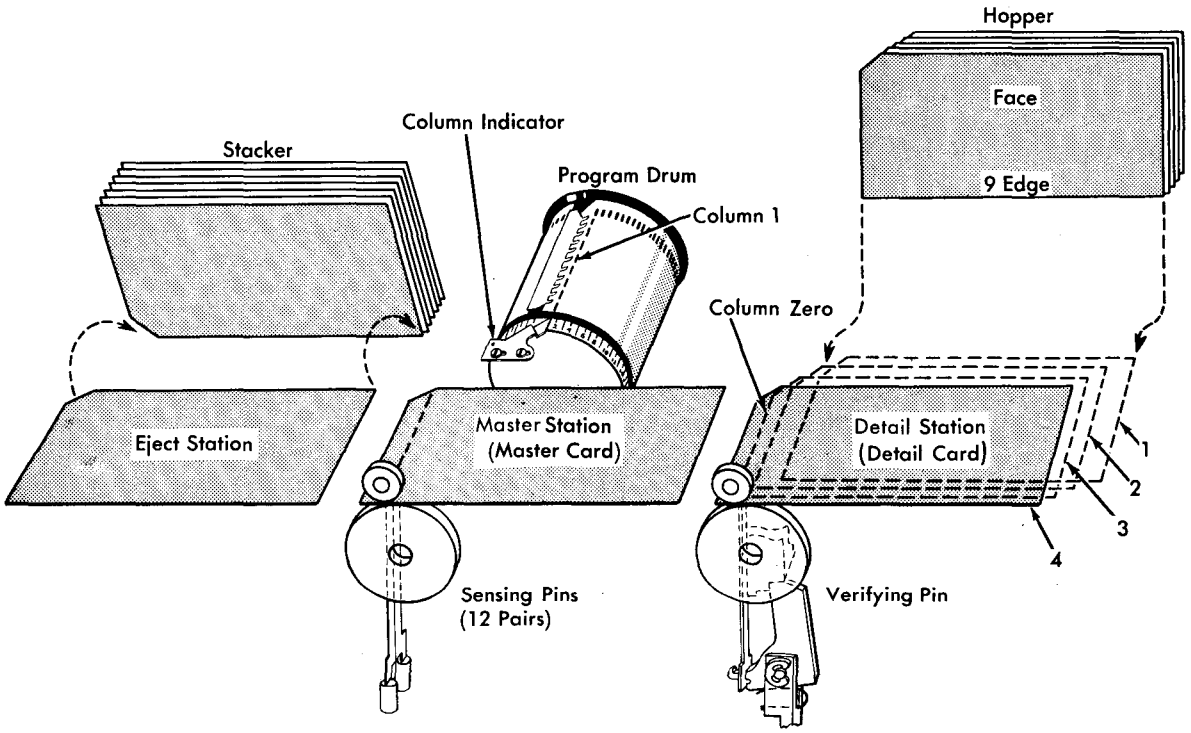


Figure 9. Path of Card Transportation

Drive Mechanism

Motive power for the IBM 56 is supplied by a ½ hp motor. A belt drives the verifier drive unit, which is controlled by the verifier clutch. A second belt drives continuously running members and the card-feed clutch ratchet.

Reduction Drive

The speed of the drive motor is reduced twenty to one to obtain a lower, more practical, speed for operating the various gear trains.

Earlier machines use a reduction drive unit as shown in Figures 10 and 12b. The reduction-gear housing is located directly below the worm gear. If lubricant must be added or changed, it is convenient to do so with the drive housing removed from the machine. A cover plate on top of the unit can be removed to expose the reduction gear for inspection. The recommended lubricant can be added and the level checked with the top plate removed.

The worm shaft rotates in powdered-bronze bearings. The rear bearing is seen at the left of the rear cover plate in Figure 10. The front bearing is shown at the right of the worm-shaft collar. The front bearing is held in place by a setscrew in the drive housing casting.

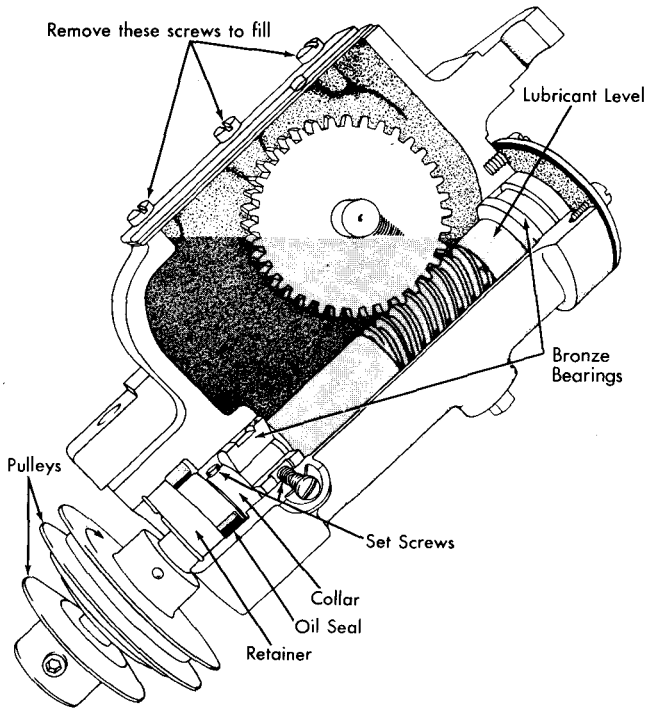


Figure 10. Reduction Drive Unit (Old Style)

Oil Seal

The worm-shaft oil seals (Figure 11) are a type often used in IBM equipment. A driving ring of synthetic rubber, leather, or composition material is contracted about the worm shaft and rotates with it. The driving ring and rotating seal are snugly fitted and seat firmly against the shaft collar. When the outer shell and gasket are fitted into the housing, the seal spring forces the stationary seal face against the rotating seal face. The two seal surfaces are micro-lapped within a few light bands of optical flatness. These mirror-like surfaces form the seal to retain the lubricant.

Newer machines accomplish this speed reduction through a system of external gears not encased in a housing.

Figure 12a shows the new reduction drive. The external gears transmit motion through an idler gear to the card-feed ratchet. A bevel gear on the card-feed ratchet assembly drives a transverse shaft. It, in turn, applies force to turn the continuous member of the friction drive, register roll, and the eject roll.

Machines with the high-speed skip device have an additional pulley on the drive-motor shaft. This cog-belt pulley drives the high-speed skip mechanism.

Card-Feed Clutch Control

When the card-feed (CF) clutch magnet is impulsed, the dog drops into the ratchet driving the stacker, feed knives, card-feed circuit breakers (CFCB's), card-pusher cam, and the card-stop cam. The card-feed clutch delivers the card into the bed and takes it out by stacking it behind others previously run. The clutch is mechanically designed to make one complete revolution

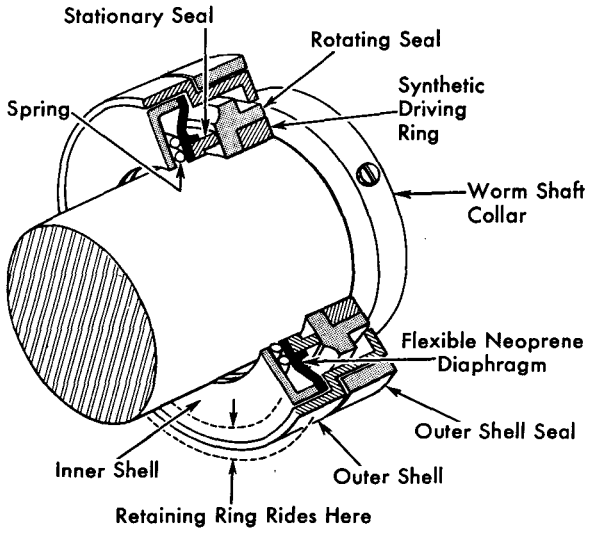


Figure 11. Oil-Seal on the Reduction Drive

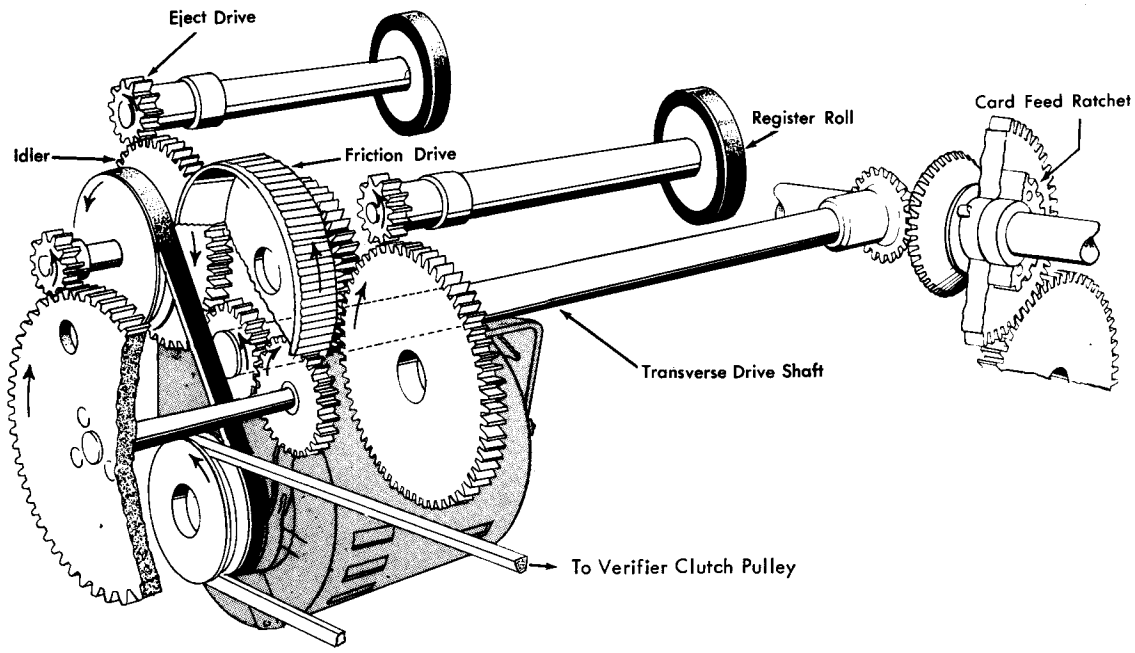


Figure 12a. Reduction Drive

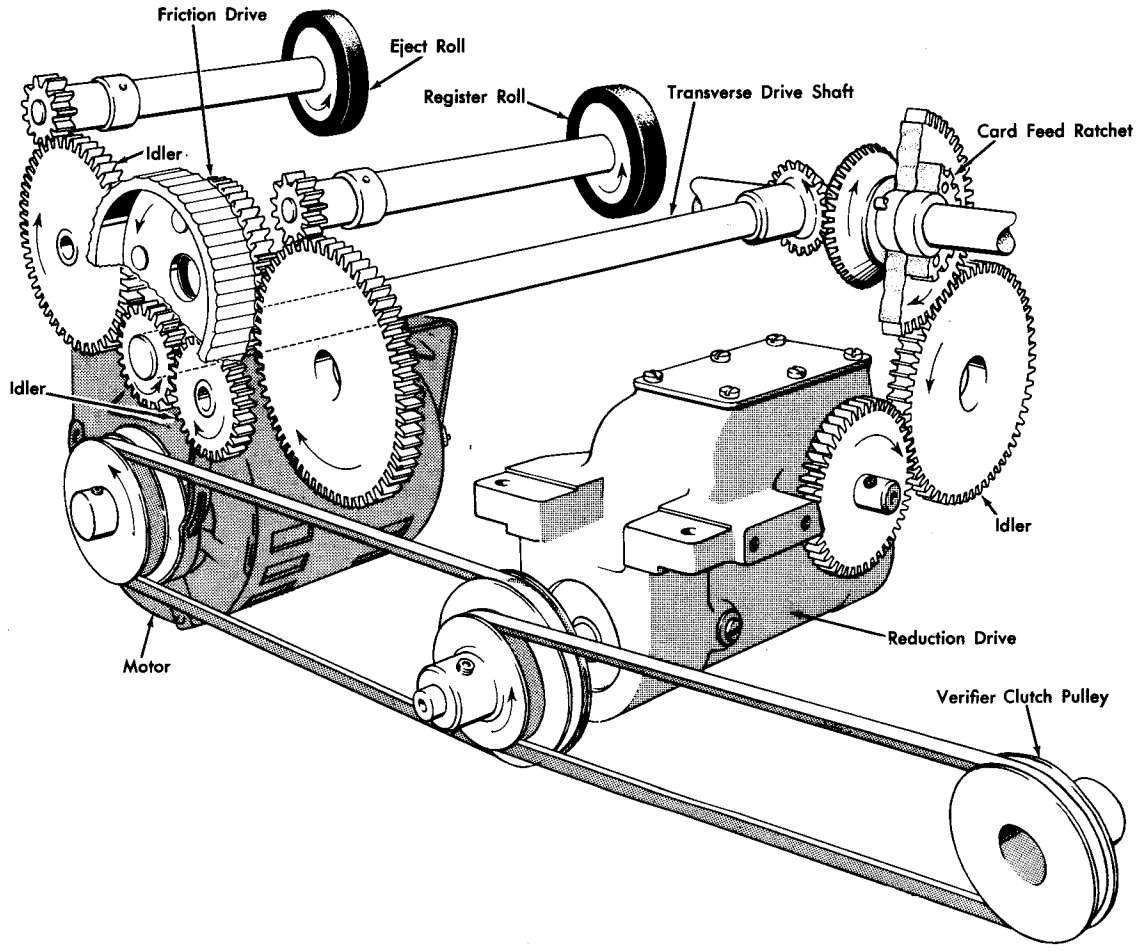


Figure 12b. Old-Style Reduction Drive

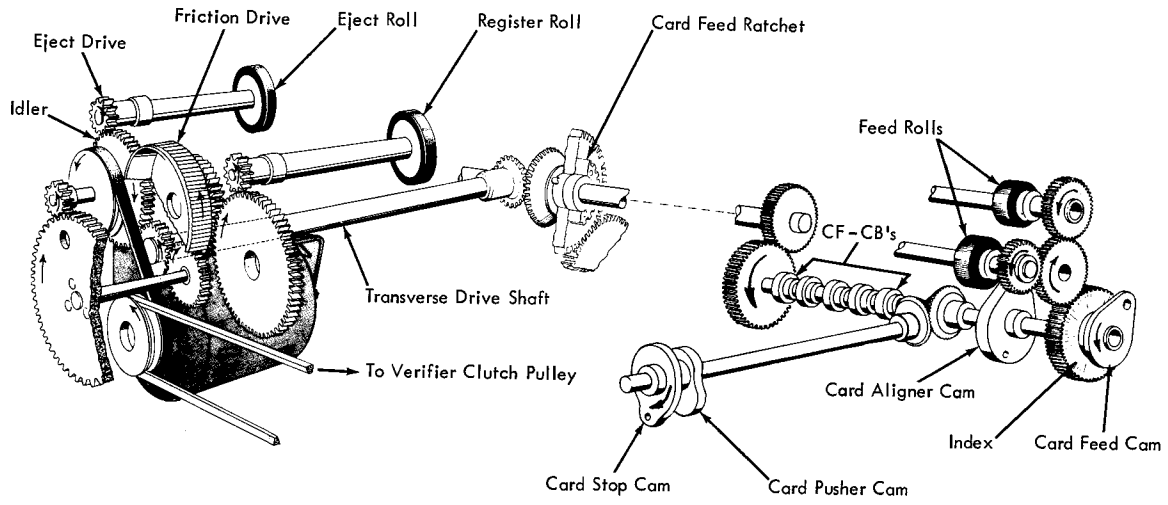


Figure 13. Card-Feed Clutch Control

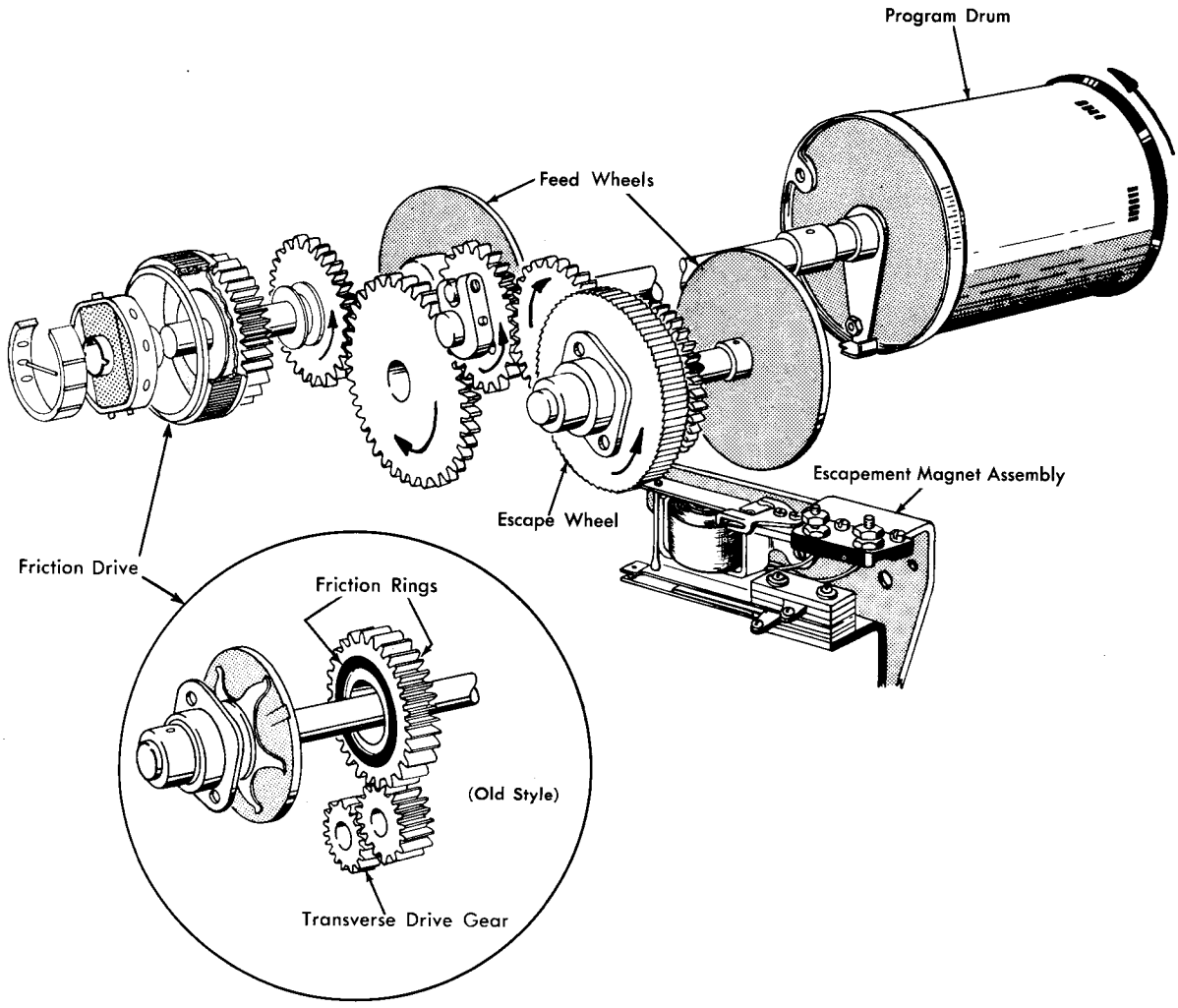


Figure 14. Friction Drive to Escapement Assembly

and then latch until the card-feed clutch magnet is again energized. The assemblies under control of the card-feed clutch appear in Figure 13.

To advance the card through the detail and master stations, the friction drive turns the escape gears when the escape armature releases the gear train. These gears are shown in Figure 14. The escape gearing must be free of binds so that, when the escapement releases it, there will be no delay before the escapement occurs. To eliminate the possibility of a lock-up resulting from a gear jam, it is important to keep card chips out of the gears. It is also important to form a clear picture of the devices that operate with each clutch control before studying the circuit description.

Friction-Drive and Escapement Gearing

The friction-drive and escapement mechanism controls transportation of the card through the master and detail stations and advances the program drum.

The friction drive is expanded in Figure 14 to illustrate its construction. In the older machines the friction-drive gear is held firmly between a pressure disk and the first gear in the escapement gear train by the force of an adjustable spider spring. The friction-drive gear is faced on each side with friction rings.

On newer machines a new-style friction drive is used. A lubricated nylon ring rubs against a clutch housing fastened to a continuously running friction-drive wheel. This ring is permanently fastened to a shaft that controls the escapement assembly and turns the assembly when the escapement armature is pulled away from the wheel.

Card-Feed Unit

Figure 15 illustrates the mechanism that moves cards from the hopper to the detail station. Two card-feed cycles are required to transport a card from the hopper to the detail station. Feed cycles are initiated by energizing the card-feed clutch magnet. Figure 9 shows the card path from the hopper to the stacker. On the first card-feed cycle, a card leaves the hopper, passes through stage 1 and ends at stage 2. On the second card-feed cycle, a card is aligned at position 3 and pushed to 4, to be ready for verifying.

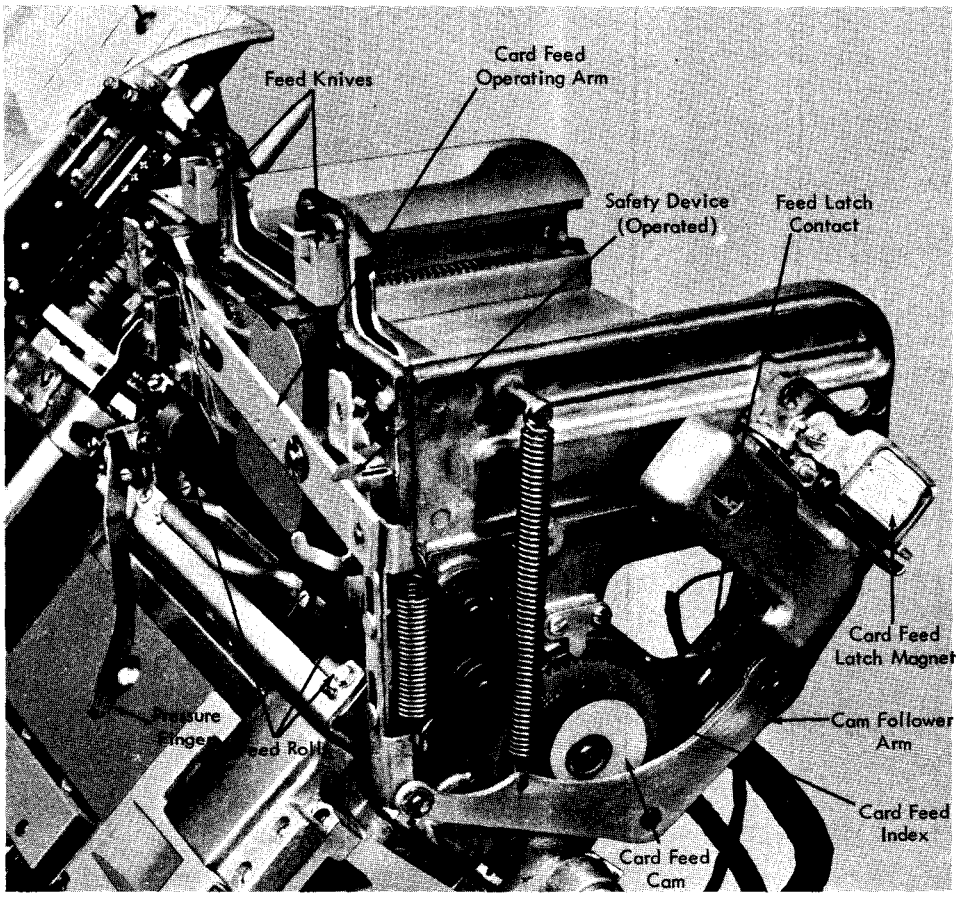


Figure 15. Card-Feed Unit

Notice that when the master card and program drum are standing at column one, the detail card is standing at column zero.

Card-Feed Clutch

The card-feed clutch (Figure 16) is a conventional dog-and-ratchet clutch. The CF (card-feed) clutch magnet attracts its armature, the dog drops into a tooth in the ratchet, and it rotates once until it hits the restored armature at which time the dog pulls out of the tooth of the ratchet.

The card-feed clutch controls the operation of the stacker, feed knives, cams, aligner fingers, pusher arm, pressure roll opening device, and eject mechanism.

The card-feed clutch magnet can be energized through the feed key, the register key, or program-cam contact two (when the auto-feed switch is ON).

The card-feed clutch ratchet is continuously driven through an idler gear from the external reduction gears and drive motor. The ratchet assembly rides free on the card-feed shaft.

Hopper

The capacity of the IBM 56 card hopper is approximately 500 cards. Cards are placed in the hopper face forward and 9-edge down. A spring-operated pusher plate holds the first card firmly against the front wall of the card magazine. Two magazine springs keep the cards from falling through the knife-and-block throat. Because the cards are registered at the detail station, the hopper has sufficient end play for easy insertion of new cards. The pusher plate latches in the rear position to aid in card manipulation.

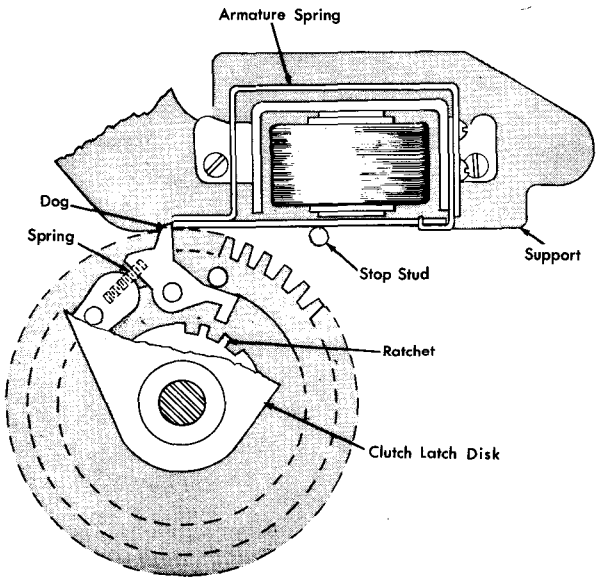


Figure 16. Card-Feed Clutch

Feed Knives

Two card-feed cycles are needed to register the first card in the detail station. Thereafter single card-feed cycles position each following card in one-fourth second as a new card is fed into the detail station. On the first feed cycle, the two feed knives grip the 12-edge of the card and slide it through the throat to the first of two sets of feed rolls. Card guide plates direct the card through its curved path to the detail station. As the first card leaves the second set of feed rolls, card aligner fingers push the card under the card rail and onto the station. The 9-edge remains under the rail (Figure 17). The card-lever pressure finger acts as a card guide and holds the cards against the detail station and the detail card lever.

Card-Feed Latch Magnet

When cards are hand fed, it is desirable to advance a card to the master- or detail-feed rolls without drawing a card from the hopper. Figure 15 shows that the card-feed cam follower arm is spring operated and cam restored. On a register operation it is desirable that everything on the card-feed and stacker units operate except the feed knives. A hook on the card-feed latch-magnet armature intercepts the card-feed cam-follower arm and prevents it from moving the feed knives.

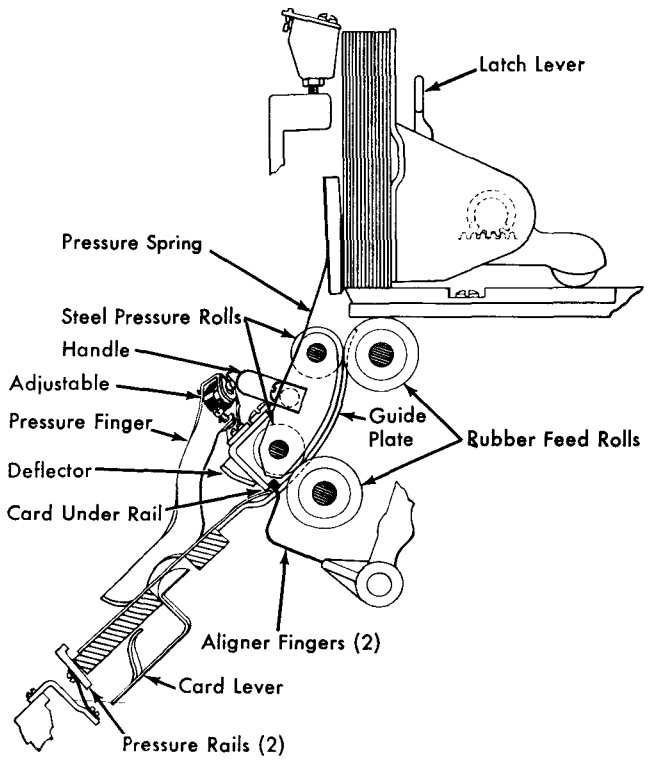


Figure 17. Card-Feed Path

Card-Feed Index

The card-index index is mounted on the right end of the CFCB shaft outside the right side frame of the card feed unit. It is stamped on the side of the feed-roll gear. The index turns at 60 rpm during card-feed cycles and indicates zero when the card-feed clutch is latched. The card-feed index is used as a reference for timing the card-feed circuit breakers, the card-pusher cam assembly, and the card-feed unit itself.

Detail-Card Lever

The detail-card lever consists of a contact-lever button, which extends slightly above the base of the card bed, and a contact. An adjustable pressure finger (see Figure 15) extends over the button from a point near the top edge of the card bed. A stiff spring keeps the pressure finger against its stop screw, so cards entering the detail station operate the card lever. Clearance maintained between the pressure finger and the card bed prevents a drag on cards being registered or verified.

The card-lever contact closes at approximately 210 degrees of the first feed cycle and remains closed until the last card passes the detail station. The card-feed circuit breaker, which picks the card-lever relay, is timed to break before the card-lever contact makes on the first feed cycle. Therefore, the detail station is not conditioned to operate during the first feed cycle.

Manual Release Lever

A manually operated release lever (Figure 18) is located at the right of the program drum. Pressing the release lever operates the pressure-roll release mechanism at both the master and the detail stations. A card thus freed at the detail station can be removed by hand. A card past the point of registration in the master station is moved out to stacking position because the eject arm roller forces the card against a continually running feed roll. If the card in the master station is at the right of the eject stop plate, pressing the release lever causes the card to move to the left and come to rest against the stop plate.

The release lever aids in removing damaged cards from the machine. Do not operate it during verification, because this would result in loss of correct card registration.

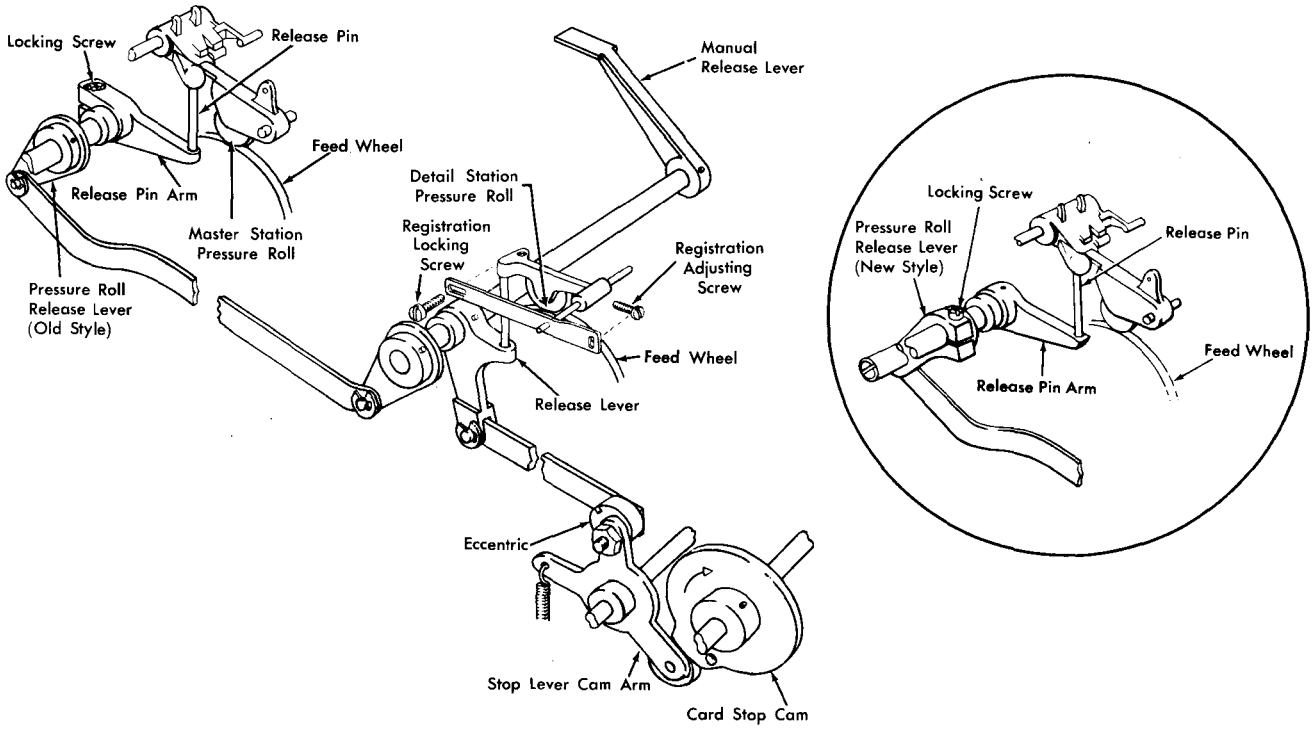


Figure 18. Manual Release Mechanism

Registration at the Detail Station

As the first card in the detail station is aligned, the card-pusher arm positions it between the lower detail feed roll and the detail pressure roll (which takes the place of a card rack). Registration occurs as follows.

After the aligner fingers position the card fully into the station, the card-pusher arm moves to the left, engaging the card at the column-eighty end. The pusher pad provides an adjustable segment of the base to the card-pusher arm (Figure 19). The pusher arm travel is limited by its stop screw, which is also the registration adjusting screw. As a new card arrives in the bed, the pusher arm is retracted to clear the card.

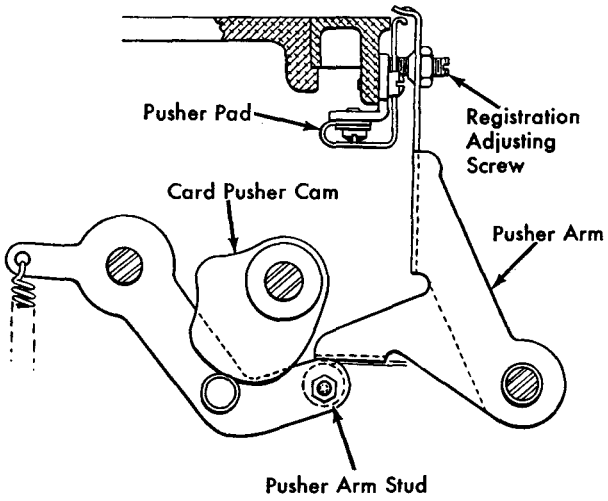


Figure 19. Card Pusher Arm (Old Style)

In Figure 20, the card is being registered between the two feed rolls just inside the front rail. These rolls close before the pusher arm is retracted.

Both the master and detail pressure rolls operate from the same cam linkage when the card-feed operates.

The release lever behind the detail station and at the right of the program-control lever opens both rolls (see Figure 17).

Registration and Ejection at the Master Station

At the master station (Figure 21) the ejection release pin, driven by the card stop cam, operates the registration and ejection mechanism to open and close the pressure feed roll. This assembly is located directly over the sensing-pin unit. The throat plate that forms the bottom of the ejection mechanism is also the up-stop for cards at the master station when the sensing pins rise.

As the release pin is raised, it operates the registration and ejection lever. This lever performs three functions simultaneously: it raises the pressure roll, it lowers the master and ejection pressure rolls against the continuously running feed rolls, and through an idler lever it causes a spring to rock the card register shaft, causing the card stop plate to drop into the path

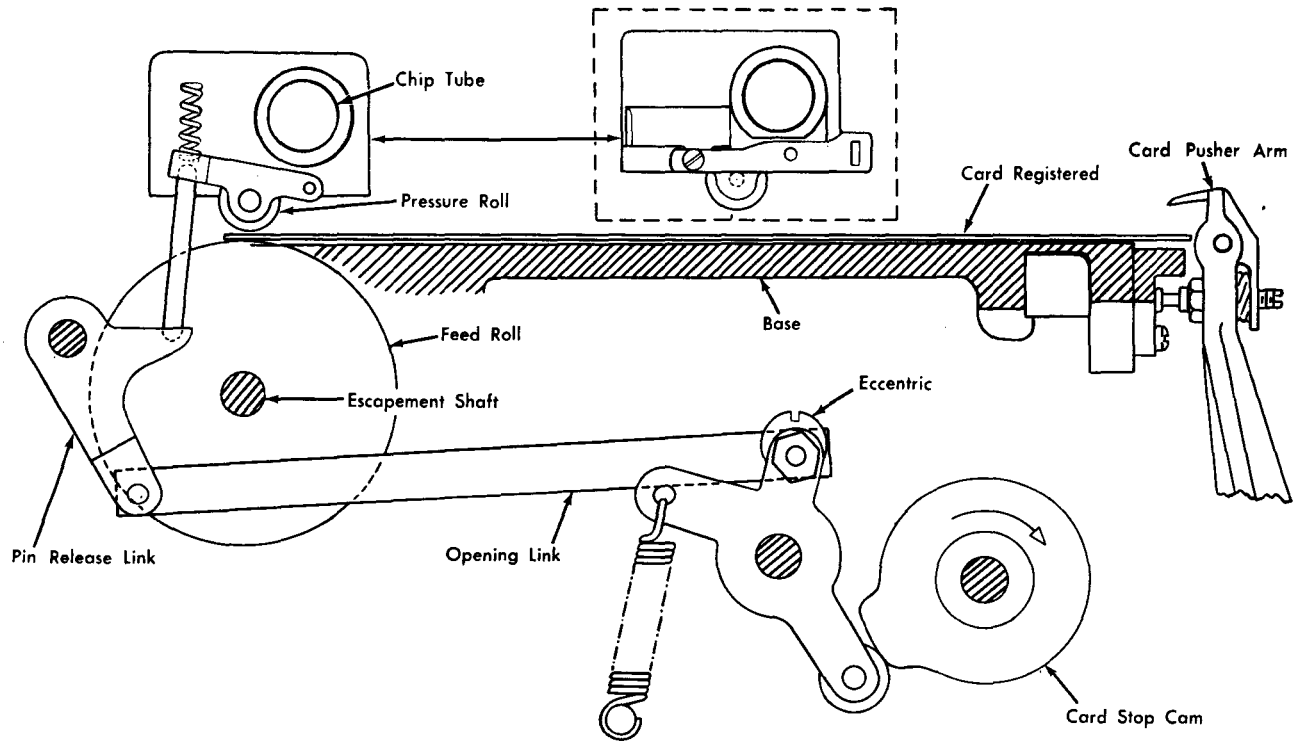


Figure 20. Registration,Detail Station

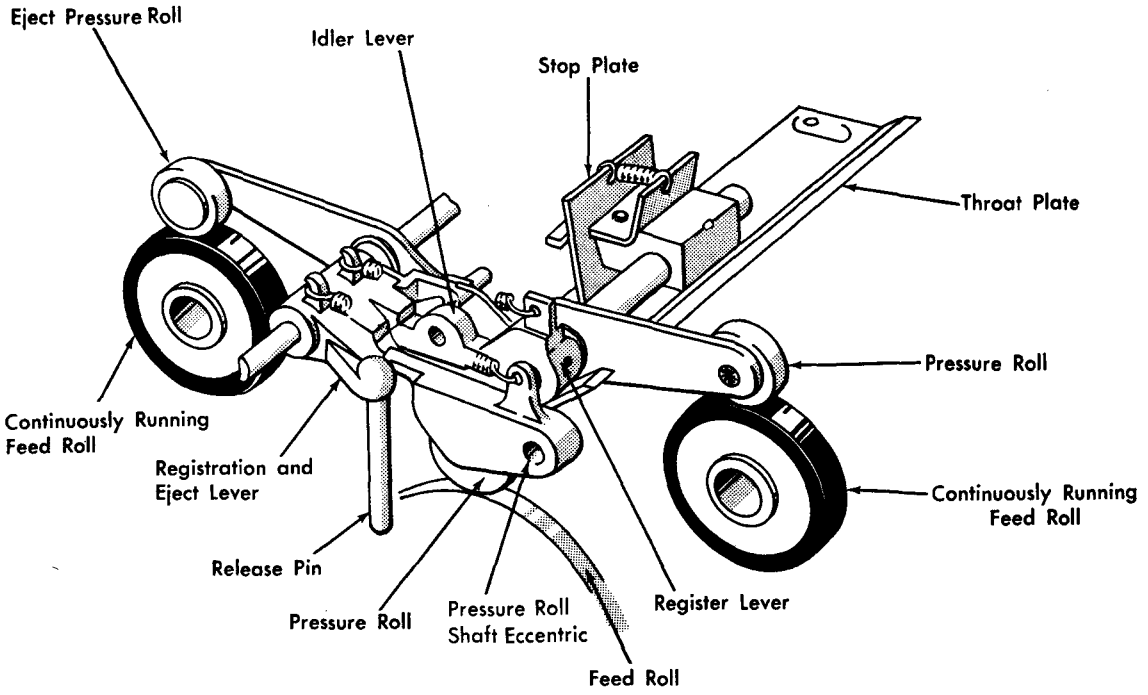


Figure 21. Registration and Eject Mechanism, Master Station

of the card. These functions remove the last master card and register the new master card in one operation. The release pin is operated either during a card-feed cycle or by the release lever. Figure 22 presents a side view of the card stop plate in operation. The stop-plate block and shaft are spring-operated because the card being ejected interferes with the dropping of the plate. It snaps down past the end of the ejected card to block the new master card. This is one of the reasons for the bevel at the bottom edge of the card stop plate.

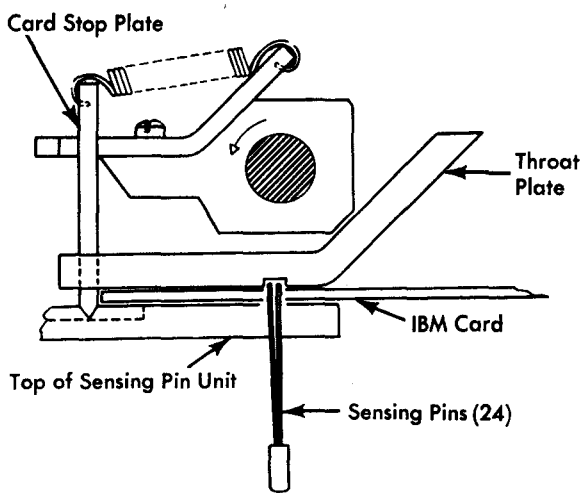


Figure 22. Master-Card Registration

Card-Stacker Unit

The card-stacker mechanism (Figure 23) is driven on card-feed clutch cycles. On card-feed cycles, the ejection mechanism lowers the pressure roll against the stacker continuously running roll, which moves the card out of the master station to the left end of the stacker bed. As the card comes to rest against the end of the bed, the pressure roll is raised and two stacker pushers pick up the card and move it upward toward the stacker drum.

As the stacker drum turns, the gripper fingers are raised by cam action to receive the card. Two sets of cam openers cause the fingers to open twice in the cycle: once when receiving the card, and again when the card reaches the stacker bed plate.

Traveling Card Guide

The traveling card guide serves as an extension of the top rail when the card is passing through the master station. When the stacker operates, the traveling guide aligns the card for an even approach to the stacker fingers. The guide is pivoted on the cam-follower shaft. As the gripper fingers receive the card, the guide moves back until it is below the card line. The card passes over the card guide while going to the stacker plate. As the card approaches the ejection station, the grippers are cammed open and the card is deposited in the stacker.

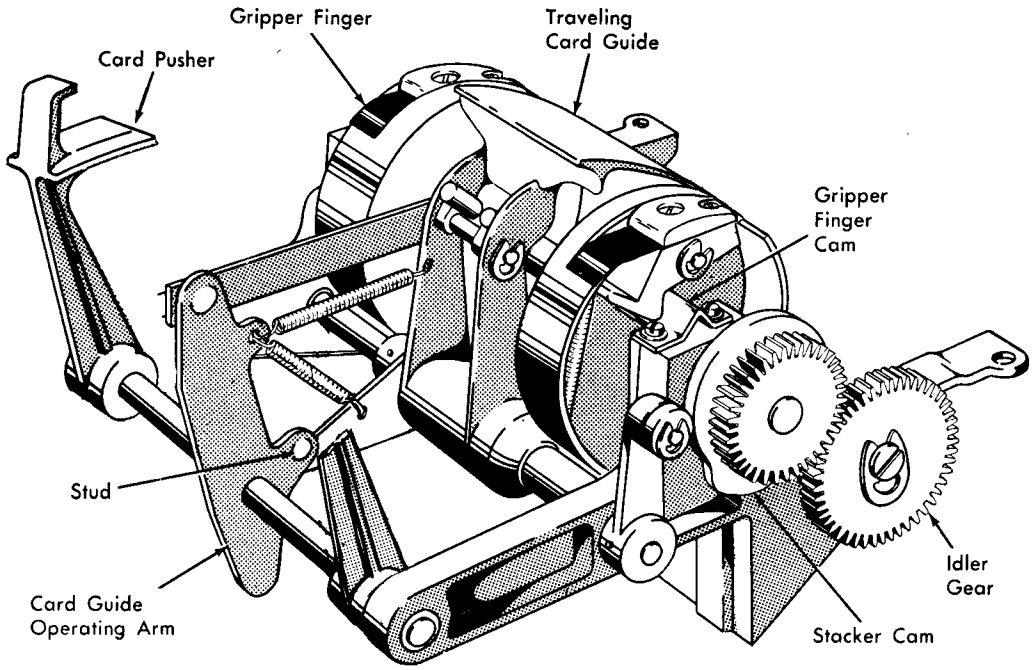


Figure 23. Card-Stacker Assembly

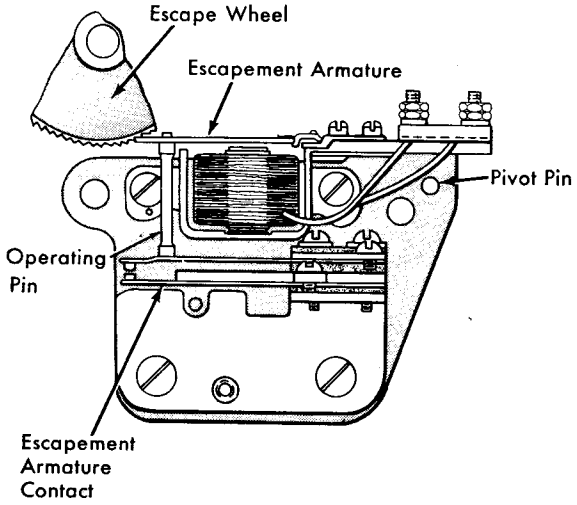


Figure 24. Escapement Assembly

An extra spring stud in the stacker drum adapts it for use either as a right- or left-hand drum. Steel bumpers, mounted in rubber, quiet the operation of the stacker. A small bumper adjusts the position of the traveling card guide in line with the top rail.

Escapement

On a card-feed cycle the detail card is registered at the zero column, the master card is mechanically stopped

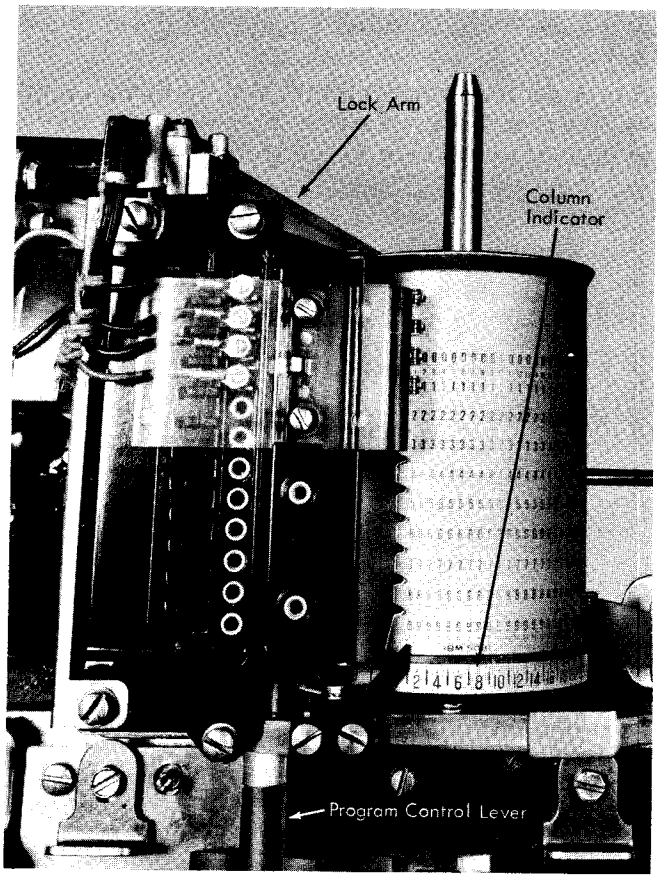


Figure 25. Program-Sensing Unit

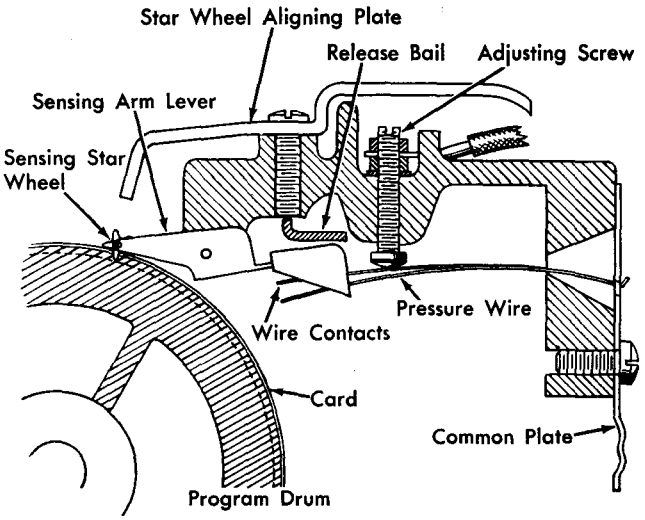


Figure 26. Program-Card Sensing

at column one, and the program drum is stopped in column one because of its number 1 cam contact timing. Once this condition is established, the escape mechanism takes over control and all three move in unison through the same drive and escapement. A review of Figure 12 shows that the transverse drive gear, through an idler gear (to reverse direction), imparts continuous force to the friction drive.

Escape-Magnet Assembly

When a key is pressed, an interposer magnet is energized. An interposer trips the interposer bail contact and energizes the escape magnet (Figure 24). The escape-magnet armature pulls out of a tooth in the escape wheel, freeing it to rotate through force from the friction drive. At the end of the escapement-armature travel, the armature pin closes the escapement contact and picks up the circuit to release the escape magnet. The time interval is short enough to drop the escape armature back into approximately the center of the next tooth of the escape wheel. Each tooth on the escape wheel causes the escapement gear train and feed rolls to advance one card column.

The escape magnet contact energizes the verifier clutch magnet. Therefore, the escapement always occurs before verification. An exception occurs during auto verification when a verify clutch cycle occurs before the first escapement.

Skipping

To skip it is necessary to hold the escape magnet energized, thus allowing the escape wheel to rotate freely at its maximum speed of 12 ms per column over the desired number of columns. The duration of a skip is controlled by the program sensing unit when skipping over fields, or by program cam contact 1 when skipping between cards.

Program-Sensing Unit

The normal machine controls for automatic-skipping, keyboard shifting, and automatic verifying are set up by punched codes in the program card. The card in turn is installed on the program drum (Figure 25).

Starwheels

Sensing wheels (commonly called *starwheels)* pick up the punched holes to control the machine electrically. In general, the holes serve the same purpose as the low dwell in the cam for a normally-closed circuit breaker.

The starwheels slide along the blank portion of the program card on two of their five points. When they encounter a hole (Figure 26), the leading point rolls into the hole and the wire contact (referred to as *program contact)* controlled by that arm closes. When the starwheel touches the bottom in the hole (Figure 27), the sensing arm that carries the wheel should ride the program card. Consecutive holes in the program card cause the contact to remain closed. Thus, the field-definition (12) contact serves as a hold circuit breaker.

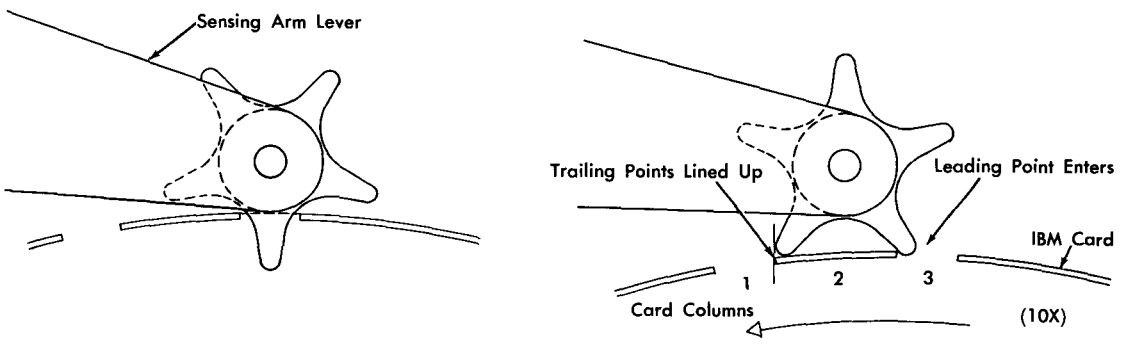


Figure 27. Starwheel Operation

The most critical function of the program unit is to drop the escapement armature into the proper tooth of the escape wheel.

Control Lever

Figure 25 shows the control lever for the program unit. The lever extends forward into the bed to activate or disengage the program control. Shifting the lever operates the release bail, which lifts or lowers all of the sensing arm levers and controls the drum lock.

The starwheels must be raised high enough to clear the program drum when it is removed to change program cards. The drum-lock arm prevents the drum from being removed when the starwheels are engaged. The drum-lock arm also prevents the starwheels from touching the card when the drum is not fully seated against the column indicator (Figure 25).

Program-Cam Contacts

Skipping automatically from column eighty to column one of the program drum and automatic feeding are controlled by the program cam contacts (Figure 28). The cam is mounted on the column indicator between the indicator dial and the base casting.

Verifier Drive Unit

The verifier drive unit is driven by a V-belt continuous drive through the verifier clutch. The clutch is engaged for all verifying and pin-sensing operations. Because the sensing-pin bar is operated from a cam on the verifier shaft, verifying and reading take place simultaneously.

The method of coordinating the mechanical and electrical devices of the IBM 56 for verifying is illustrated in Figure 29. Pressing a key closes contacts that cause an interposer magnet to be energized. The interposer armature causes an interposer on the end of the error-cam arm to close the bail contacts. Relay 5 is energized through the bail contacts. The 5AL point causes tube 3 to conduct and pick up the escapement magnet. The escapement contact closes; tube 1 conducts; relay 22 is picked up. Relay 22 and tube 7 energize the verifier-clutch magnet.

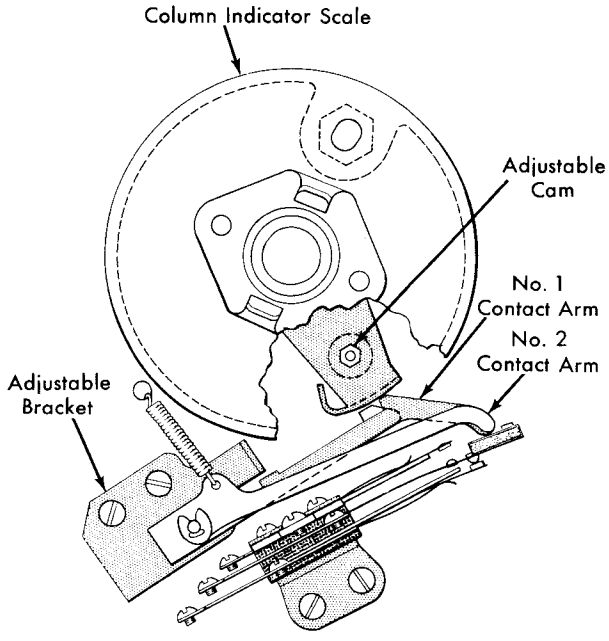


Figure 28. Program-Cam Contacts

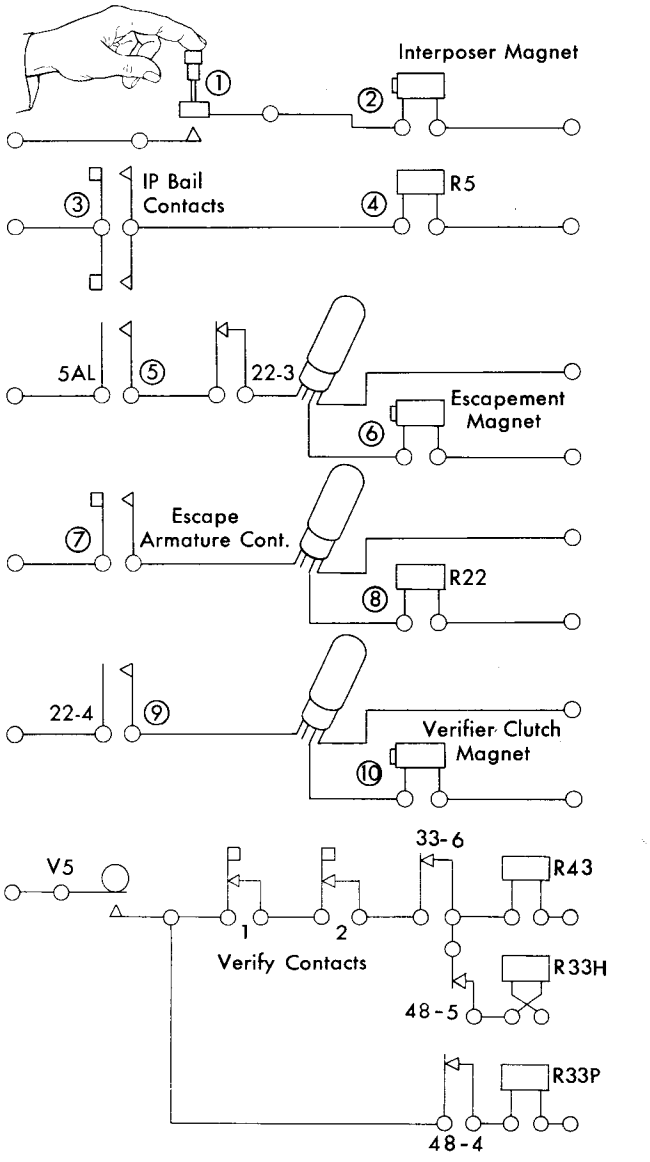


Figure 29. Schematic of Manual Verification

When the verifier-clutch drive shaft rotates, mechanical sensing of the detail-card column occurs. During the clutch cycle, circuits are conditioned to permit the next escapement and verification. An error would alter the circuits so that escapement on the next cycle would be suspended. A description of these circuits, in detail, appears in the *Circuit Description* section of this manual.

Verifier Clutch

The verifier clutch (Figure 30) is the friction-spring type with a continuously driven pulley and drive-pulley sleeve. The sleeve fits around the drive shaft and inside the clutch spring. With the clutch sleeve latched on the clutch magnet armature and with the detent latched, the clutch spring is uncoiled tightly within the clutch sleeve. When the clutch is unlatched, the tension of the clutch spring causes it to coil about the drive pulley sleeve, locking the drive pulley to the verifier drive shaft.

The clutch sleeve has two steps at which the clutch magnet armature can latch up. These steps are at 135 degrees and 345 degrees of the verifier-clutch cycle. During normal operation the verifier-clutch magnet is energized to pass 135 degrees and latch up at 345 degrees. The extra step is for use in the error-retention device described later in the manual.

When the drive shaft approaches latch up position, a step on the clutch sleeve strikes the tip of the rubber mounted clutch-magnet armature. A stop on the front inner wall of the clutch sleeve engages the tip of the clutch spring. Momentum of the driven mechanism

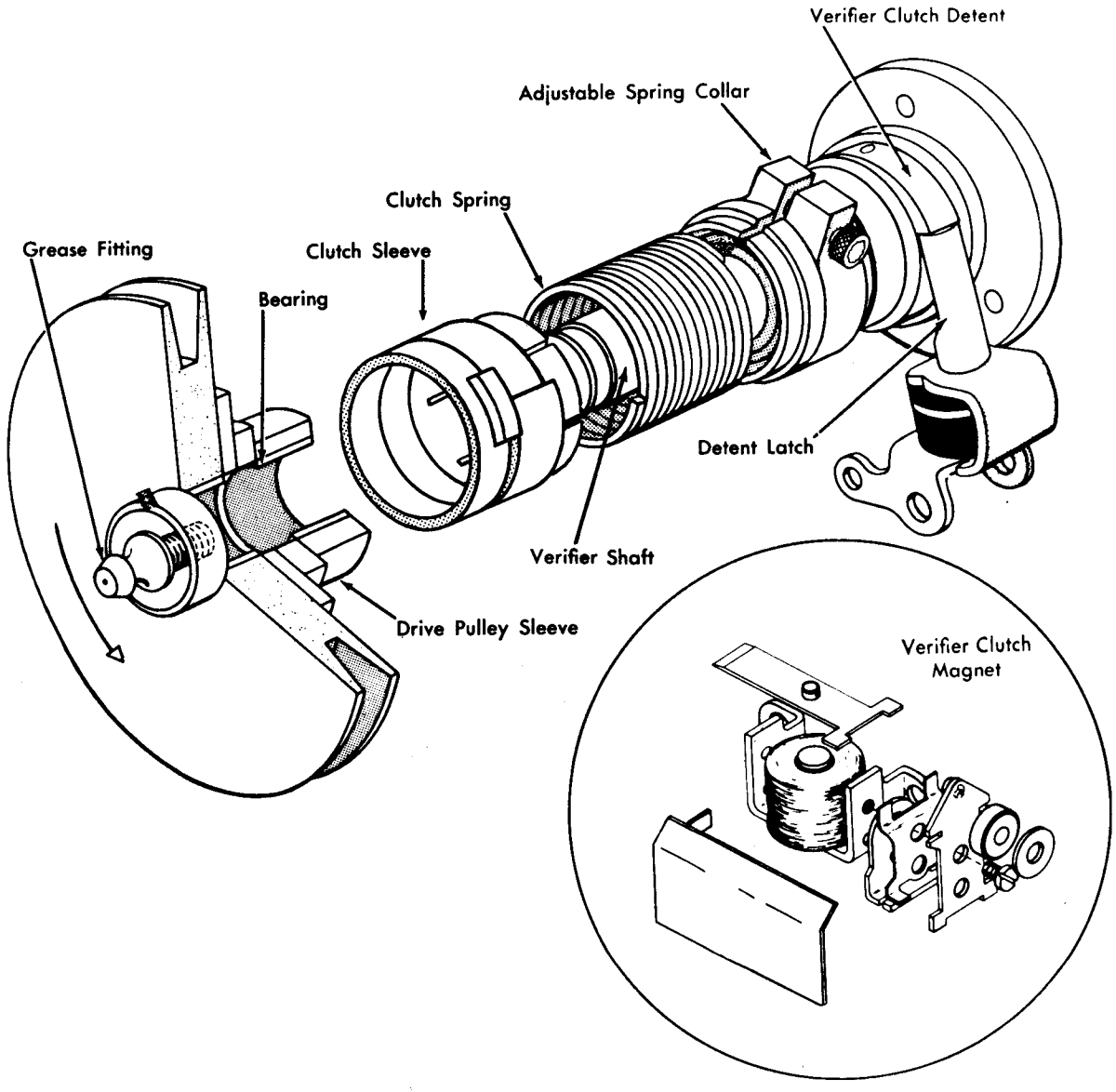


Figure 30. Verifier-Clutch Assembly

causes the clutch spring to unwind until a point is reached at which the clutch detent latch engages the detent corresponding to the clutch-sleeve step. The spring, fully unwound, frees the drive pulley from the verifier drive shaft. During normal operation, the index pointer should indicate 345 degrees when the clutch is latched.

Verifier Clutch Magnet and Detent Latch

The clutch magnet (Figure 31) on new machines employs a bondless one-piece metal armature although on older machines you will find an armature made of bonded steel and rubber. The detent latch on all machines is of bonded steel and rubber. Armature travel is controlled by an armature stop (Figure 32).

Verifier Drive Shaft

A side view of the verifier drive shaft in Figure 33 shows the mechanical and electrical cam location as well as the verifier index.

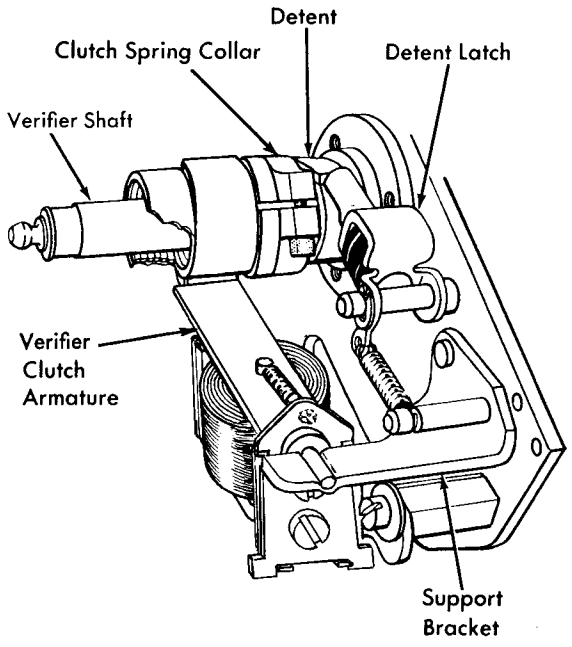


Figure 31. Verifier-Clutch Magnet

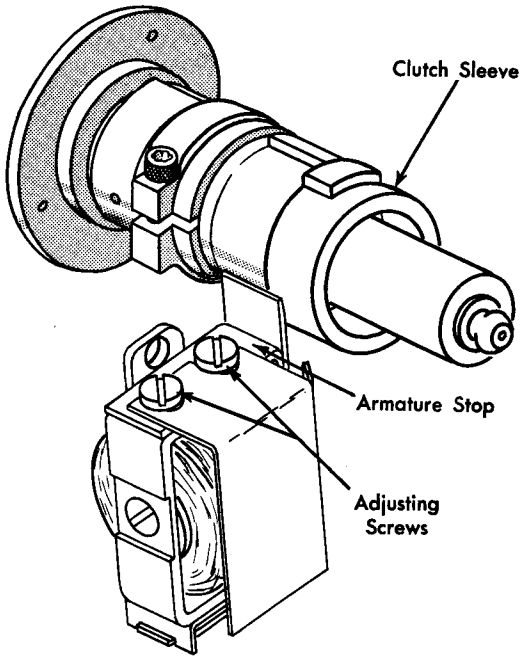


Figure 32. Verifier-Clutch Armature Stop

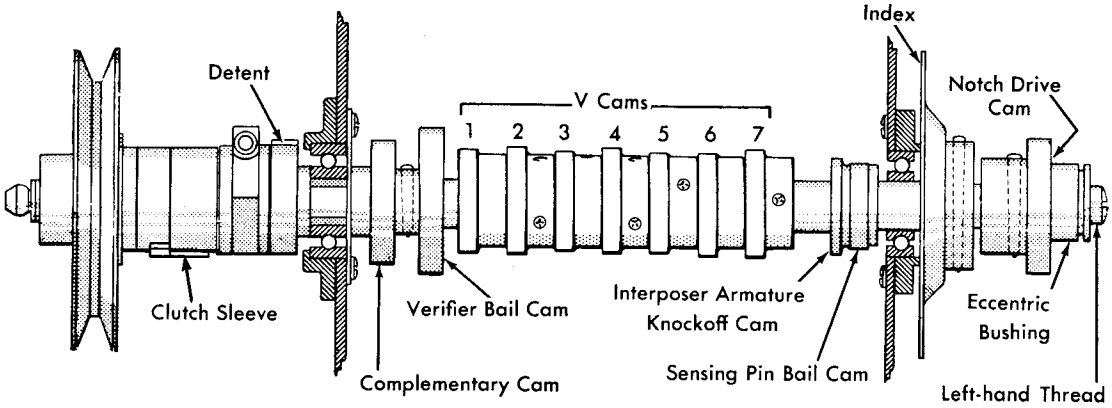


Figure 33. Verifier Drive Shaft

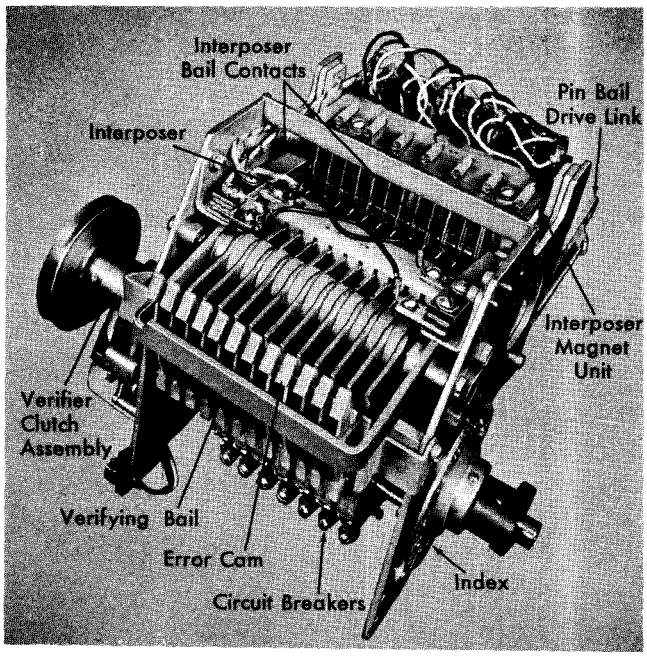


Figure 34. Verifier Drive Unit

Interposer Magnets

The interposer-magnet assembly (Figure 34) consists of twelve coils and armatures on the newer machines. Older machines have thirteen coils and armatures, the thirteenth coil operating the space interposer. The polarity of adjacent coils is alternated by reversing the leads to alternate coils.

When an interposer magnet is energized and an armature releases its interposer, the unit becomes a mechanical storage unit. An interposer must be latched on the verify drive bail to operate its error cam and be restored on its armature. The only time it can latch on the bail is at the highest point the bail travels (between 234 degrees and 350 degrees). Reading time for the master card is between 70 degrees and 140 degrees of the verifier index. It therefore becomes impossible to read and latch on the bail at the same time in the cycle. Because of this, the information is mechanically stored until about 234 degrees. The interposer bail contact remains closed from reading time of one cycle until about 70 degrees of the following cycle, when the interposer is pulled down by the bail. This occurs in a programmed auto-verification only.

A cam on the verifier drive shaft operates the knock-off bail. The interposer magnet armatures are knocked off just before relatch time.

Interposer-Bail Contacts

When an interposer magnet is impulsed, the armature is attracted, releasing the interposer latched to it. The interposer pivots on the error-cam arm and closes the interposer-bail contacts, front and rear. Two contact assemblies are used to insure continuity once an armature is attracted.

Verification Principle

To verify a card column, the machine compares punched information with information read from a master card, or information keyed by the operator. The success or failure of the comparison determines whether both verify contacts remain normal (OK verification) or one or both contacts are transferred (error indication).

In manual verification the error cams represent key depressions; the pin drivers represent the punching in the card column. Pressing a key selects and positions the error cams. The pin drivers are positioned by the presence or absence of punched holes in the card column (Figure 35a). The error cams pivot on the ends of the error-cam arms. They are impelled to turn clockwise about the pivot by spring tension. This tendency to rotate is opposed (Figure 35a) by a land on the pin driver. The relative positions of the error cam and the pin-driver land determine whether the error cam can rotate about its pivot far enough to transfer a verify contact. Because the two contacts are bail operated by any one of the twelve error cams, opening either or both contacts indicates an error condition (Figure 35b).

On older machines, a system of twelve verify contacts is used, one contact transferred by each error cam that detects an error condition.

Verifying-Bail Assembly

Two bails and cam-follower rollers form the verifying-bail assembly. The assembly is pinned to its pivot shaft, which rides in bearings mounted in the verifier drive unit. The coil springs of the twelve pin drivers hold the bail against its complementary cam roller. The operating cam (under control of the verifier clutch), turning counterclockwise, actuates the verifying-bail assembly. The bail cam follower moves the bail in a counterclockwise direction during the verifying portion (first half) of the cycle, and clockwise during the restoration portion (second half) of the cycle.

The interposer section (left half) of the bail, moving downward during verification, engages any unlatched interposers, pivoting the corresponding error-cam arms counterclockwise. The error cams move upward, away from home position. The right-hand section of the verifying-bail assembly moves upward and causes the pin drivers to move upward, driven by individual driver springs. During the restoring portion of the cycle, the bail returns all pin drivers to normal and restores all interposers whose armatures were not reattracted. The interposers must be hooked on the interposer section of the verify bail in order to travel over the notch in the armatures and be relatched.

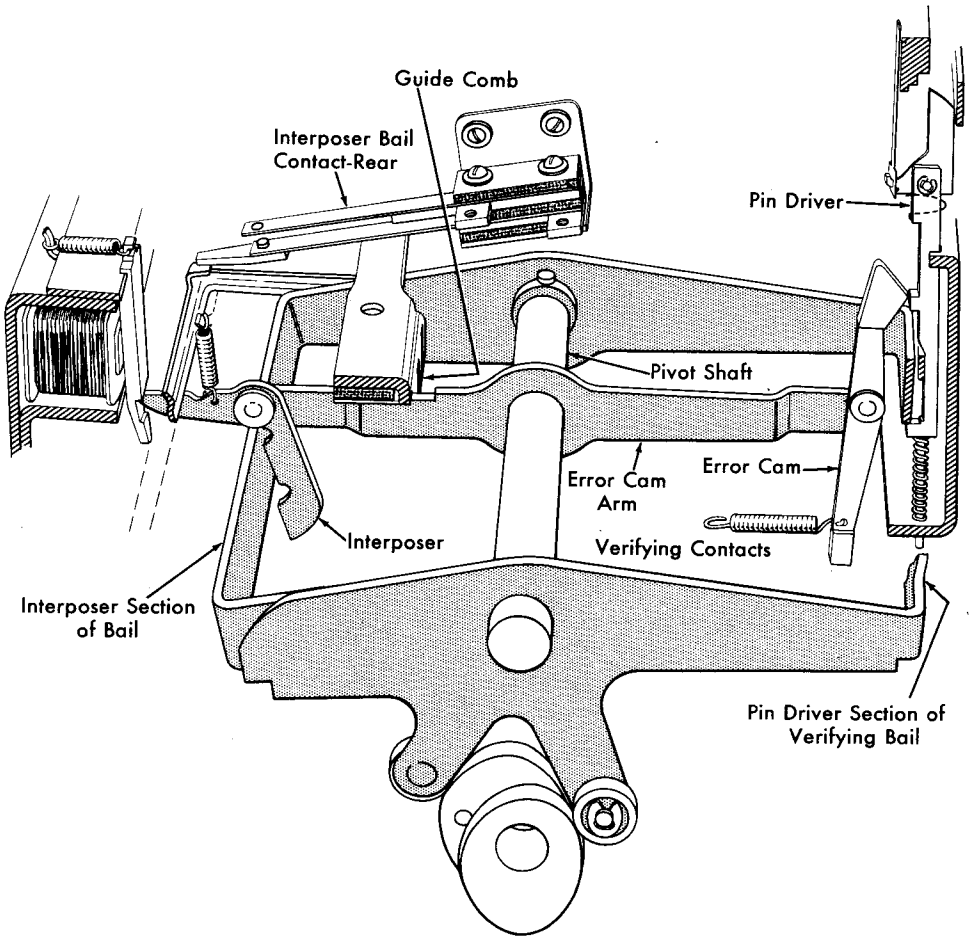


Figure 35a. Verify-Bail Assembly

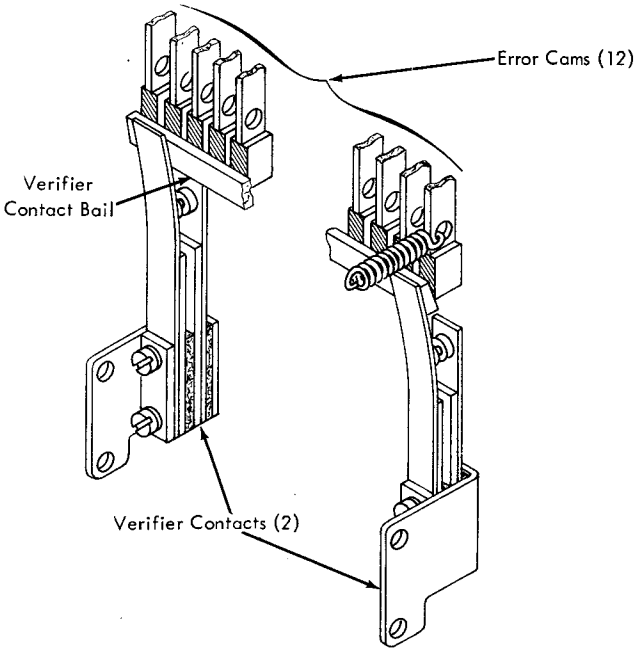


Figure 35b. Verify-Contact Assembly

Pin Drivers

The pin drivers are moved upward by spring tension under control of the verifying bail. On each verifier-clutch cycle the verify pins sense a column at the detail station. The distance the pin drivers move upward depends on whether a punch is read by the verifying pin.

Verifying-Pin Latch

When a blank position is read, the force of the verifying pin against the card operates the pin latch mechanism as shown in Figure 36. The pin latch rotates counterclockwise to engage the pin latch stop. The pin latch stop stops the upward travel of the pin driver. About .040 inch upward travel of the pin driver is required to latch out a verifying pin.

If the verifying pin senses a hole in the card, the latch is not operated (see Figure 28). The pin latch slips by and travels over the pin latch stop. Total upward travel of the pin driver is .191 inch.

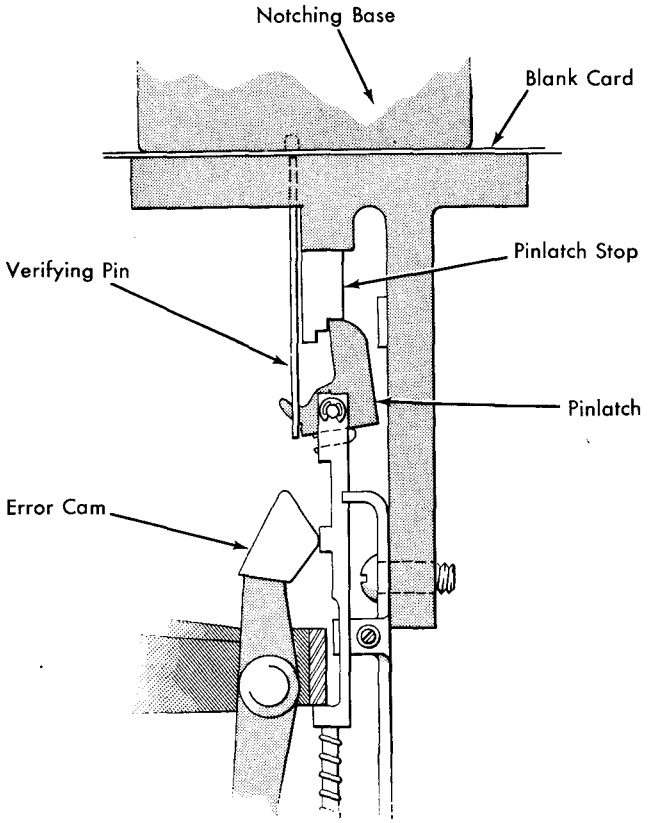


Figure 36. Verify-Pin Latched

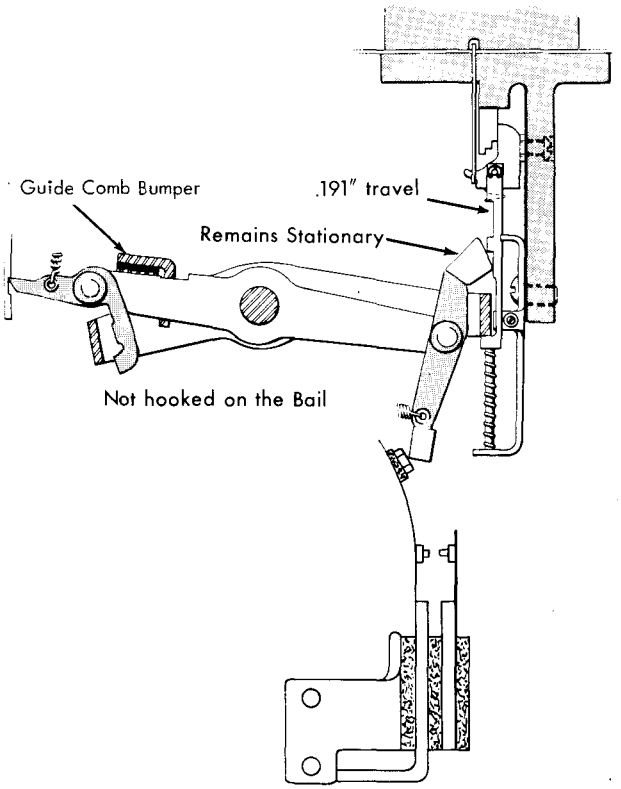


Figure 37. Error in Card

Error Cams

Error cams remain stationary on verifier-clutch cycles in which their interposers remain latched on the interposer magnet armatures (Figure 37). On cycles in which the interposers engage the verifying bail, the error-cam arms turn on the pivot shaft and the error cams move upward (Figure 38). The error cam upward travel is .172 inch.

Verify Contacts

The lower end of each error cam rides against a bail connected to one of the verify contacts (see Figure 35b). Attached to the lower portion of each error cam is a coil spring that moves the error cam and consequently, the verify contact bail, thus opening a verify contact when the error cam leaves the pin-driver land. The contact opens whether the error cam travels over the land or the pin driver travels over the error cam.

The pick coil and the hold coil of relay 33 are buck wound so when both coils are impulsed, the relay does not pick up. Therefore, breaking a contact results in a failure to pick relay 43, energizes the error relay, locks the keyboard, and lights the error light.

The machine is reset by pressing MP/ER and the keyboard is unlocked. Following the third attempt to verify the same column, the transfer contact picks a relay which causes the incorrect column to be error-notched above the 12 position. The OK notch is suppressed, and the auto-feed cycle is prevented.

Error Conditions

Card-feed cam 5 energizes the hold coil of relay 43 prior to the registration of the detail card to cause the first escapement before verifying column one. Relay 43 prepares the machine to escape before each verifying cycle. Disagreement between the information keyed and the holes read results in an error indication. (It is possible for two error conditions to exist.)

The first condition to be considered is one in which a key is operated for a blank column. In this case, the verifying pin is latched out and the pin driver stops after .040 inch travel. The interposer magnet trips and latches its interposer onto the interposer section of the bail. When the verifying bail tilts counterclockwise, the error cam for the blank position leaves the land and breaks the verifying contact (Figure 38). Breaking the contact prevents picking OK relay 43 and energizes an error relay. If the second trial is the space bar, the contacts remain closed and pick up OK relay 43. Thus, the next verifying cycle is preceded by an escapement to the next column of information.

For the second error condition to be considered, assume the skip key is pressed in a punched column. The column of operation is tested for punches and a hole is sensed by a verifying pin. This time the pin driver travels over the error cam, because none of the interposer magnets is energized. Because no interposers unlatch, all of the error-cam arms remain against the guide-comb bumper as shown in Figure 37.

Notice the slight difference in the amount of travel to the transfer contact shown in Figures 37 and 38. The variation is due to the .040 inch travel necessary to latch out a sensing pin when the error cam travels over the pin-driver land.

Another condition concerning the error cam and pin-driver land should be observed. Both the error-cam arms and the verifying bail pivot on the same shaft. The distance from the pivot shaft to the verifying bail is greater than the distance from the pivot shaft to the error-cam rivet. Both assemblies move in unison, but because the bail is farther from the pivot, it moves higher than the error cam. When the correct key is pressed, both the error cam and the pin driver move upward, but the pin driver travels nearly .020 inch higher than the error cam (Figure 39a). The land on the pin driver is .100 inch long. Rest position for an error cam is .030 inch from the top of the land (Figure 39b).

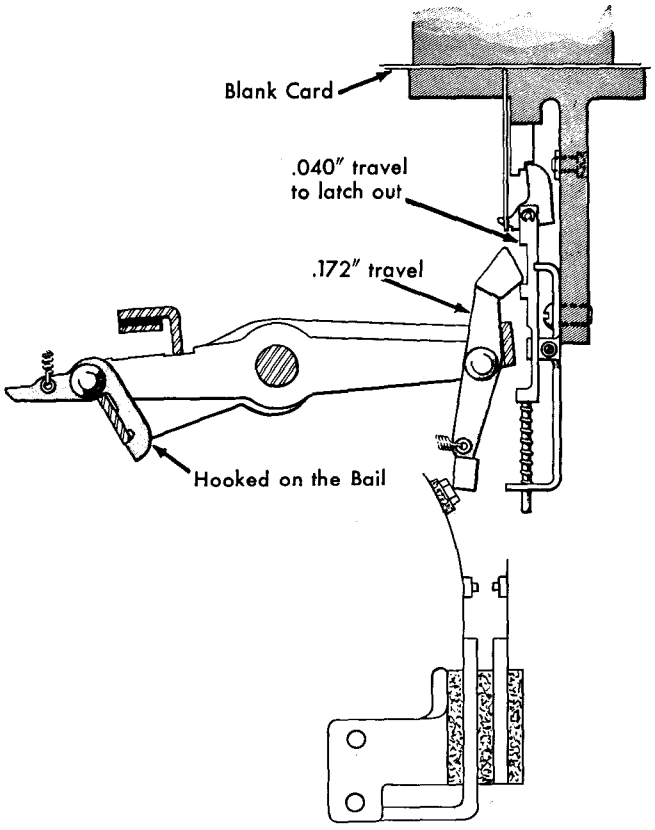


Figure 38. Error in Keying

After a pin driver has traveled its .040 inch to latch itself out, the land and cam stand as shown in Figure 39c. When adjusting the verifier drive unit, these facts should be considered. The entire verifier drive unit is moved to change the above relationship. The time at which the contacts transfer varies with the type of disagreement. Both circuits through the verifying contacts are protected by V5.

Error Retention

Machines put out after October 1953 feature the *error retention* device. This device simplifies analyzing machine failures under operating conditions.

Relay 31, the error-retention relay, was added to the circuit and the verifier clutch was redesigned. An extra detent was provided and an extra step was added on the clutch sleeve. This enables the verifier clutch to latch at either of two points on the verifying cycle.

The clutch can latch at 345 degrees for normal operation, or it can be made to latch at 135 degrees. A test switch on the relay gate panel makes the device operative. The clutch is controlled electrically so that with the test switch in NORMAL position, the machine functions in the usual manner. The verifier-clutch magnet is de-energized and the armature drops and prepares to latch up on the first step but because the switch is on NORMAL, the clutch is re-energized by a circuit through V5 (70°-140°). This enables the clutch-magnet armature to miss the step located at 135 degrees and latch at 345 degrees for standard operation.

When servicing the machine, the customer engineer can throw the switch to TEST.

Keying the machine causes a verifying cycle. When the card column is correctly verified, verification continues. If, however, an error occurs, the circuit through V5 opens and does not energize the verifier clutch. Therefore, the clutch latches up at 135 degrees instead of continuing to 345 degrees, the normal latch point. The customer engineer then, by examination, determines which error cam or cams transferred to cause the error condition. By noting the position of the error cam relative to the pin-driver land, it is possible to determine whether the error resulted from a failure to read at the detail station or from, for example, a failure of

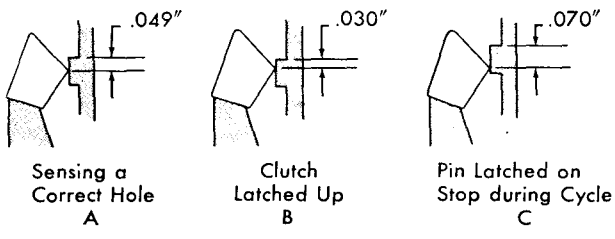


Figure 39. No Error Conditions

an interposer-magnet armature to unlatch. The error-retention feature, in this way, greatly reduces the time required to isolate the trouble.

A complete description of the circuits involved follows in *Circuit Description.*

Notching Mechanism

The notching device facilitates correcting error cards. Error cards are notched directly above the column or columns in error. Cards that have been correctly verified are OK notched at the column eighty end of the card between the one and zero positions.

Two round punches, an interlocking system, and a drive mechanism accomplish notching. The notching punches are driven from a cam on the verifier drive shaft. Because OK notching is suspended for all cards that receive an error notch, only one type of notch can appear on a single card during normal operation.

Notching-Punch Interposer

The OK notching punch and the error-notching punch are interlocked by an interposer bar so only one can operate at a time. The position of the interposer is determined by the last column notching solenoid (see Figure 41). When the solenoid is de-energized, the interposer rests against the OK punch; the error punch is free to operate if a notching cycle is signalled (Figure 40).

At column 80½, when program-*cam contact one* transfers, relay 47 picks. This causes the last column notch solenoid to be energized. Attracting the solenoid plunger shifts the interposer bar to a point where it restricts the downward travel of the error punch (Figure 41). When the notch lever lowers, the error-punch shoulder seats on the interposer bar. The bearing surface between the error-punch shoulder and the interposer supports a fulcrum for the notch-punch arm. Downward motion of the notch lever forces the notch drive mechanism.

On older machines a notch drive unit shown in Figure 42 was used. The notching mechanism is inoperative until the notch drive magnet is energized. The block on the end of the notch drive-magnet armature normally rides between the suppress arm and the cam-follower arm.

Every time the shaft revolves, the suppression-eccentric bushing operates the suppress arm. When the block is engaged by the suppress arm, it moves the cam-follower arm clockwise and prevents it from falling into the low dwell of the notch drive cam.

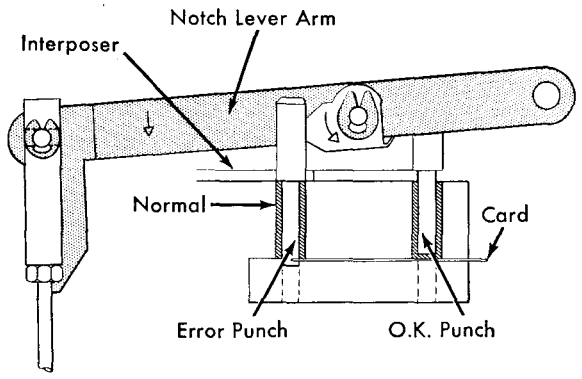


Figure 40. Error Notching

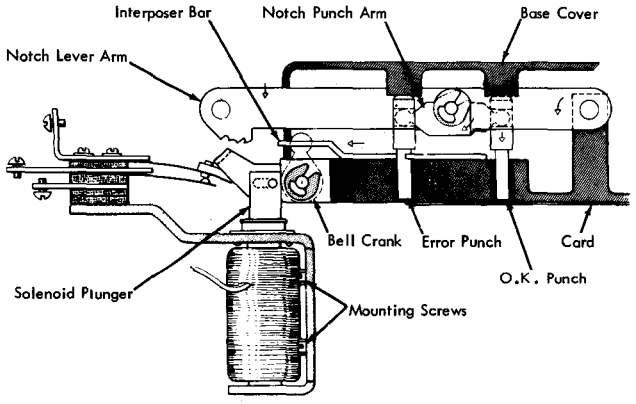


Figure 41. Last-Column Notch Solenoid

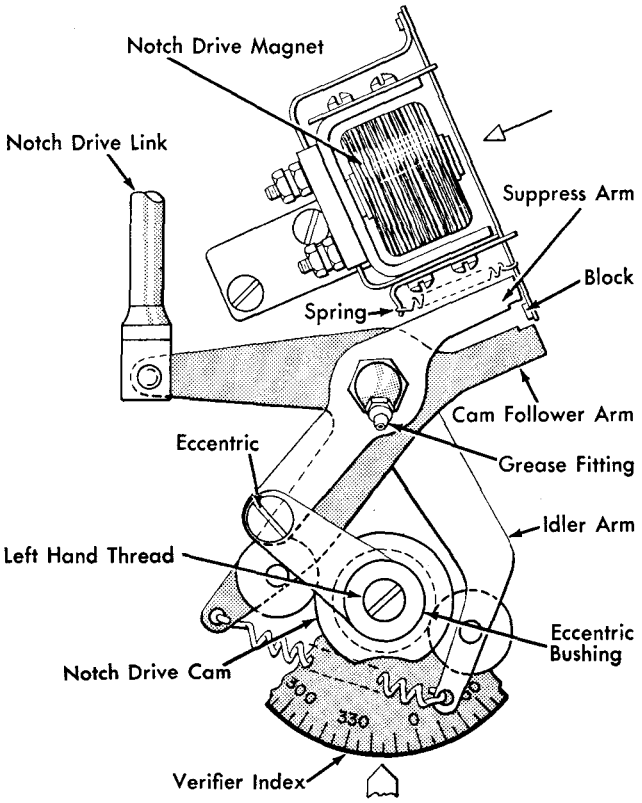


Figure 42. Notch Drive Unit

On a notching cycle, the notch drive-magnet armature is attracted. The interposer block on the armature is lifted from between the tips of the suppress arm and the cam-follower arm. Spring action causes the cam follower to ride into the low dwell on the cam and pull down on the notch lever arm. The resulting downward thrust on the drive link forces a punch through the edge of the card and into the die. The punch is positively restored when the cam follower reaches the high dwell of the cam. The idler arm, whose roller rides on the hub of the notch drive cam, equalizes the force on the verifier cam shaft to prevent the shaft from whipping under the notching load.

On newer machines the notch drive unit has been replaced by a solenoid notch drive mechanism as shown in Figure 43. When the solenoid is energized, the plunger is attracted downward and brings the notch-lever arm with it. The notch-lever arm drives either the OK punch or error punch into the card, depending on the last column notch solenoid.

Notch Relay 50

The machine circuits are conditioned for notching by relay 50, which picks up in parallel with the notch drive magnet. Relay 50 establishes circuits to:

1. Hold the keyboard restored during notching.
2. Energize the verifier clutch magnet.
3. Open the test circuit to the verify contacts during notching.
4. Pick up relay 43 so that verification continues on the cycle following an error notch.

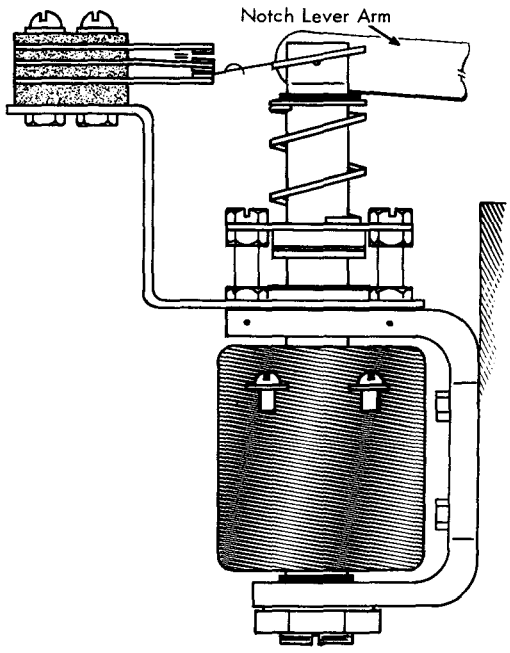


Figure 43. Solenoid Drive Unit

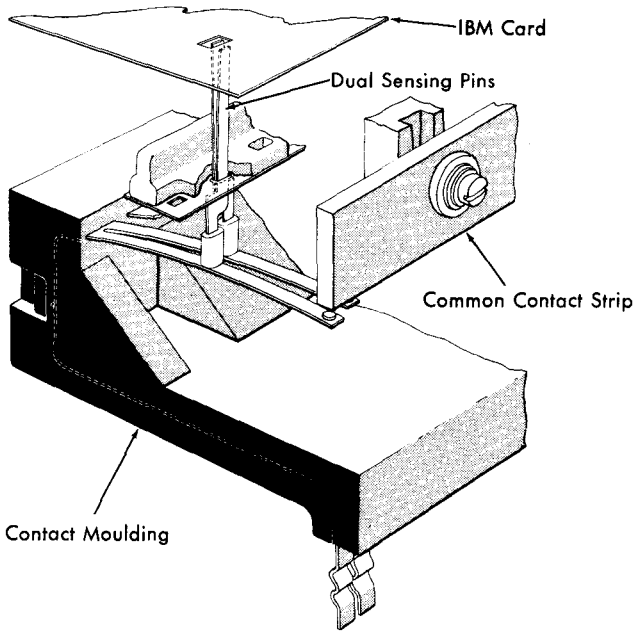


Figure 44. Pin-Sensing Mechanism

Pin-Sensing Unit

The registration of an IBM card is usually gaged in reference to the column eighty edge of the card. Cards at the master station of the IBM 56 are registered at the column-one end. Any slight variation in card length, therefore, tends to prevent perfect registration of the master card. To meet this possibility, dual-sensing pins (Figure 44) are used to read the card. A set of pins spans .043 inch or half the lateral distance between the leading edge of a punched hole and the leading edge of a punched hole in the next card column. If the card is of proper length and correctly registered, both sensing pins enter the punched hole as shown in Figure 45. The space between pins is too small to permit reading two columns at once (Figure 46).

Both pins have a contact. This assures that a punch reads when either pin enters a hole in the card.

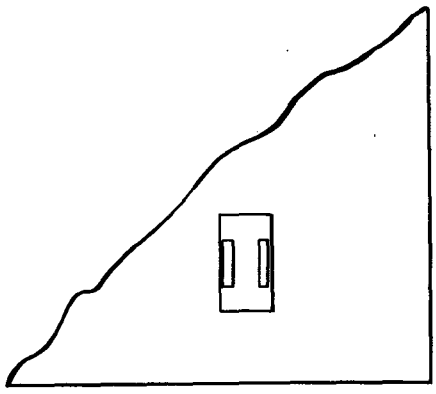


Figure 45. Dual Pin Sensing (Ideal)

Contact Moulding

The contact moulding (see Figure 44) contains twelve dual-contact assemblies. The individual contact-assembly terminals are electrically connected to corresponding interposer-magnet terminals. When a card column is sensed at the master station, the spring tension of the sensing contacts forces the sensing pins upward to read the card. If the card position above one of the dual-sensing pins is blank, then the upward travel of the pins is arrested at a point where their contacts cannot make contact with the common terminal strip. If, however, the card is punched at the position being sensed, one or both of the dual-sensing pins pass through the hole in the card. The contact or contacts, thereby transferred to the common terminal strip, complete a circuit to an interposer magnet.

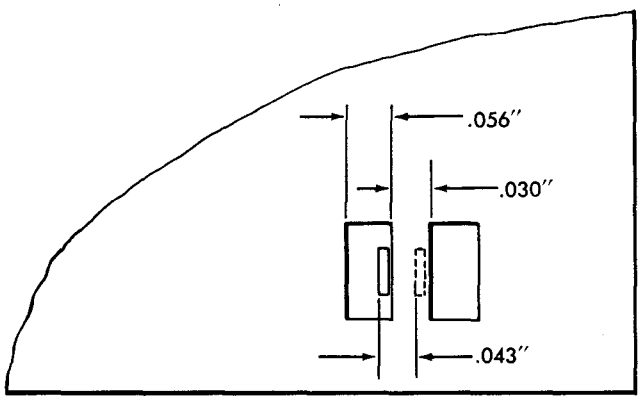


Figure 46. Dual Pin Sensing (Worst Condition)

Pin Bail

The sensing pins are raised by the spring tension of their contacts and are retracted by a cam-driven bail. As shown in Figure 47, the sensing-pin bail cam on the verify shaft raises the pin bail so the sensing pins seek the punched holes in the master card from pressure of their contacts. The adjustable drive link and the short bail link have been provided with a square hole in each member for inserting a screw driver when adjusting the sensing unit.

Card Lever

The pin-bail drive-link spring causes the drive link to follow its operating cam. When a card is not at the master station, it is not desirable to pin-sense because all the pins would rise and close their contacts. A spring-operated card lever (Figure 47) blocks the rise of the pin bail by preventing the drive-link cam follower from riding into the low dwell of the pin-sensing cam. Thus, pin-sensing of all twelve positions is eliminated while cards are at the detail station only, and the verifier clutch magnet is energized. When the verifier clutch is latched up at 345 degrees, the pin bail is lowered, the pins are retracted below their separator guide, and the card lever is free to operate.

The removable pin-sensing unit, while operated through linkage from the punch shaft, is not essentially a part of the punch drive-unit assembly.

Consult the mechanical time chart for comparison of verifier pin travel and sensing-pin contact duration. The two nearly coincide. Both sensing pins and verifying pins are free of the card by 180 degrees when V1 makes to cause escapement. Notice that both the verifying pins and sensing pins are positively restored. In spite of this fact, a binding or sticky pin causes the card to hang up or jam.

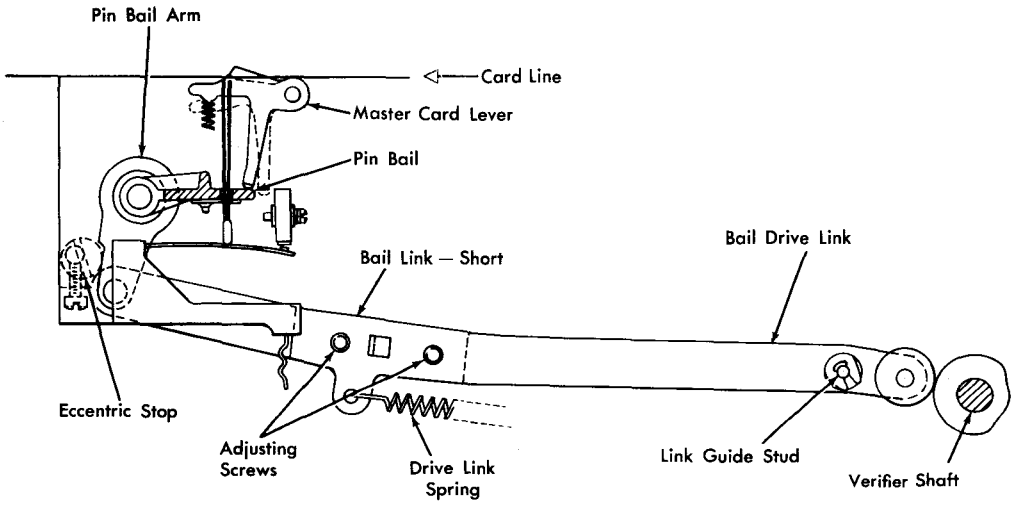


Figure 47. Sensing Pin Bail

Pressure Rails

Cards are guided in their path through the detail station by the top stationary rail. This rail is pinned to the bed at the factory.

The bottom edge of the card is guided by pressure rails. The two spring rails in the master station have less tension than the ones in the detail station. These pressure rails greatly affect registration.

Combination Keyboard

The principles of operation are identical for the numerical and the combination keyboards. Therefore, discussion of the combination keyboard with its maximum capacity covers all features. It should be pointed out that although the mechanical features of the IBM 24 and IBM 56 keyboards are identical, the keyboards are not interchangeable.

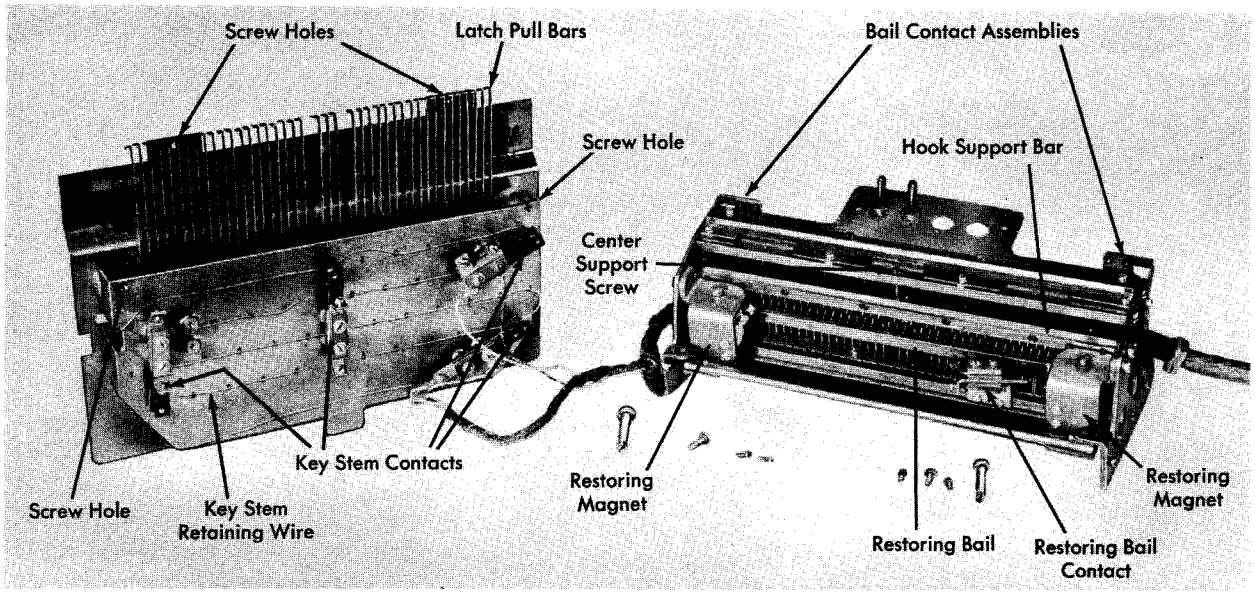


Figure 48. Key and Permutation Units

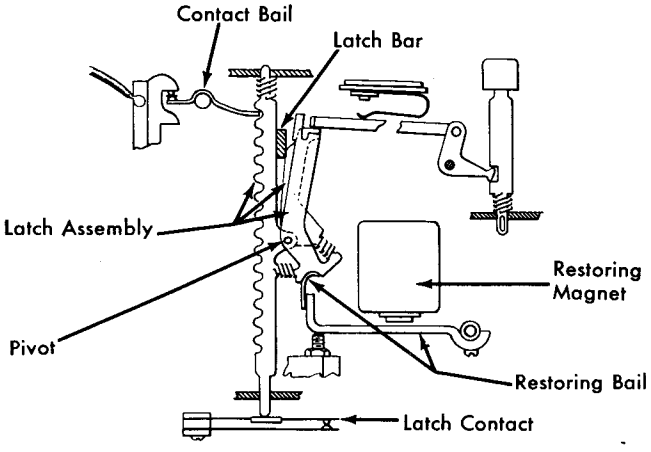


Figure 49. Keyboard-Latch Tripped

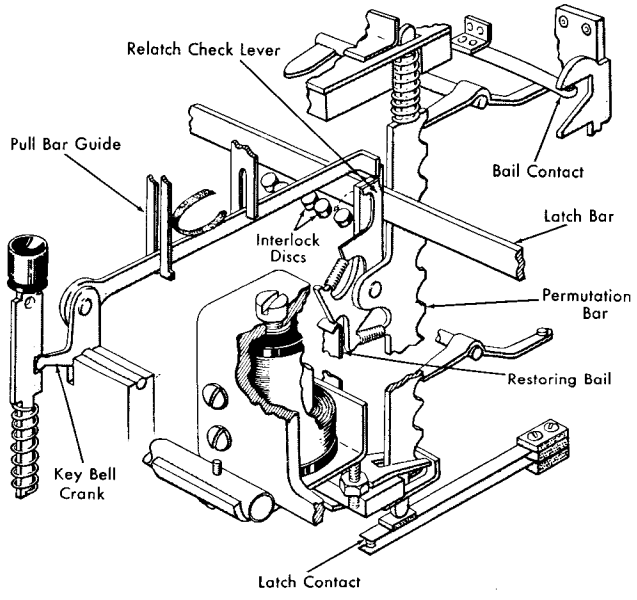


Figure 50. Keyboard Operation

Key Operation

Consult Figure 48 for location of parts on the keyboard. Pressing a key causes the key-stem bell crank to move its latch pull bar forward, which causes the latch assembly to drop off the latch bar. Individual key-stem springs restore the keys and pull bars. A separate flat spring holds each pull bar against its latch assembly and insures its relatching in the notch in the latch.

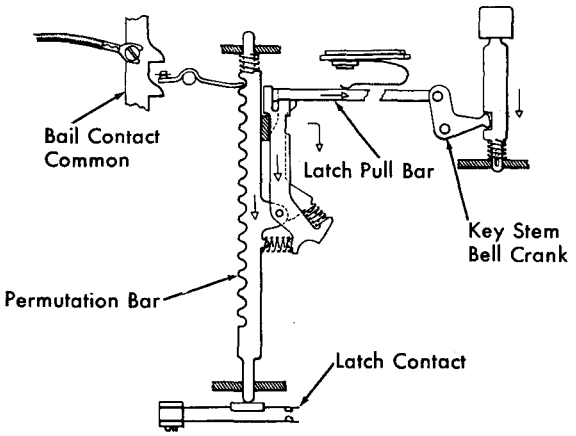


Figure 51. Keyboard-Latch Normal

In Figure 49 notice that the latch assembly is made up of three parts that, although attached by a rivet, are free to rotate about this point. Each part has its own function.

The latch assembly consists of the latch itself, a relatch check lever, and a permutation or *code* bar. Pressing the key stem pivots the bell crank and moves the pull bar, which is engaged with the latch (Figure 50). The latch bar holds the latch assembly restored and prevents the permutation-bar spring from driving the permutation bar downward. The pull on the latch causes it to slip off the latch bar, drop the permutation bar, and close the latch and bail contacts. The permutation bar operates a selection of contact bails and latch contacts which are discussed later.

The relatch check lever slides over the notch in the latch to block a second operation before the latch assembly is fully restored. The lever pivots on the same rivet as the latch and permutation bar. This pivot must be kept free for satisfactory relatching. The assembly remains tripped, as shown, until the keyboard restoring magnets (see Figure 49) are impulsed and the latch is restored to the position shown in Figure 51.

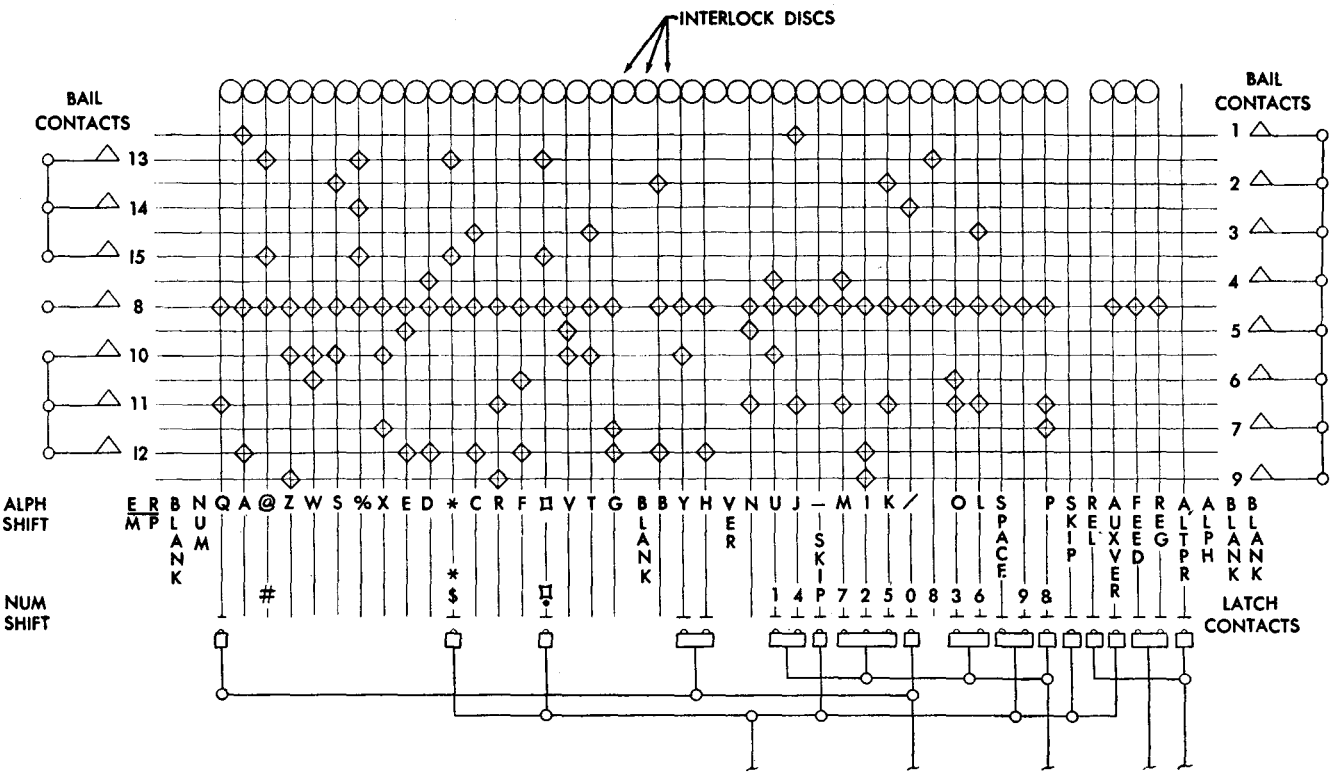


Figure 52. Combination Keyboard Chart

Keyboard Restoration

In Figure 49 notice the position of the restoring bail. This bail rests under all latches and rehooks the latches on the latch bar.

In addition to restoring latch assemblies, the restoring bail operates its contact, which breaks the common to all the keyboard-latch and bail contacts. The restoring-bail contact breaks before the other keyboard contacts and is, therefore, the only keyboard contact protected by a capacitor and resistor in parallel to the contact for arc suppression.

Two restoring magnets operate their armatures at either end of the restoring bail. Two magnets are required because under some operating conditions these magnets and the bail hold the keyboard locked up (for example, on feed cycles) to prevent verifying if the first field of the new card is to be auto-verified. Releasing the keyboard restoring magnets after the program has been read gives the program control precedence. These magnets restore when the register, feed, or release key is pressed. If a key was tripped while the machine was turned OFF, this operation restores it.

Keyboard Contact Codes

Not all permutation bars operate both latch and bail contacts. Notice that the 8-key operates only the numbers thirteen and eight bail contacts and no latch contact. Notice also that all latch positions except the release, skip, and alternate program operate functional-bail contact eight.

For location of the bail and latch contacts consult Figure 52. This information is also found on the machine wiring diagram. The contact bails are numbered in sequence with 1 at the top to aid installation and removal.

An example of a normal contact operation follows:

Pressing the U/1 key closes bail-contacts ten, eight, and four, besides latch-contact one. Depending upon whether the keyboard is alphabetic or numerical, either the ten, eight, or four interposer magnet is energized for the letter *U*, or the one and eight interposer magnets are energized for the numerical *1*.

Therefore, each time a key is operated, all its individual contacts close, but only those controlled to operate by keyboard shifting energize interposer magnets.

The numerical, alphabetic, multiple-punch, and verify keys operate key-stem contacts only as shown in Figure 53.

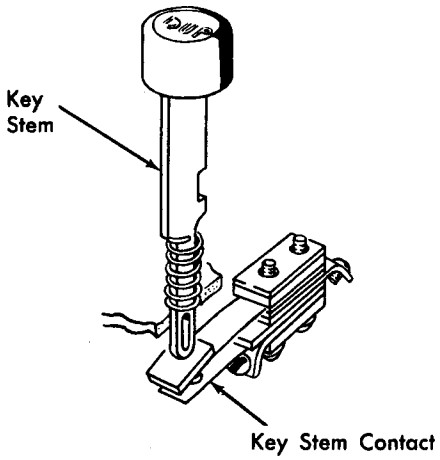


Figure 53. Key-Stem Contacts

Frequent reference has been made in this manual to the close similiarity between mechanical features of the IBM 56 and the IBM 24. A study of the wiring diagram for the IBM 56 points up many circuits that are alike in the two machines, others where difference is apparent. For this reason, an effort has been made, in the *Circuit Description* section, to give little emphasis to circuits that are common to the IBM 24 and IBM 56. Circuits pertaining to verification are outlined in detail.

Power Supply

Wiring Diagram

References to the location of circuit components apply to wiring diagram 308601-N in conjunction with supplement wiring diagram 311496-A. These two diagrams have been incorporated into one instructional diagram.

Wiring diagram 308601-N is composed of sixteen sections, two on each page. Supplement wiring diagram 311496-A is shown in sections 17 and 18. The pages are divided into A (upper) and B (lower) sections. The general layout of the diagram is as follows:

Sections 1-2	Power supplies for different voltage options
Sections 3-4	Keyboards and card-feed control
Sections 5-6	Vacuum-tube circuits
Sections 7-8	Error test and relay control
Sections 9-10	Locations and cam timing
Sections 11-12	Mechanical timing chart
Sections 12-14	Sequence chart — three-trial system. Error-retention switch on TEST.
Sections 15-16	Sequence chart — three-trial system. Error-retention switch on NORMAL.

Supplement wiring diagram 311496-A indicates engineering changes that have been made to wiring diagram 308601-N.

Drive Motor

The drive motor for ac machines is a ½ hp straight induction type with an external-start relay. With this type of construction, greater horsepower can be had for a given-size frame. The start relay is a high/low current relay. On a 115V ac line, the relay picks up when the current reaches 5.1 amperes and drops out when it reaches 4.35 amperes. The relay contacts cut in the starting winding of the motor in place of an internal starting switch.

Direct-Current Supply

The line input to the IBM 56 is rectified by a full-wave selenium rectifier. A 200 mfd capacitor is connected across the rectifier output and shunted by a 47K bleeder resistor. The high resistance of the parallel bleeder holds the capacitor charged to a point near peak value of the applied voltage at no load. This source supplies a plus potential of 140-150V to the plates of the vacuum tubes during operation. Changes in load cause the voltage to fluctuate, but it should never drop below 130V in normal operation. The rectifier stack (part number 340913) is rated at 1 amp. The minus side of the dc supply is connected to the tube cathodes and to R2BU. The plus side is connected to terminal G1 in 8A of the wiring diagram. R2BU is, therefore, the point of zero potential and power supply voltages.

The dc plus supply is protected with 2-amp fuses, one in each side of the input line to the rectifier.

Grid Bias and Filament Supply

The line voltage supplied to the machine is stepped down through a transformer. With a 115V ac input to the primary, 35V ac is induced in the secondary. A 25V tap supplies the parallel-connected 25L6 filaments. The lower end of the secondary winding connects to junction 7 and to R2BU (zero volts reference point).

The 35V ac, which appears between upper and lower secondary terminals, is rectified by a selenium disc rectifier (number 4). The rectifier causes electrons to flow in the reverse direction. As a result, the 10 mfd capacitor (between post 10 and post 9) receives an excess of electrons on its upper plate. The capacitor charges to a point near peak value of the secondary voltage. About —49V is obtained from this source to serve as grid for the 25L6's.

Tube Applications

The tubes used in the IBM 56 in the older machines are all 25L6 beam power pentodes. Figure 54 illustrates a typical circuit. The bias voltage is applied between the grid and cathode. The cathode is connected to R2BU. The plate and screen connect through resistance to the dc supply.

In newer machines all tubes that control relays in the IBM 56 have been triode connected. In normal operation the triode connected 25L6 delivers a lower current to the load than does the same stage with pentode connection. The resulting lower voltage drop across the load (the relay) greatly increases the life of both the relay and its control tube.

The triode connection causes about a one-half millisecond increase in the pickup time of the wire-contact relays. The pentode connection is retained for tubes that must energize magnets. The high current and rapid acceleration characteristics of the pentode are useful here.

In Figure 54 the tube is held below cutoff because its grid is highly negative with respect to its cathode. If the bias were removed, that is, if the grid and cathode were made the same potential, the tube would conduct heavily and current would flow through the load.

In the illustrated circuit the 25L6 is zero-biased by closing the switch. Similarly, in the machine circuits zero-biasing is done by closing one or more relay points that connect the vacuum-tube grids to zero voltage. This connects the grid indirectly to the cathode because the cathodes are connected through filament 1 on chassis 1 and J7 to zero voltage.

It can be seen from the illustrated circuit that if the contact were opened, the grid would return to its normal level at —49V. The tube would cut off immediately.

An important advantage is gained by using tubes to pick relays. The current flowing in the control grid circuits is very small. These circuits can be interrupted by wire-contact relay points without a destructive arc.

The 25L6's require a filament voltage of 22 to 25V for best operation and prolonged tube life. Only glass-envelope type 25L6's should be used in this machine. Figure 55 shows the standard tube layout.

Circuit Description

The circuits described in the first part of this section apply to IBM 56 machines wired to W.D. 308601-N with supplement W.D. 311496-A. The section includes a description of changes incorporated in the IBM 56 circuits in February, 1960.

A circuit description begins with a general discussion of the operation, followed by the preparation necessary to begin operation. The general objective is stated. The circuits are then described in outline form. A step in the outline will not include all the relay points in the circuit, but only enough to enable the reader to follow the circuit. Notes are interspersed to relate mechanical action and clarify circuits that may be difficult to trace.

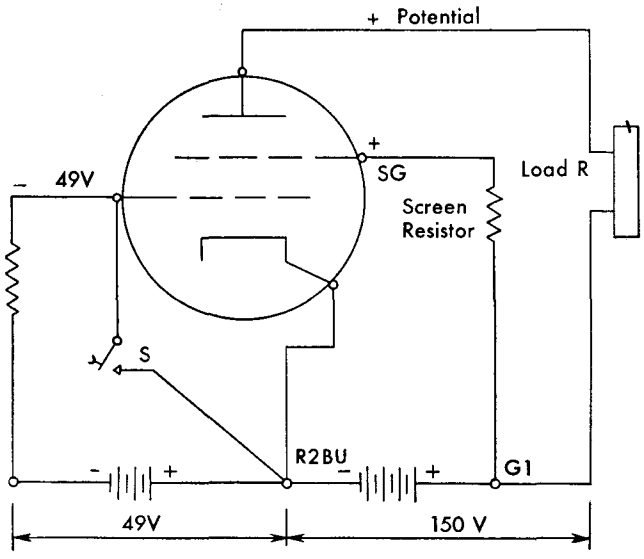


Figure 54. Simplified Tube Circuit

Card Feeding

Preparation: Power switch is turned ON. Auto-feed switch is OFF. Program control is OFF.

Objective: 1. To cause a release cycle to clear the detail station of cards, if any are present. 2. To cause a card to feed from the hopper to the verifying bed. 3. To cause the first card to be registered at the detail station (a second card feeds from the hopper to the verifying card bed). 4. To energize card-lever relay 2.

RELEASE KEY PRESSED

To restore the keyboard:

1. (4B) R1 is picked through release key latch contact.
2. (4B) R1 is held through 1AL and program-cam contact 2 normal points.
3. (4B) R46LP is picked in parallel with R1.
4. (6A) Keyboard restore magnets are energized through 1BU N/O and 46-3 N/O.

To cause escapement:

1. (6B) R25 is energized by tube 4; circuit to tube 4 grid is through 1BU N/O and 21-4 as a terminal.
2. (6A) Tube 3 is fired through 25-4 N/O, energizing the escapement magnet.

Attracting the escapement-magnet armature results in mechanical action. The friction drive causes the program drum to rotate. As a result:

1. (7B) Program cam contact 1 N/O makes at column 80½ to hold tube 4 conducting through 33-2.
2. (4B) R1 drops out when program-cam contact 2 N/C breaks at column 82½.
3. (7B) At column 88⅓ program-cam contact 1 breaks, retiring R25 and the escapement magnet. The escapement armature drops into a tooth on the escape wheel.

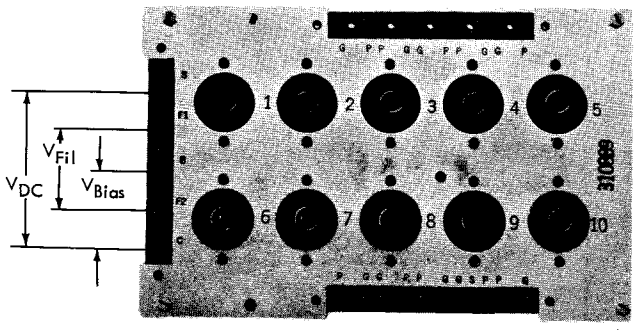


Figure 55. Tube Panel

FEED KEY PRESSED FOR FIRST CARD-FEED CYCLE

To energize the card feed clutch magnet:

1. (4B) Card-feed clutch magnet is energized by feed-key latch contact.
   Note: Mechanical action occurs. The card-feed clutch engages, a card is fed from the hopper, and the CF cam shaft is driven.
2. (4B) R46 is latch-tripped through CF3 and CF5.

To energize OK verify relay 43:

1. (8B) R43H is picked during overlap of CF3 and CF5 through rectifier 2.
2. (8B) R43 is held by V4.
3. Mechanical action continues. The first card causes the card-lever contact to close at about 210 degrees on the index — too late to cause R2 to pick up from CF3 on this cycle. The card comes to rest in the upper section of the detail-card bed. The card-feed clutch latches at 0 degrees on the card-feed index.

FEED KEY PRESSED FOR SECOND CARD-FEED CYCLE

To energize the card-feed clutch magnet:

1. (4B) Feed-key latch contact closes to energize the card-feed clutch magnet.
2. Mechanical action occurs as for first cycle. A second card is fed from the hopper. The first card is registered at column 0 in the detail-card station by mechanical action.

To pick the card-lever relay:

1. (4B) R2 is picked by CF3 through the card-lever contact.
2. (4B) R2 is held through 2AL by program-cam contact 2.

OK Manual Verification

Electrical circuits established in the card-feeding section prepare the machine for normal verification. Relay 2 conditions many of the circuits to the tube grids, as can be seen in sections 5 and 6 of the wiring diagram. Relay 43 must be up at the beginning of the first cycle of verification to cause an escapement before the first column is verified. The following outline assumes, then, that a card is fully registered at the detail station and that R2 and R43 have been energized in preceding operation.

Objective: To manually verify column 1 of the detail card

To energize an interposer magnet:

1. (3A) The correct digit key is pressed, closing a latch contact.
2. (4A) The interposer magnet is energized through the latch contact from 2BU.
   Note: Attracting an interposer magnet armature causes its associated verifier interposer to slip by the armature and close the parallel interposer bail contacts.

To restore the keyboard:

1. (7B) Relay 5 is picked through the interposer bail contacts through V4 and 2BU.
2. (6A) The keyboard-restore magnet is energized as tube 2 is fired through 2BU N/O and R5AU N/O with 27-2 as a terminal.

To cause an escapement to column 1:

1. (6A) The escapement magnet is energized as tube 3 is fired through R5AL, 43-2 N/O, and 25-4.
   Note: The escapement magnet attracts its armature, momentarily freeing the escape wheel. Before the armature can seal, the escapement-armature contact closes.

To cause a verifier clutch cycle:

1. (6A) R22 picks as tube 1 is fired through 21-2 as terminal, 43-3 (8A), and 33-4 to 2BU and the escapement-armature contact.
2. (8B) R22 is held by V4 through 22-1.
3. (6A) The verifier-clutch magnet is energized as tube 7 is fired through 22-4 N/O. The clutch is also energized by V5 (7A) from 70 degrees-140 degrees to prevent latching at 135 degrees.
4. (6A) The escapement magnet is dropped out by 22-3.
   Note: Mechanical action follows: The verifier drive unit mechanically compares the digit punched in the detail card with the digit that has been keyed. Because the digits are the same, the verify contacts remain normal.

To pick the OK relay:

1. (8A) R43 is picked from V5 at 70 degrees through the verify-contact normal points.
2. (8B) R43 is held by V4 through 43-1 N/O.

The verifier clutch latches at 345 degrees to complete verification of column 1 of the detail card. The same sequence of events occurs for each correctly verified card column. Special attention should be given to the action of R43. At the end of an OK verification R43 is held up by V4. It drops out at 30 degrees of the next verifier-clutch cycle and R43 is re-picked during that cycle only if the next card column is correctly verified.

OK Notch and Skip

Preparation: All card columns have been correctly verified. R43 is being held up by V4. As the program drum moves from column 80 to column 81, program-cam contact 1 makes on the N/O side.

Objective: 1. To cause the detail card to be OK-notched. 2. To cause a skip to column 1 after notching.

To energize the notch drive solenoid.

1. (8B) R47 is latch-picked through program-cam contact 1 N/O, 22-1 N/C and V4.
2. R47 is held by its mechanical latch.

3. (8B) The last-column notch solenoid is energized through 47-3 and the program-cam contact 2 N/C. *Note:* Energizing the LC notch solenoid closes the LC notch-solenoid contact.
4. (8B) The notch-drive solenoid is energized through the last-column notch-solenoid contact in parallel with the last-column notch solenoid from 2 AL (4B).

To energize the verifier clutch magnet:
1. (8A) R50 picks in parallel with the notch-drive solenoid.
2. (8A) R50 is held through 50-1 and V6.
3. (6A) The verifier-clutch magnet is energized as tube 7 is fired through 50-3 and 2BU N/O. The notch-solenoid contact breaks the grid circuit to tube 3 to prevent escapement while notching.

To keep the keyboard restored during notching:
1. (6A) The keyboard-restore magnet is energized through 47-4 N/O and 2BU.
2. The detail card is notched mechanically during the verifier-clutch cycle.

To cause a skip to column 1:
1. (4B and 5A) R46 is latch-picked by V3 at 5 degrees of the notching cycle through 47-1.
2. R46 is held up by its mechanical latch.
3. (6B and 7B) R25 is picked as tube 4 is fired through 33-2 N/C, 46-1 N/O, program-cam contact 1, 22-1 N/C, and V4.
4. (6A) The escapment magnet is energized by tube 3 as 25-4 N/O completes a circuit between the grids of tube 3 and tube 4.
5. (6A) R25 and the escapement magnet are held up until program-cam contact 1 N/O breaks at column 88⅓. The program drum comes to rest in column 1. *Note:* R46 and R47 remain latched until 70 degrees of the next card feed cycle when they will be latch-tripped by CF3 and CF5.

Automatic Feed

Preparation: The auto-feed switch is ON. The card has been correctly verified and OK-notched. R47 has been picked by program-cam contact 1.

Objective: To cause an automatic feed cycle:
1. (4B) The card-feed clutch magnet is energized through the auto-feed switch, 47-2 and program-cam contact 2 N/O.
2. (4B) R47 is latch-tripped when CF3 makes at 70 degrees of the card-feed cycle.

Verifying Error — Three-Trial System

Objective: To cause the machine to indicate the error and lock the keyboard.

FIRST TRIAL

To indicate the error:
1. (8A) R33 points are transferred when V5 (70 degrees-140 degrees) fails to impulse R33H (buck-wound with respect to R33P) but impulses R33P through rectifier 9.
2. (8A) The impulse to R33P is continued as a hold by program-cam contact 2 N/C through 33-7 N/O (4B) and 36-12 N/C.
3. (8B) The error lamp and the movable column indicator are energized through 33-11 N/O, 22-1 N/C and V4 (130 degrees-30 degrees).

To lock the keyboard (6A):
The keyboard-restore magnets are energized through 33-1 from R1BU (0 voltage).
Note: With test switch 1 set to N, V7 energizes the keyboard-restore magnets from 0 degrees to 158 degrees of each verify cycle.
To reset after first trial:
1. MP/ER key is pressed to pick R24 (6B).
2. (8A) V6 (325 degrees-145 degrees) picks R36, error reset through 33-9 N/O and 24-6.
3. (8A) R36 holds through 36-1 and V6.
4. (4B) R36-12 opens to drop R33P (8A).

SECOND TRIAL

A second key is pressed:
1. Key depression results in the transfer of the interposer bail contacts.
2. (8B) R5 is energized through the interposer bail contacts and 24-3 N/C.

To hold the keyboard restored (6A) keyboard restore magnets are energized as tube 2 is fired through 5AU N/O and 2BU N/O.
To cause a verifier clutch cycle:
(6A) The verifier-clutch magnet picks as tube 7 is fired through 2BU N/O, 24-1 N/C, R5AL N/O, and 43-2 N/C.
The card column again fails to verify and one or both verify contacts are opened.
To indicate the second error:
1. (8A) V5 picks R-45, error 2 through 36-8 N/O.
2. (8A) R45 holds through V4 (130 degrees-30 degrees) and 45-1.
3. (8A) V5 also impulses R33P but not R33H (verify contacts open). R33 points transfer.
4. (8A) V6 drops R36 at 145 degrees.
5. (8A) The impulse to R33P is continued by program-cam contact 2 N/C through 33-7 N/O and 36-12 N/C.
   Note: R33P is picked by V5, but 36-12 N/C (4B) does not close until R36 drops at 145 degrees (V6). At this time, R45 is up and holding through V4 and re-picks R33P through 45-2 N/O (4B), as soon as R36 drops.

6. (8B) Error lamp and movable column indicator magnets are energized through 33-11 N/O, 22-1 N/C and V4 (130 degrees-30 degrees).

To lock the keyboard:
(6A) The keyboard is held restored by 33-1 N/O. Tube 2 is fired through 33-1 from 1BU.

To reset after the second error:
1. (6B) MP/ER key picks R24.
2. (8A) V6 picks R36 through 24-6 and 33-9.
3. (8A) V6 holds R36 until 145 degrees through 36-1.
4. (4B) R36-12 opens to drop R33P.
5. (8A) V6 picks R48 through 24-6, 33-9 N/C, and 45-3 N/O.
6. (8A) R48 holds through 48-1, 36-1, and V6.

THIRD TRIAL

Pressing a key produces the sequence of events previously described. An interposer-magnet armature closes the interposer-bail contact, energizing R5. R5AL causes tube 7 to fire and pick the verifier-clutch magnet. During the verifier-clutch cycle, verify contacts open to signify an error.

To recognize the third error:
1. (8A) R39 is picked by V5 through 36-8 and 48-2 N/O.
2. R39H is held by V4 (130 degrees-30 degrees) and 39-1. R33P cannot pick because 48-4 is open.

To prepare for error notching:
1. (3B and 4B) R46 is latch-picked through 2BU N/O, 33-4 N/C, 39-4 N/O, 36-9 N/C, and rectifier # 11.
2. (8A) The notch-drive solenoid and R50 are energized through V4 by 39-6 N/O.
3. V6 holds R50 through 50-1.

To cause a verifier clutch cycle:
1. (5A and 6A) The verifier-clutch cycle is energized as tube 7 is fired through 50-3 and 2BU N/O.
   Note: Normal verification can be resumed after the notching cycle. So that an escapement can precede the verifier-clutch cycle for the next card column, R43 must be energized during the notching cycle.

To lock the keyboard during notching:
V7 (0 degrees-158 degrees) holds the keyboard restored during the error notching cycle through test switch 1 NORMAL (8B).

To pick R43:
1. (8A) V5 picks R43 through 50-4 and 33-6.
2. V4 holds R43 through 43-1 and 33-12.
   Note: R46 remains latched until the card-feed cycle, preventing a card that has been error-notched from receiving an OK notch (46-1 and 46-4 in 8B).

Automatic Verification (Key Controlled)

Key-controlled auto-verification occurs at the rate of 100 ms per column. Information is pin-sensed at the master station and compared with the information read from the detail card by the verifying pins. Auto-verification will begin with a pin-sensing verify clutch cycle followed by an escapement and a verifying cycle; another pin-sense, escapement, and verify cycle follows; and so on in that order until the key is released or the card is completed.

Preparation: Identically punched cards are fully registered at both the master and detail stations. Program control is off. Preceding feed cycles have energized R2 and R43.

Objective: To cause low-speed auto-verification of detail card.

To cause a pin-sensing verifier-clutch cycle:
Note: Cards can be sensed electrically at the master station during a verifier-clutch cycle in which R27 is energized.

1. (7B) The verify key is pressed.
2. (6B and 7B) R28 is picked by tube 5. Tube 5 is fired through V4, 22-1 N/C, verify key, and R27-1 N/C.
3. (6B) R28 holds through 28-1 and V2, which is shunted by 22-2.
4. (8B) R50H is picked through 28-4 N/O, 27-4 N/C, 22-1 N/C, and V4.
5. (6A) The verifier-clutch magnet is energized as tube 7 is fired through 50-3 and 2BU.
6. (6A) R27P is picked, as V3 makes at 5 degrees, through 2BU N/O.
7. (6B) R27H is held through V6 and also 27-2.
8. The circuit to the pin sense contacts is through 27-6 and 28-6 (7A).

   Note: The mechanical action of the verifier drive unit causes the master card to be sensed. The pin contacts make between 47 degrees and 57 degrees on the clutch index, completing circuits to energize the interposer magnets. The interposers, which are tripped off by the sensing operation, unlatch too late to engage the verifying bail. They rest against the bail, storing the information from master-card column 1 until the next verifier-clutch cycle.

To suspend verification for the pin-sense cycle:
1. (8A) R43 is picked through 50-4 N/O and V5.
2. (8B) R43 holds through 43-1 and V4.
3. The 50-4 N/C point prevents the normal test circuit through the verify contacts on this cycle. R50 drops out at 145 degrees as V6 breaks.

To cause an escapement: *(Note:* When the master card was pin-sensed, the interposer-bail contacts closed, energizing R5).

1. (6A) When V1 makes at 180 degrees, the escapement magnet is energized. Tube 3 is fired through 2BU, R5AL, and 43-2 N/O.
2. (6A) The escapement armature closes, firing tube 1 and picking R22.
3. (8B) R22 holds through 22-1 and V4.

To initiate the verify cycle:
(6A) Tube 7 is fired through 2BU and 22-4 to energize the verifier-clutch magnet.

During the clutch cycle:

1. (6B) R27P and R28 drop out as V2 breaks at 355 degrees. R27H drops as V6 drops at 145 degrees.
2. (8B) R22 drops when V4 breaks at 30 degrees.
3. Column 1 of the detail card is verified mechanically.
4. (8A) R43 is picked through V5 and the verify contact normal points.
5. (8B) R43 holds through V4 and 43-1.
   Note: It can be seen that, as verification is completed for column 1, the relays that governed the operation have returned to their original status. R2 and R43 are up as before; R28, R27, R22, and R50 are de-energized as before. The verify key is again active through 27-1 N/C to fire tube 5 and repeat the sequence described above for each card column. Had an error occurred during the verification, the verify relays 27 and 28 would have been dropped by the error-relay points in the tube 5 grid circuit. The error would have been treated manually by the three-trial system described earlier.

Auto-Verification (Program Controlled)

Programmed automatic verification proceeds at 50 ms per card column. The operation begins, as did key-controlled verification, with a pin-sensing cycle. Each cycle thereafter is both a pin-sensing and a verifying cycle, in which verification of a card column and pin-sensing of the next card column are concurrent. Programmed auto-verification is initiated when the zero sensing wheel reads a punch in the program card. The 0 in the program card is usually followed by a series of 12-punches defining the field to be auto-verified.

Preparation: Cards are registered at both stations. The auto-skip auto-verify switch is ON. Program control is ON. Column 1 of the program card is punched with a 0; subsequent columns are punched 12. The card-lever relay and the OK relay are energized.

Objective: To cause the detail card to be auto-verified.

To cause a pin-sense cycle:

1. (6B) R28 is picked as 0 program contact makes, firing tube 5.
2. (6B) R28 is held through 28-1 and V2 (shunted by 22-2).
3. (8A) R50H is picked through 28-4, 27-4, 22-1 and V4.
4. (6A) R28-3 N/O holds the keyboard restored during pin sensing.
5. (6A) Verifier-clutch magnet is energized as 50-3 fires tube 7.
6. (6B) R27 is picked at 5 degrees of the clutch cycle through 50-2 N/O, 28-5, 2BU, and V3.
7. (6B) R27 holds through V6 and 27-2.
8. (7A) The 27-6 point completes a circuit from V5 to the pin-sense contact common bar.
   Note: As the master card is pin-sensed, interposers are unlatched. The bail contacts close and pick R5. This sets up the escape circuit through 5AL and 43-2 N/O. The test impulses from V5 are shunted around the verify contacts by 50-4. Relay 43 is energized by V5 and held through V4 exactly as in key-controlled operation. The circuits for key auto-verification and those for programmed auto-verification are similar up to this point. A major difference occurs here. After escapement, the 12 sensing wheel moves into a hole in the program card. The 12 program contact completes a circuit, which holds both R27 and R28 energized. This hold circuit is maintained throughout the field to be auto-verified. V2 bridges escape time so the hold circuit is protected if the program contact bounces between columns.

To hold R27 and R28:

(5B and 6B) A circuit through 2BU, 12 program contact, 28-2 N/O, and 27-1 N/O keeps tube 5 conducting and R28 energized. Relay 27 holds through 27-2 and 28-5.

To hold the keyboard restored during auto-verification:

1. (5A and 6A) The keyboard-restore magnets are energized as tube 2 is fired through 28-3 N/O.
   Note: If an error occurs during auto-verification, R33 picks from V5 on the cycle in which the error column is verified. The 33-3 N/C point in the grid circuit of tube 5 opens, to drop out the verify relays. 33-1 holds the keyboard restored. 33-11 lights the error lamp and energizes the movable column indicator magnet. The error can then be treated manually by the three-trial system discussed previously.

To end auto-verification of a field:
The 12 sensing wheel moves from a punched to an unpunched column of the program card, disabling the hold circuits for R28 and R27 through the 12 program contact. When V2 breaks at the beginning of the next cycle, R28 and (consequently) R27 are retired.

Skip Key

Preparation: Program control is ON. Skip begins in a blank column in the detail card. The program card is punched with 12's to define the field to be skipped. The last column before the skip was verified correctly.

Objective: 1. To verify the column of operation to assure that it is blank. 2. To initiate a skip if the column is blank.

The skip key pressed:

1. (3A) The skip-key latch contact closes, picking R42.
2. (8A) The 43-3 point prevents the hold of R42.
3. (8B) R21H picks when 42-3 points transfer.
4. (5A) The 21-2 point closes to hold the keyboard restored. The circuit is through 2BU N/O, 43-3 as terminal, 21-2 N/O, 43-2 N/O, and 36-6 as a terminal to the grid of tube 2.
5. Also at the same time (through 36-6) tube 3 is fired energizing the escape magnet.
6. (5A and 6A) The escapement-armature contact completes a circuit to the grid of tube 1, energizing R22.
7. (5A and 6A) R22-3 suspends escapement and 22-4 causes tube 7 to energize the verifier clutch.
8. (5 and 6) At 5 degrees of the clutch cycle, V3 fires tube 4 through 21-4 N/O. R25 is picked.
9. (5B and 6B) R25 holds through 25-1 and program contact 12.
   Note: Verification takes place. Because the column is blank, no verify contacts are transferred and R43 is re-picked. Had there been a punch in the column, R33 would have been picked instead. The 33-2 point in 6B would have broken the hold circuit for skip relay 25.
10. (6A) The keyboard is held restored during skipping by 25-2 N/O.
11. (5 and 6) A circuit from tube 4, through 25-4 N/O, fires tube 3 to energize the escapement magnet after V1 makes at 180 degrees of the clutch cycle.
12. Skipping continues until program contact 12 breaks at the end of the field definition to drop out the escape magnet and R25.

Dash-Skip Key

Preparation: Same as described earlier, except that the column of operation in the detail card is punched 11.

Objective: To verify an X and initiate skipping.

Dash-skip key pressed:

1. (3A and 4A) The dash-skip latch contact picks R21 and the 11 interposer magnet.
2. (8B) R21 holds through 21-1 and V4.
3. (6A) R5 is picked by the interposer bail contact as 11 interposer trips.
4. (5A and 6A) The 21-2 and 5AL points close to complete a circuit through 43-2 N/O to the grids of both tube 2 and tube 3 to restore the keyboard and energize the escapement magnet.
   Note: From this point, the machine operation is similar to that for the skip key, the difference being that an X, instead of a blank column, is verified in the detail card. The pick and hold circuits for R25 are identical with those in skip key operation. Skipping is suspended when the 12 program contact breaks, signalling the end of the defined field. Relay 21 will not pick if there are one punches in the program card due to 30-4 N/C (4A).

Programmed Auto-Skip

The preceding circuit description concerned skipping operations that were initiated by or as a result of a key depression. In both instances, R25 was energized on a verifier-clutch cycle by V3 through 21-4. Programmed auto-skipping occurs when the 11 starwheel senses a hole in the program card. The 11-punch in the program card is followed by a series of 12's to define the field to be skipped. Tube 4 is fired through the 11 program contact and held in conduction by a circuit through the 12 program contact.

Preparation: Program control is ON. The machine is at rest in a column punched 11 in the program card. Subsequent card columns are punched 12 for field definition. The card lever relay is up. The auto-skip/auto-verify switch is turned ON.

Objective: To cause automatic skipping over the field defined in the program card.

To pick R25 and the escapement magnet:

1. (5B and 6B) R25 is picked as tube 4 is fired through 2BU, 11 program contact, and the auto-skip/auto-verify switch.
2. (5A and 6A) R25-4 transfers, completing a circuit through 21-4 as a terminal at the grid of tube 4 to the grid of tube 3, and picks the escapement magnet.
3. (5A and 6A) The keyboard is held restored during skipping by 25-2.
4. (6B) As escapement begins and the 11 program contact breaks, 25-6 shorts the R25H coil, and delays the drop-out of R25 until the 12 program contact makes in the next column.
5. (5 and 6) Tube 3 and tube 4 are held conducting by a circuit through 25-1 and the 12 program contact.

To stop skipping:

6. (5 and 6) When the 12 starwheel rides up out of the last 12-punch in the auto skip field, the 12 program contact breaks. The escapement magnet and R25 drop out when tubes 3 and 4 return to cut-off bias.

Skip Key Pressed after Error Reset

The operation of the skip key after an error reset causes the card column of operation to be error-notched. If the column lies in a field that is defined by program card 12 punches, the remainder of the field is skipped.

Preparation: Assume that an error occurred during operation. Program control is ON. The column of operation is part of a defined field.

Objective: Resetting the machine and pressing the skip key results in an error notch in the card and a skip over the field defined in the program card.

To reset:

1. (6B) R24 is picked by the MP/ER key.
2. (8A) R36 picked through 33-9, 24-6, and V6.
3. (8A) R36 holds through 36-1 and V6.
4. (4B) R33H is dropped by 36-12 in 4B.
5. (5A and 6A) R33-1 opens unlocking the keyboard.

To notch:

1. (4A) R42 is picked by the skip key.
2. (8A) R42 holds through 42-1, 43-3 N/C, and 2BU N/O.
3. (8B) R21 picks through 42-3 (7B) and V4.
4. (8B) R21 holds through 21-1 and V4.
5. (5A and 6A) Tube 7 is fired through 21-2 N/O and 43-2 N/C.
6. (7A and 8A) At 70 degrees R39 receives a pick impulse from V5 through 36-8 N/C and 42-2 N/O.
7. (8B) R39 holds through 39-1 and V4.
8. (3B) R36-9 N/C and R39-4 N/O pick R46LP. (4B) See circuit change in supplement W.D. 311496-A (sections 17 and 18).
9. (8A) R50 and the notch-drive solenoid pick through 46-2, 39-6, and V4 at 130 degrees.
10. (8A) R50 holds through 50-1 and V6.
11. The keyboard is restored through 46-3 as a terminal, through test switch and V7 made at 0 degrees.
    Note: Since R43 failed to pick on this cycle, the hold for R42 is maintained through 43-4 N/C. Relay 21 therefore holds through 42-3.

To skip:

1. (6B) R50-3 energizes tube 7 driving the verifier clutch.
2. (5 and 6) Tube 4 is fired through 21-4 N/O and V3 at 5 degrees. R25 is energized.
3. (5B and 6B) R25 holds through 25-1 and the 12 program contact.
4. (5A and 6A) Tube 3 is fired by 25-4, which closes a circuit between the grids of tube 4 and tube 3.
5. (6A) At 180 degrees, when V1 makes, the escapement magnet is energized.
6. (5A) R25-2 holds the keyboard restored during skipping.
7. The escapement magnet and R25 are held energized until the 12 program contact opens, signalling the end of the defined field.

Keyboard Shift Control

The design of the combination keyboard requires that circuits be switched, so that some keys may serve dual purposes in alphabetic and numerical operation. The switching function is accomplished by R30. When R30 is up, the keyboard is conditioned to verify alphabetic information. The 30-2 and 30-3 points make the appropriate circuit selection (sections 3 and 4 of the wiring diagram). The 30-4 point in (4A) prevents a pick of the X-skip relay when an X is verified in an alphabetic field.

The keyboard is normally in alphabetic shift when program control is off. When program control is on, the keyboard remains in numerical shift until programmed alphabetic (1's in the program card), or until ALPH is pressed.

To pick R30:

1. (5B and 6B) R30 is picked by tube 8.
2. Tube 8 is fired through 2BU N/O, program handle switch, numerical key-stem contact, and 24-4 N/C. *Note:* Pressing NUM opens the key-stem contact and keeps the keyboard in numerical shift as long as the key is held down.

To pick R30 by programming alphabetic shift:

1. (5B and 6B) R30 is picked by tube 8. The circuit to fire tube 8 is through 2BU, program contact 1, R5BU N/C, 36-10 N/C, NUM key-stem contact, and 24-4 N/C.
2. (5B) The ALPH key shunts around the program contact 1 and can be used to put the keyboard in alphabetic shift when program control is ON and alphabetic shift is not programmed.

Error in Last Column of Alphabetic Field

A special problem in shift control arises when an error occurs in the last column of an alphabetic field that is followed by a numerical field. The keyboard must be held in alphabetic shift while attempting to clear the error.

To keep the keyboard in alphabetic shift:

1. (8A and 5B) Relay 40 is picked by 30-1 N/O, 22-2 N/O, and 2BU N/O, following escapement to the error column.
2. (8A) R40 is held through 40-1 and V6.
   Note: Because each trial cycle is a verifier-clutch cycle, it was necessary to design additional hold circuits to keep R40 energized during the portion of these cycles when V6 is open. The 33-8 and 45-4 error relay points each complete a hold circuit for R40 to program-cam contact 2 N/C. The three hold

circuits are: through 40-1 and V6, through 33-8 and program-cam contact 2, through 45-4 and program-cam contact 2.
3. (8A) R36 is energized before the second and third error trials as the machine is reset.
4. (8A) R36 holds through 36-1 and V6.
5. (6B) R30 is energized as tube 8 is fired through 36-10 N/O, 40-2 N/O, and 2BU N/O. Relay 30 is held up by this circuit until 36-10 opens at 145 degrees of each trial cycle. Note that if the error condition is cleared on any trial cycle, the hold for R40 through the error relay (33-8 or 45-4) is destroyed. The machine then reverts to numerical shift for the next column.

Release — Card Lever Relay Not Energized

Preparation: Program control OFF. Card-lever relay 2 is down. The auto-feed switch is OFF.

Objective: To cause a smooth, uninterrupted release cycle.

Release key pressed:
1. (4B) R1 and R46LP are picked by the release-key latch contact.
2. (4B) R1 holds through 1AL and program-cam contact 2.
3. (5A and 6B) Tube 4 is fired through 1BU (inner) and 2BL N/C. R25 is picked.
4. (5A and 6A) Keyboard-restore tube 2 is fired and held conducting through 25-2 N/O.
5. (5 and 6) A circuit through 25-4 connects the grids of tube 4 and tube 3, energizing the escapement magnet. The escapement begins.
6. (7B) At column 80½, program-cam contact 1 N/O makes to complete a hold circuit through 46-1 N/O that will keep tube 4 and tube 3 conducting after program-cam contact 2 breaks.
7. (8B) When the escapement reaches column 88⅓, the program-cam contact 1 returns to normal. The escapement magnet and R25 are dropped.
8. (4B) R46 will be latch-tripped through CF5 and CF3 on the next feed cycle.

Release — Card Lever Relay Energized

Preparation: Program control is OFF. Relay 2 is up. The auto-feed switch is OFF.

Objective: To cause a series of automatic spaces which will continue over the entire card.

Release key pressed:
1. (4B) R1 and R46LP are picked by the release-key latch contact.
2. (4B) R1 holds through program-cam contact 2.
3. (5A and 6A) Tube 2 is fired through 1BU N/O and 2BL N/O. The keyboard is restored.
4. (5A and 6A) Tube 3 and the escapement magnet are energized. Circuit to fire tube 3 is through 1BU, 2BL N/O, 25-2 N/C, 28-3 N/C, 47-4 N/C, 36-6 N/C, 25-4 N/C, and 22-3 N/C.
5. (5A and 6A) The escapement armature contact fires tube 1, picking R22.
6. (8B) R22 holds through 22-1 and V4.
7. (5A and 6A) R22-4 closes to energize the verifier clutch.
8. (6A) R22-3 opens to drop the escapement magnet. *Note:* On the verifier-clutch cycle, R22 drops out at 30 degrees. At 180 degrees the circuit to energize the escapement magnet is completed by V1 and the sequence is repeated for each card column. When program-cam contact 1 makes at 80½, R25 is picked and held through the 46-1 N/O point until program-cam contact 1 breaks at column 88⅓. Relay 1BL point prevents a test of the verify contacts by V5.

Release with Program Control

When the release key is pressed, the machine spaces over unprogrammed columns exactly as described in the last section.

The controls for auto-verification are operative during release. Release auto-verification circuits are otherwise identical to those described earlier for fully automatic operation.

Where manual fields are defined in the program card with 12-punches, these fields are skipped automatically.

Preparation: Program control is ON. Relay 2 is up. The auto-skip/auto-verify switch is ON.

Objective: To cause a skip over defined fields.

The release key is pressed:
1. (5B and 6B) Tube 4 is fired through the 12 program contact, 28-2 N/C, and 1AU N/O. R25 is energized.
2. (5 and 6) R25-4 N/O completes a circuit between the grid of tube 4 and the grid of tube 3, energizing the escapement magnet.
3. Tubes 3 and 4 are held conducting through the 12 program contact until it breaks at the end of the defined field.

Space Key

Operation: To cause a skip over a blank column.

The space key is pressed:
1. The escape magnet is picked as tube 3 is energized through 36-6 N/C and 43-2 N/O.
2. The escape-armature contact closes energizing tube 1 and picking R22 through 21-2 as a terminal and 33-4 as a terminal in 3B back to 2BU.
3. Tube 7 is energized through 22-4 and a verifier-clutch cycle ensues. Because the column is blank, no error is detected and R43 is picked for the next column.

Purpose of Relays

This section does not include a stated purpose for all relay points. Relay hold points and points whose purpose are obvious from their position in the circuit are omitted. This section applies to *Wiring Diagram 308601-N.*

Relay 1 — Release Relay

Relay 1 is the release relay. It causes cards at both the pin-sensing and verifying station to be moved to the left through the station. The effect of the card-lever relay and the program-control lever on release were discussed under *Circuits.*

R1AU causes skip relay 25 to pick and hold when the field definition is sensed on a release to cause a skip over the 12's of the field definition.

R1BL breaks to prevent reading through the verifying contacts while automatically spacing over blank columns of the program card during a release.

R1BU, on a release operation, uses the outer point to pick and hold the keyboard-restoring magnets energized. The inner contact causes tube 4 to conduct and pick skip relay 25. This contact shunts around R5AL to cause escape and verify-clutch cycles for automatic spacing (without reading) over blank columns of the program card.

Relay 2 — Card-Lever Relay

This is the main controlling relay for verification and the program controls. Relay 2 is normally picked on the second card-feed cycle of a new run, but can be energized on the first card-feed cycle when a card is hand fed and the register key is pressed.

R2AU opens the circuit to grid 5. It is possible to hold down the verify key after column 80 is completed or before a new card is fully registered. This point prevents picking up the auto-verify relays until the machine is conditioned for operation.

R2BL N/O causes the machine to follow the program controls on a release operation with program control ON.

R2BL N/C completes a circuit to grid 4 when relay 2 is normal so that pressing the release key results in a smooth skip.

R2BU N/O (outer) completes a circuit to make the keyboard contacts operative when a card is fully registered and relay 2 is energized. This point and its circuits are separated from the grid control circuits to prevent placing a plus potential on the grids when relay 2 drops out. The circuit eliminated would follow from the interposer magnets which are connected to positive voltage through a key tripped, the two R2BU contacts (as one terminal) and any control grid circuit completed at this time.

R2BU N/O (inner) breaks between cards to prevent tubes from firing through a back circuit. It also cripples the keyboard contacts between cards.

Relay 5 — Interposer-Bail-Contact Relay

R5 provides a delay (while its contacts transfer) which assures that interposers have ample time to latch under the bail.

R5AL completes circuits to the control tube grids when one or more interposers are unlatched.

R5AU N/O provides a circuit to restore the keyboard through 27-2 when a key has been pressed and an interposer magnet has been energized.

R5AU N/C provides a means of obtaining the keyboard-restore magnets.

R5BL breaks so that with an error during auto-verification when the test switch is ON, an extra verifying cycle occurs to restore any interposers that were tripped during the error cycle. Otherwise, the error-reset keys drop the error relays and, when the clutch latches are at 345 degrees of the next cycle, no error conditions exist.

R5BU N/O provides a means of holding relay 30 at the end of an alpha field when a key has been pressed picking relay 5. This way relay 30 holds through an escapement and until 30 degrees of a verify cycle.

R5BU N/C provides a means of picking relay 30 to get programmed alphabetic information.

Relay 21 — X Skip Relay

Relay 21 can be energized through several circuits by the dash-skip key, by the 11 pin-sensing contact, and by relay 42 on the hold coil when the skip key is operated. This relay causes a verifying cycle in the column of operation before setting up a skip over the field definition.

R21-2 provides a means of starting an escape and verify cycle when the skip key is pressed and the interposer-bail contacts are not closed. This causes the machine to escape and verify a blank column before skipping.

R21-3 prevents a pick of the verify relay if the verify key is pressed by mistake after a skip has been keyed.

R21-4 makes during the verifying cycle when the skip key is operated in a blank column to pick skip relay 25.

Relay 22 — Escapement-Interlock Relay

This relay serves two vital functions on the verifier:

1. It picks fast to drop the escapement armature back into the next tooth of the escape wheel.
2. It impulses the verifier-clutch magnet after escapement is accomplished.

R22-1 N/C provides an interlock from the time relay 22 is energized until 130 degrees of the cycle when V4 makes. This is needed to delay the pick of R47LP when the detail card is standing in column 80. Program-cam contact 1 transfers before the verify cycle. R47LP must be delayed until after V5 time if the column was in error. It would then be necessary to pick relay 46 and not relay 47.

This point also prevents picking relay 50 until after master-card reading time to insure the extra pin-sensing cycle for the start of auto-verification, if it is preceded by a manual verifying cycle.

R22-2 completes a hold circuit for auto-verify relay 28 when the program contact transfers from the zero to the field definition 12's. It also provides a hold for relay 28 during pin-sensing cycles for the key controlled auto-verification. The N/O point completes a circuit to relay 40 during an escapement so that the problem of alpha-shift hold-over is eliminated.

R22-3 breaks the grid circuit of tube 3 which drops out the escapement after a space.

R22-4 completes the circuit to fire tube 7 and energize the verifier clutch after escapement for normal verify cycles.

Relay 24 — Multiple Punch and Error-Reset Relay

The most frequent use of this relay is to reset the machine after an error. Its second use is in verifying multiple-punched columns. R24 contacts hold up escapement while the interposer magnets are being tripped. Releasing the key drops relay 24 and all holds in the column can be checked at once.

R24-1 breaks the circuit through the interposer-bail contact relay until all of the desired magnets have been tripped off for multiple-punch verification.

R24-2 breaks the circuit to X skip, relay 21, so that X's can be verified in multiple-punched columns.

R24-3 completes a circuit for keyboard restoration when verifying in a multiple-punched column.

R24-4 drops out relay 30 to insure that a multiple-punched column is always verified with the keyboard in a numerical shift.

R24-5 breaks the circuit to insure that a space does not take place if the space key should be accidentally hit in a multiple-punched column.

R24-6 completes a circuit on error resets to energize the reset relays.

Relay 25 — Skip Relay

Relay 25 is the main control over the escapement for skipping. Its contacts suspend other controls while skipping.

R25-1 closes the hold circuit for relay 25 through the field definition 12's for skipping.

R25-2 N/O holds the keyboard restored during skipping.

R25-3 prevents the pickup of the auto-verifying relay 28 from the verifying key-stem contact when skipping.

R25-4 N/O places the control grid of tube 3 under control of R1BU when relay 2 is normal for a skip to column 80. The contact closes for a skip to place the grid of tube 3 under control of the field definition.

R25-5 opens during a skip to prevent relay 22 from picking and consequently prevents the verifier clutch from energizing.

R25-6 provides a delay in the drop out of relay 25 when transferring from the 11 to the 12 program contact by shorting out its hold coil.

Another delay is necessary during card releasing when program control is ON. After a skip during the release, if the field being skipped is followed by an auto-verification field, relay 28 must be energized before relay 25 drops out to prevent R28-3 N/C and R25-4 N/C from shunting around the R5AL contact.

A shunt of the 5AL contact would cause an escape and verify cycle followed by a skip instead of a pin-sensing cycle to read from the master card.

Relay 27 — Auto-Verify Relay 2

This relay prepares the master-card sensing-pin contacts to read from the master card. Also, the contacts are used to read through the verify contacts in the units column of an auto-verification field during release.

R27-1 N/O closes to help complete the hold circuit for relay 28 through the field definition.

R27-1 N/C causes single-column auto-verification by key control.

R27-2 provides a hold for relay 27 during auto-verification with program control.

R27-3 shunts around the 5AL contact during auto-verification to permit auto-verification of blank columns.

R27-4 breaks to allow only one cycle of operation for relay 50: the first column of auto verification.

R27-6 N/C permits a circuit for manual verification to test for errors.

R27-6 N/O reads through the verify contacts in the units column of an auto-verification field during release. Also, during auto verification a circuit is completed to the pin-sense contact common bar.

Relay 28 — Auto-Verify Relay 1

Relay 28 is the auto-verification control relay. It is the first of a series of relays picked to read from the master card automatically and compare it with the detail card. Relay 28 contacts interlock all other machine functions while auto-verification is being performed.

R28-1 establishes a hold circuit for relay 27 and relay 28 when the program contacts transfer from zero to 12's. It also completes a circuit through 22-2 N/C to hold relay 28 on pin-sense cycles during key-controlled auto-verification.

R28-2 N/C on a release auto-verification breaks the grid circuit to tube 4 to prevent re-energizing the skip circuit should an error occur in the first column before relay 25 drops.

R28-3 N/O closes to lock the keyboard during auto-verification.

R28-3 N/C on a release operation, when programmed, breaks the circuit through R1BU and R25-2 N/C to prevent the R5AL from being bypassed. The first cycle should be a pin-sensing cycle without a preceding escapement.

R28-4 closes the circuit to energize relay 50 for the first cycle of auto-verification either by key or program control.

R28-5, during auto-verification, provides a circuit for a hold on relay 27 so its contacts can be used to read through the verify contacts in the units column during release.

R28-6 closes to make the master-card sensing-pin contacts operative through V5 during auto-verification.

Relay 30 — Alphabetic Field-Control Relay

This relay is not used with the numerical keyboard. Relay 30 contacts switch the combination keyboard circuits to select numerical or alphabetic information for dual-purpose keys.

R30-1 picks relay 40, the shift hold-over relay, following escapement to the error column.

R30-2 N/O selects the bail contacts of the keyboard for alphabetic or special-character codes.

R30-2 N/C breaks to eliminate certain latch contacts which are used only when verifying numerical codes.

R30-3 N/O closes to select interposer magnet 4 for alphabetic codes using keyboard bail contact 15.

R30-3 N/C selects interposer magnet 3 in numerical shift for codes using the 15-bail contact.

R30-4 breaks to prevent skipping from X-verification either alone or in combinations when in the alphabetic shift.

R30-6 closes to provide a hold on relay 30 when the program-handle switch is ON and in alpha field.

Relay 31 — Error Retention Relay

This relay aids the customer engineer in locating an error in the verifying cycle.

R31-1 connects the plus terminal of the verifier-clutch magnet to the + dc line by passing V1.

R31-2 N/C opens the normal circuit to the verifier-clutch control-tube grid.

R31-2 N/O places the clutch control-tube grid under control of the MP/ER key. The verifier clutch can be reset to 345 degrees when the MP/ER key is pressed.

R31-3 prevents picking relay 24 with the MP/ER key until after the verifier clutch has been impulsed to reset. It also prevents the voltage applied to the plus side of relay 24 from reaching the control-tube grid.

R31-4 N/O restores the keyboard.

R31-5 N/C opens the normal verifier-clutch-magnet pick circuit from V5.

R31-5 N/O diverts the impulse from V5 through the verify contact normal points to the clutch magnet.

Relay 33 — Error 1 Relay

This relay is designated *Error 1* because it is the first relay picked when an error is sensed by a transferred verifying contact. By locking the keyboard electrically, it prevents further keying until the machine is reset.

R33-1 locks the keyboard on error cycles to indicate to the operator by the increased tension that an error condition is present.

R33-2 breaks the skip circuit when a punched hole is found if an operator attempts to skip over punched information. An error signal occurs.

R33-3 drops auto-verify relay 28 when an error is sensed during auto-verification. This relay point also prevents holding relay 28 if the units position of the previous field is in error.

R33-4 breaks to prevent extra keys from affecting the circuits when an error occurs.

R33-5 prevents energizing the verifier clutch at 70 degrees when an error has been found when the switch is on test. Therefore, the clutch latches up to 135 degrees.

R33-6 breaks to prevent picking relay 43 when an error is sensed during auto-verification.

R33-7 establishes the hold circuit for R33 with relay 36-12 until the machine is manually reset by relay 24.

R33-8 N/O keeps relay 40 energized when an error is made in an alphabetic field.

R33-8 N/C breaks to drop relay 1 if an error is detected during auto-verification after a release with program control.

R33-9 N/O makes on first and second error to pick relay 36.

R33-9 N/C completes a circuit on error 2 reset for relay 48 and sets up the relays so a third failure will energize relay 39.

R33-10 closes to hold relay 5 on auto-verify with the switch on TEST so that relay 36 cannot be picked when the MP/ER key is pressed.

R33-11 N/O closes to light the error lamp and move the column indicator back.

R33-11 N/C breaks to prevent the start of auto-verification if an error takes place in the units position of a manual field followed by an auto-verify field.

R33-12 breaks the hold circuit for relay 43 on an error condition.

Relay 36 — Error-Reset Relay

R36 restores the machine after the first and second trial when the trials are in error.

R36-3 prevents relay 28 from being energized during trial cycles until after the verifying contacts have determined the likeness of information. This problem exists in the units column of a field followed by a programmed auto-verify field.

R36-5 prevents picking relay 47 from reset until verifying-trial time when an error occurs in column 80 of the detail card.

R36-6 N/C breaks to prevent escapement before error-trial cycles.

R36-6 N/O restores the keyboard on first and second error trials.

R36-7 breaks to prevent an auto skip when an error occurs in the last column of a field with program control for auto skipping of the next field. The program drum reads one column ahead and must be delayed until the error column is cleared.

R36-8 makes to energize relay 45 on the second error and R39 on the third error.

R36-9 picks drum-skip relay 46 but not until after the verify pins have signalled the third error.

R36-10 N/O makes during reset to re-energize alphabetic shift R30 if the column being verified is in an alphabetic field.

R36-10 N/C breaks to prevent keyboard shift prematurely when an error occurs in the last column of a numerical field followed by an alphabetic field.

R36-11 makes to keep the error lamp lit and the movable column indicator back during error reset on the first and second error trials.

R36-12 breaks on machine reset to drop relay 33 after the first and second trials.

Relay 39 — Error 3 Relay

Relay 39 is energized when the third trial at verifying a column still indicates an error. This relay sets up error notching.

R39-2 breaks on an error cycle to prevent skipping before error notching when in the units column of a field that is followed by an auto-skip field.

R39-3, when an error occurs in the last column of a field, breaks on the third error cycle to prevent starting auto-verification until after the error-notching cycle.

R39-4, when skipping by the use of the skip key is attempted in a punched column, closes on the second cycle to pick R46LP, which eliminates OK notching for that card. Without this contact, relay 46 would be energized every time.

R39-5, if a card is verified in column 80 and an error occurs, this point breaks until the error-notch cycle is under way to prevent picking relay 47.

R39-6 N/O closes when an error picks relay 39 to cause an automatic notching by energizing relay 50 and the notch-drive magnet in parallel.

Relay 40 — Shift-Holdover Relay

This relay holds the machine in alphabetic shift when an error occurs in the last column of an alphabetic field and the next field is numerical.

R40-2 holds relay 30 during an error to make sure the machine is still in alphabetic shift.

Relay 42 — Skip-Key Relay

This relay controls skipping from the keyboard. Relay 42 causes auto-verification in the column of operation.

When the column is blank, the resultant skip follows the field definition. If the column is punched, the error light turns ON. A reset and second pressing of the skip key causes error notching and a skip to the end of the field.

R42-1 sets up a hold for relay 42 if the column of operation is punched. Relay 43 must be dropped and 43-3 closed to set up the hold circuit. This condition exists after the skip key is struck after an error.

R42-2 N/O picks relay 39 to notch and skip when the skip key is pressed after an error reset.

R42-3 N/O closes to pick and hold relay 21 when the skip key is pressed.

R42-4 N/O makes to provide a shot to the verify clutch bypassing the verify contacts on an error condition with the skip key pressed and the switch on TEST.

R42-5 breaks the hold on relay 33 during a skip to set up circuits for use after the skip through the programmed field.

Relay 43 — OK Verify Relay

This relay is energized on each correct verifying cycle. Its contacts make it possible to escape before verifying on correct card columns and shift the control to impulse the verifier clutch when an error is encountered.

R43-2 N/C breaks to prevent a verifier-clutch cycle before escapement for correct verification.

R43-2 N/O is closed to permit an escapement before the verifier clutch is impulsed for correct verification.

R43-3 prevents skip key relay 42 from holding and causing error notching when the skip key is pressed for the first trial.

R43-4 breaks to prevent holding 39 and 45 when a column is OK verified on the second or third error trial.

R43-5 breaks to drop the hold on relay 33 when a column is OK verified.

R43-6 makes to pick the skip relay during the third error cycle when the card is notched and a smooth skip follows.

R43-6 makes to pick relay 25 during the second error cycle when the skip key is pressed and thus it initiates a smooth skip over the field definition.

Relay 45 — Error 2 Relay

When the second error transfers the verifying contacts, relay 45 is energized through the R36-8 N/O points. When the machine is reset to prepare for the third-trial cycle, relay 45 sets up the circuit to pick relay 48.

R45-2 picks relay 33 during the second error cycle when R36-12 returns to normal at 145 degrees.

R45-3 establishes a circuit to pick relay 48 for the third trial during the second machine reset when relay 36 picks and R33 drops.

R45-4 continues the hold for relay 40 to keep the keyboard in alphabetic shift if it was in that shift when an error occurred.

R45-5 prevents the pick of R47LP when the second trial in column 80 is wrong.

Relay 46 — Drum-Skip Relay

This is a latch-type relay having a latch-pick and latch-trip coil. Relay 46 makes it possible to skip from column 80 to column 1 of the program drum. Relay 46 is energized on the third error-notching cycle and remains latched to cause a drum skip from column 80 to 1 instead of allowing the machine to OK notch column 80. Correct cards are OK notched and relay 46 is energized on the OK notching cycle to skip the drum to column 1.

R46-1 N/O completes the circuit to the grid of tube 4 to pick R25 to skip to column 1 when program-cam contact 1 transfers.

R46-2 picks up the notch-drive solenoid and relay 50 during the third error cycle.

R46-3 holds the keyboard restored during release cycles.

R46-4 prevents the pick of the last-column notch solenoid if any column is error notched.

Relay 47 — Auto-Feed Relay

This relay starts the OK notching cycle by energizing the last-column notching solenoid. It also causes auto-feeding after correct cards.

R47-1 N/O makes to provide a means to pick relay 46 if a card is OK and the auto-feed relay is latch picked.

R47-2 permits auto-feeding after cards that are verified and OK notched.

R47-3 picks the last-column notch solenoid to shift the punch interposer to block the error punch.

R47-4 holds the keyboard restored between cards when the last card has been OK notched.

Relay 48 — Reset 2

This relay is energized during the second machine reset to select circuits that pick relay 39 if a third disagreement is read through the verifying contacts.

R48-2 N/O makes to select relay 39 if a third error occurs.

R48-2 N/C breaks to prevent another impulse to relay 45 during the third cycle.

R48-3 N/O makes on the second reset of an error condition with the switch on TEST to energize the verify clutch from 70 degrees to 140 degrees.

R48-4 breaks to prevent picking relay 33 on the third error cycle so the machine is normal and ready for the next column.

R48-5 breaks to prevent picking the relay 33 hold coil.

Relay 50 — Notch Relay

Relay 50 is the notch relay. It also causes a verifier-clutch cycle for the first cycle of auto-verification and a clutch cycle for notching. Its points restore the keyboard, suspend testing of the error contacts, and pick relay 43 for the first verifying cycle following an error notch.

R50-2 makes to pick relay 27 after an error-notching cycle to prepare the master-card sensing-pin contacts to read from the master card on the next column.

R50-3 completes a circuit to the grid of tube 7 to cause a verifier-clutch cycle.

R50-4 N/C opens to prevent V5 from testing the verify contacts on a notching cycle or during the first cycle of auto-verification.

R50-4 N/O shunts around the verify contacts to pick relay 43 for the first verifying cycle after an error notch. It also picks relay 43 during the first (pin-sensing) cycle of auto-verification so an escapement precedes verification of the next column.

The variable-length-card device is covered in detail because it is the most common optional feature. Circuit description for the remaining features is not covered. However, there is a great similarity between these features and features in the IBM 24 Card Punch. Additional aid can be obtained by consulting the manual of instruction for the IBM 24-26 Card Punch (Form 223-8319).

Variable-Length-Card Device

Functional Principles

The variable-length-card device is an optional feature on IBM 24 base machines (Figure 56). An IBM 24, 26, or 56 equipped with this device can process 51-, 60-, 66-, and 80-column cards (not intermixed). The conversion of the machine from one length card to another is under the operator's control. Instructions are carried inside the program drum cover (Figure 57).

The machine has the following modifications:

1. Additions to the feed hopper and card feed mechanism.
2. New registration assembly.
3. Additions to the card transport.
4. Additions to the program assembly.
5. Additions to the eject mechanism.
6. Additions to the electrical system.

PROGRAM CONTROL

Program card preparation is the same for short cards as for an 80-column card. To prevent machine damage, it is imperative that field definition not be punched beyond the last column of the particular short cards being processed.

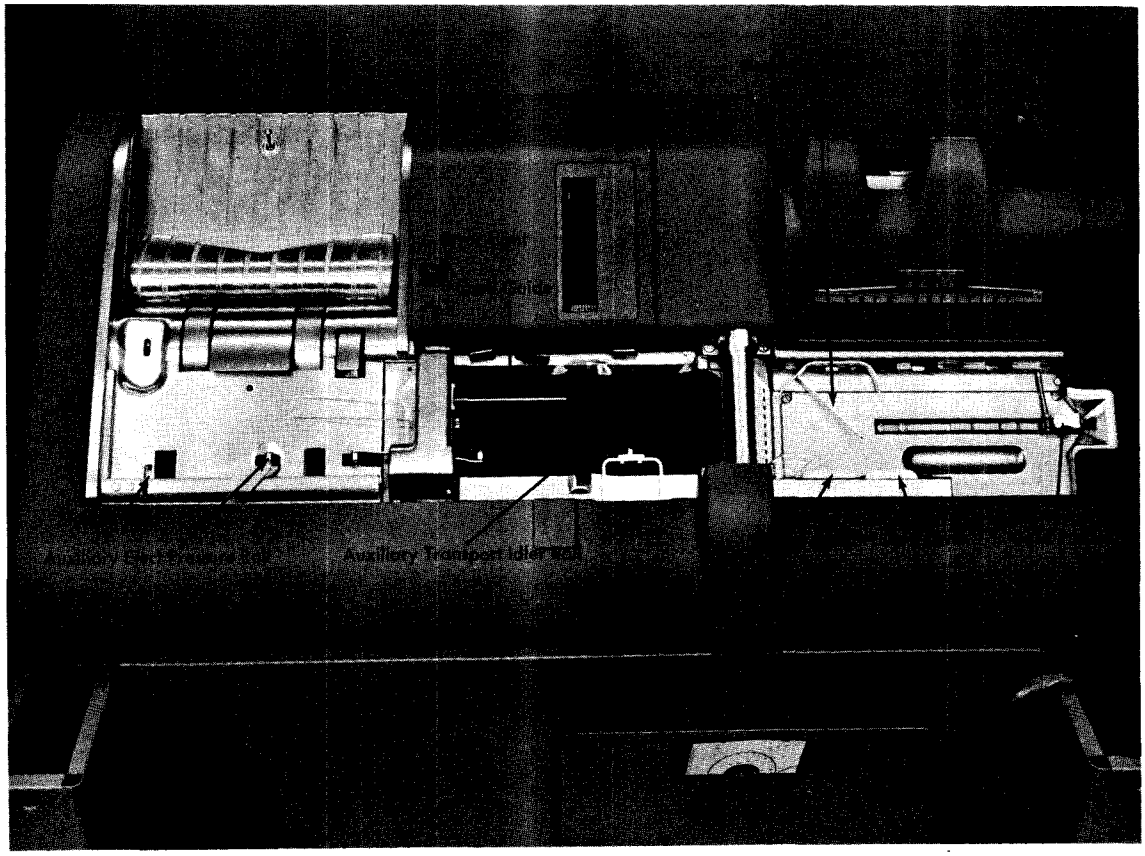


Figure 56. IBM 56 Verifier with Variable-Length Card Device

HOPPER

FOR 51-60-66 COLUMN CARDS LIFT LEFT CENTER, OR RIGHT CARD GUIDE IN HOPPER BED RESPECTIVELY.

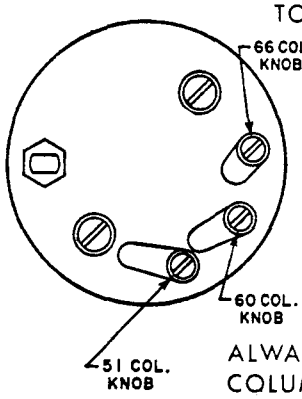
PUNCHING STATIONS BED

LIFT CARD PUSHER AND POSITION SECURELY IN DESIRED NOTCH. LEFT TO RIGHT THE NOTCHES CORRESPOND TO 51, 60, 66 AND 80 COLUMN CARDS RESPECTIVELY

STACKER BED

FOR 51 AND 60 COLUMN CARDS MOVE CARD STOP IN STACKER BED TO RAISED POSITION.

PROGRAM DRUM



TO SET PROGRAM ASSEMBLY FOR LENGTH OF CARD:

1. TURN PROGRAM CONTROL LEVER OFF.
2. SPACE TO COLUMN 16
3. TURN SWITCH OFF.
4. REMOVE PROGRAM DRUM.
5. POSITION KNOBS ON COLUMN INDICATOR BY LIFTING AND MOVING FULL LENGTH OF SLOTS.

80 COLUMN CARDS - ALL KNOBS TO LEFT.
66 COLUMN CARDS - KNOB 66 ONLY TO RIGHT.
60 COLUMN CARDS - KNOBS 60 AND 66 ONLY TO RIGHT
51 COLUMN CARDS - ALL KNOBS TO RIGHT.

ALWAYS MOVE KNOBS IN SEQUENCE. 66 COLUMN KNOB, 60 COLUMN KNOB, 51 COLUMN KNOB FOR SHORTER CARD SETTING FOR LONGER CARDS, MOVE KNOBS IN REVERSE SEQUENCE.

Figure 57. Instructions Inside Program-Drum Cover

Knobs in the column-indicator index control program-cam extensions for skipping from card to card (Figure 58). Because of these knobs, be careful when installing the program drum. Guide the locating pin into the hole in the column indicator without damaging the knobs. If necessary, move the clamping-strip handle slightly to aid installation.

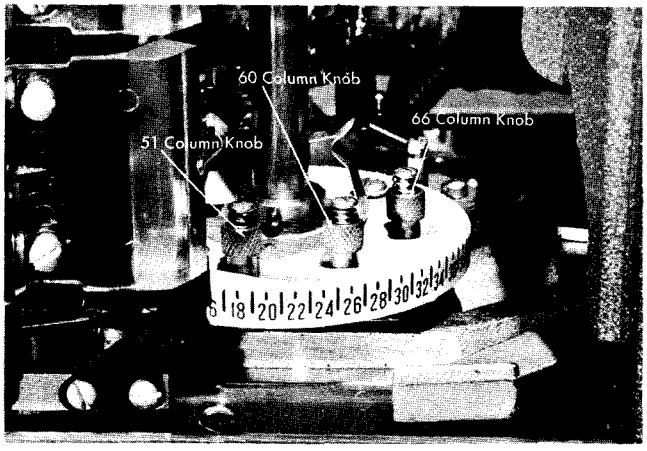


Figure 58. Program-Cam Extension Knobs (80-Column Setting)

BACKSPACE

Backspacing has the limitation that it cannot be used on or through the sixteenth column from the end of the card. Backspacing in this area would cause interference with a card in the preregistered position.

MANUAL INSERTION OF A CARD

Manual card insertion for verifier registration is possible for all four card lengths. For proper registration, be sure that the card is moved to the right against the registration pusher.

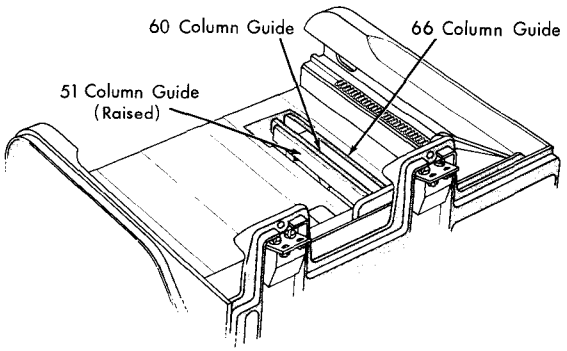


Figure 59. Hopper Card Guides

Mechanical Principles

FEED HOPPER

All cards, regardless of length, are aligned to the left side of the hopper. Alignment is maintained by one of three hopper guides in an elevated position. A guide is normally preselected by lifting the rear edge. From left to right, the guides correspond to 51-, 60-, and 66-column cards (Figure 59).

For the device to handle both short and long cards, the feed knives and feed rolls have been shifted to the left and placed closer together. Three aligner fingers have been provided and two curved guides have been added to the right end of the card guide.

The card-feed clutch latches at 70 degrees for better feeding of short cards.

CARD REGISTRATION

The registration assembly and verifier station have been changed considerably. A sliding registration device replaces the arc-motion pusher arm. The mechanism consists of a notched bar mounted in guides and driven by the pusher arm. The card pusher is carried on the bar and latched in one of the notches. The position of the pusher, set to the correct card length, can be repositioned by the operator. Left to right, the notches are used for 51-, 60-, 66-, and 80-column cards (Figure 60).

Beneath the bar is a plunger rod. When the pusher registers a card, the plunger is moved a short distance, causing the pusher to grip the card. Registration and the amount of gripping action are adjustable. They are not changed by the removal of the detail-station bed plate (Figure 61).

The card-lever finger has been replaced by a fixed card guide (see Figure 56). The right pressure rail incorporates the verifier-card lever. A coil-spring card guide with a bullet nose replaces the pusher-hood plate and guides the card under the pusher gripper.

CARD TRANSPORT

An auxiliary-transport assembly moves short cards from the verifier to the master station (Figure 62). The mechanism, located below the bed plate of the master station, consists of a feed wheel geared to the program-drum shaft. Normally, the feed wheel clears the bottom side of a card. Under control of a magnet, the feed wheel can be brought up against a card, pressing it against an idler roller for transport.

The magnet is energized by a tube during card-to-card skip only. The tube receives its signal from program-cam contact 1. The magnet is de-energized when program contact 2 transfers.

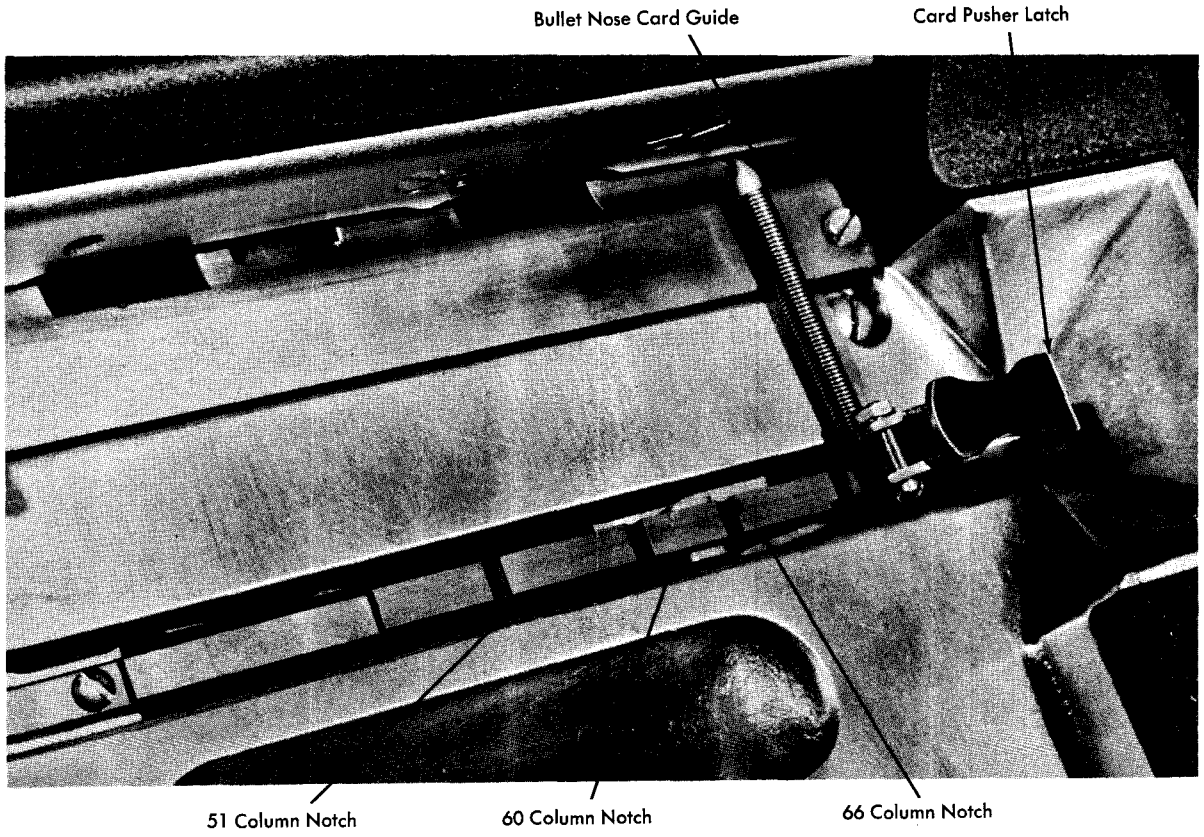


Figure 60. Latch-Type Card Pusher

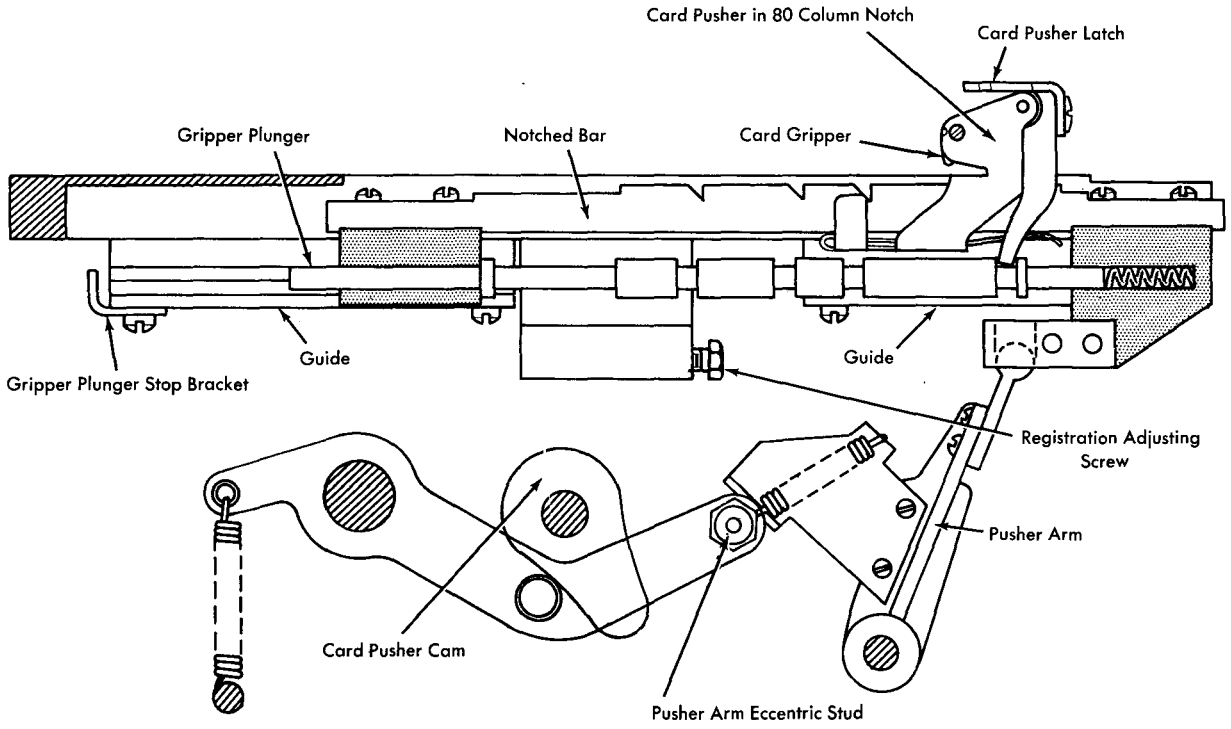


Figure 61. Card-Pusher Registration Assembly

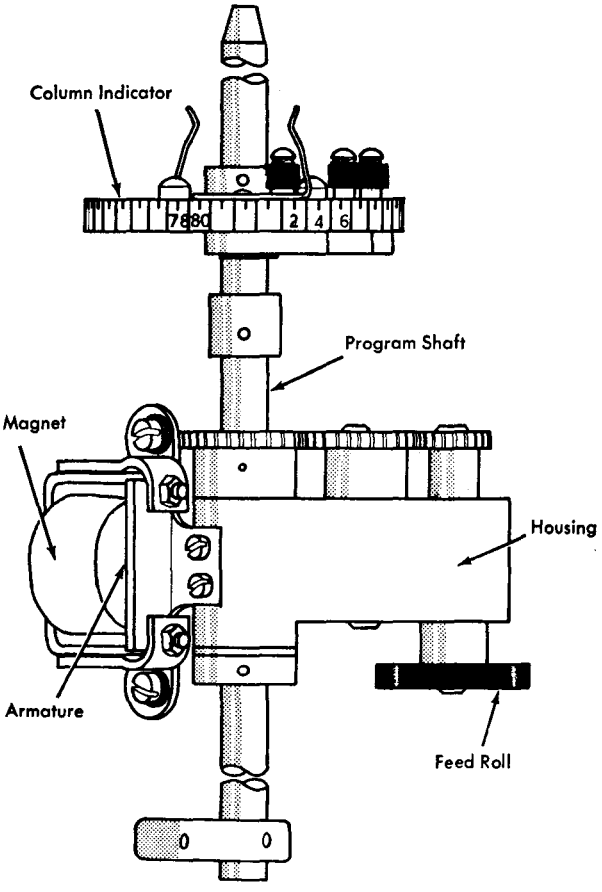


Figure 62. Auxiliary Card-Transport Mechanism

CARD STACKING

For the device to handle short cards, the eject station has been supplemented with an auxiliary eject roll, a stacker stop, and an extension on the traveling card guide (see Figures 56 and 63). The auxiliary roll, located in the bed plate of the eject station, runs continuously. During eject operations, a pressure roll is pivoted against the card, bringing it against the auxiliary roll. The pressure arm-and-roll mechanism is driven by a cam on the left end of the stacker-drum shaft.

The stacker stop in the left side of the bed plate is pivoted up to stop 51- and 60-column cards only. The operator can select and raise it to its operating position by pressing down on the front edge of the L-shaped stop. The stacker operation is delayed 25 degrees to provide the necessary time to carry a short card against the stacker stop.

An arm extends to the right from the traveling card guide to guide a short card properly as it is ejected from the master station.

PROGRAM-SENSING MECHANISM (PROGRAM-CAM EXTENSIONS)

Three program-cam extensions control automatic skipping from the last column of a short card to column 1 of the program drum (Figure 64). The extensions are mounted next to the 81-column cam and are detented into place by knurled knobs. There is an overlap to the extensions so a low-value knob cannot be detented away from center until the higher-value knobs are detented.

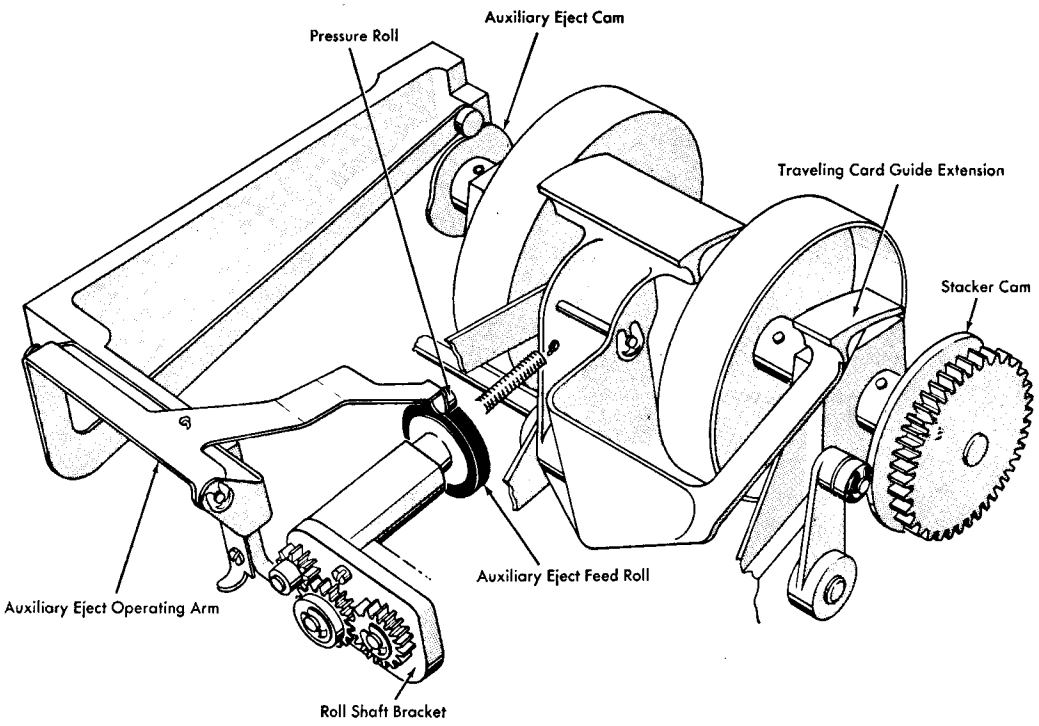


Figure 63. Auxiliary Eject Mechanism

The extensions, their overlap, and the eighty-first column can provide one continuous camming surface for program-cam contact 1. Therefore, if all cams are in their extreme outside position, indicating 51-column cards, program contact 1 makes at 51½ and stays made until 88⅙. The same is true for 61- and 66-column cards. The contact makes one-half column after the last column in the card, and continues to be made until 88⅙.

Program-cam contact 2 timing remains the same regardless of the card length.

Circuits

An IBM 56 with the variable-length-card device uses WD 341080-C. The variable-length-card device modifies IBM 56 circuits as follows:

1. Addition of an auxiliary card transport.
2. Change of latch time of card-feed clutch to 70 degrees.
3. The use of a card-feed latch-interlock relay (R8).
4. Addition of CF2.

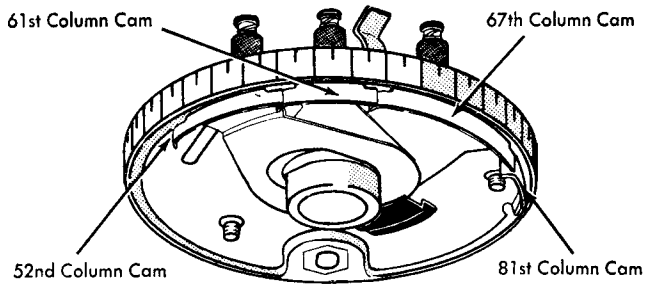


Figure 64. Program-Cam Extensions on Column Indicator (Card Setting)

Auxiliary Transport

The auxiliary-transport magnet brings a roller against a card to enable short cards to reach the master station on card-to-card skips. The magnet is de-energized when program contact 2 opens, dropping R7 at column 82½.

For the circuit description, refer to Figure 65. This is an educational schematic and does not necessarily include all points involved. It is meant to be used as a guide only.

Objective: When the end of a short card is reached, to transfer program-cam contact 1 and skip the card to the read station with the AT (auxiliary-transport) mechanism. Assume that the card has been verified correctly and that card-lever relays 2 and 7 are up.

1. Program-cam contact 1 closes, causing tube 4 in tube chassis 1, and tube 4 in tube chassis 2 to conduct. This picks skip relay 25 and the AT magnet.
2. Operating the AT magnet causes the AT roller to operate, positioning the card in the read station.
3. R25 starts a normal card-to-card skip.
4. The AT magnet de-energizes when program-cam contact 2 transfers, dropping R7.
5. R25 drops when program contact 1 breaks.
6. Card feed takes place as in a normal operation.

CARD-FEED CLUTCH AND CAM TIMING

Because the card feed clutch latches at 70 degrees, it is necessary to time the card-feed cams as follows:

1. CF2 makes at 85 degrees ±2 degrees and breaks at 60 degrees ±5 degrees.
2. CF3 makes at 170 degrees ±2 degrees and breaks at 250 degrees ±5 degrees.
3. CF4 makes at 95 degrees ±2 degrees and breaks at 175 degrees ±5 degrees.
4. CF5 makes at 100 degrees ±5 degrees and breaks at 175 degrees ±2 degrees.

CARD-FEED LATCH INTERLOCK

Because of the 70 degrees latch time of the card-feed clutch, the card-feed latch magnet can no longer be picked directly from the register key. The register key picks R8 (Figure 65) and the card-feed clutch as soon as 8BL closes. At 85 degrees, CF2 holds R8 and picks the card-feed latch magnet through 8BU.

Auxiliary Verification

Auxiliary verification is performed by comparing the card with an auxiliary-drum controlling card, rather than the card at the master station or information keyed by the operator. This controlling card is fastened around an auxiliary drum which is inserted in the machine on a spindle in back of the program drum.

Auxiliary verification is controlled manually by pressing an auxiliary-verify key. The field to be verified is punched in the program card with the field definition code. Pressing the key once causes the entire field to be verified.

Auxiliary verification should be used for fields that were punched by using the auxiliary-duplication feature of the IBM 24 Card Punch. Auxiliary duplication and verification are advantageous when common information is required for certain cards but not for others, when major-minor verification is performed, or when prepunched master cards are inserted during the verifying operation. In the case of major-minor verification, the major data can be dropped when the automatic skip-and-verify switch is turned OFF for a change of information in the minor field. When prepunched master

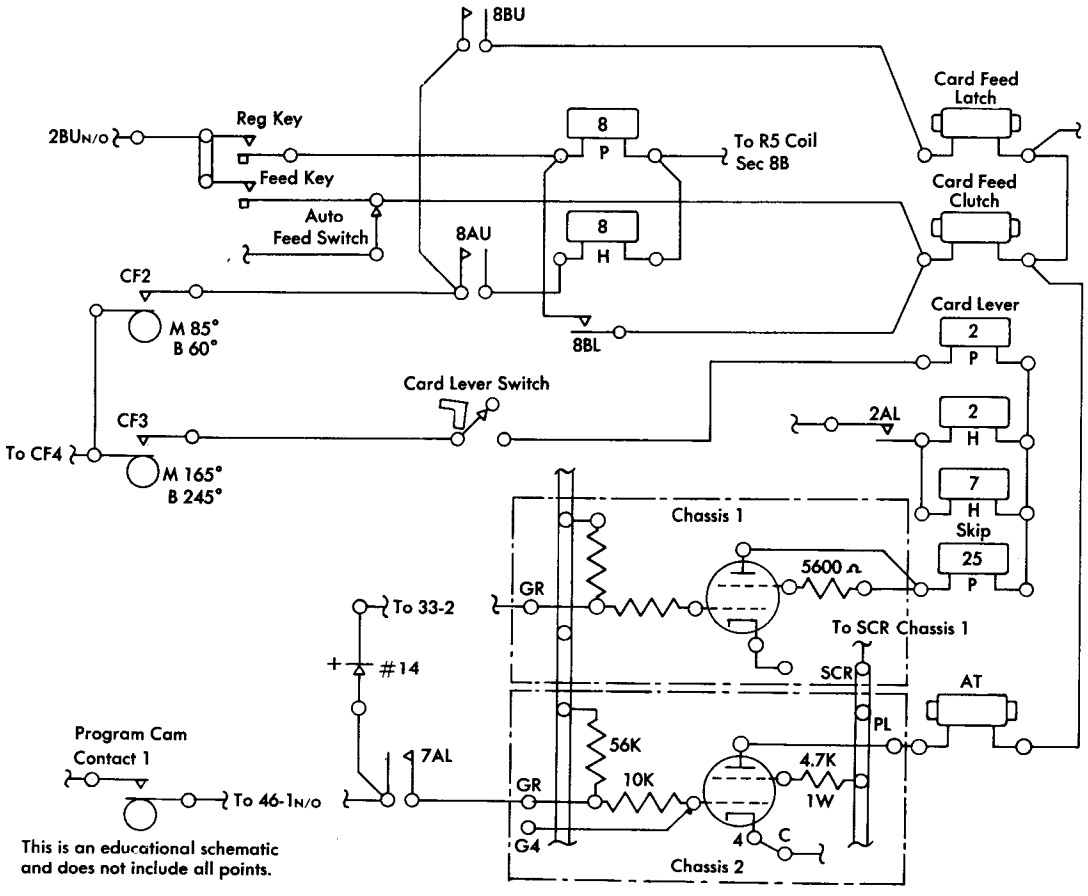


Figure 65. Auxiliary-Transport Schematic

cards were used in the punching operation, information common to all detail cards, such as the date, is dropped when the master card is fed. In either case, the common information can be readily verified in the first detail card of each group with one key depression and without reference to the source document.

11-12 Elimination

Cards are frequently punched with control X's or 12's that do not need to be key-verified. The optional feature, 11-12 elimination, can be installed for this purpose. This feature operates in conjunction with program-card coding, thus making 11-12 verification selective by column. Program 2 code 2 in a column eliminates the necessity of verifying the 11 or 12 punching but requires the verification of the 0-9 punching.

0-9 Elimination

When only the 11 or 12 punching, or a portion of the numerical punching, needs to be verified, the 0-9 elimination feature can be installed. Normally, this feature splits the column between 0 and 11 so that 11 and 12 punches must be verified, and digits 0-9 are eliminated from verification. Any split other than between 0 and 11 can be specified (for example, between 8 and 7), so that all punches above the split (7-12) must be verified, and all punches below the split (8-9) need not be verified.

Like 11-12 elimination, this feature operates in conjunction with program-card coding and can therefore be applied to the desired columns only. Code 3 in a column of the program card eliminates the necessity of verifying the 0-9 punching or any specified portion of the numerical digits, but requires the verification of the 11 or 12 punching.

Alternate-Program Unit

An alternate-program unit can be installed in the machine as an optional feature so two program setups can be punched in one program card. The coding for the alternate program consists of the 4-9 codes used in the same manner as the 12-3 codes for the normal program. All program codes are summarized:

Normal Code	*Program Function*	*Alternative Code*
12	Field Definition	4
11	Start Auto Skip	5
0	Start Auto Verification	6
1	Alphabetic Shift	7
2	11-12 Elimination	8
3	0-9 Elimination	9

This feature is especially advantageous in those cases where an occasional card requires a different program control. Perhaps the card is of a different design or is a partially prepunched master. By pressing on alternate-program key, the operator controls the transfer from the normal program to the alternate program.

To use the alternate-program feature for a complete card, press this key either before or after the card is registered, depending upon the normal-program coding in column 1. If column 1 of the normal program is coded for manual verification, the key can be pressed after the card is registered. If column 1 of the normal program is coded for automatic skipping or verifying, the key must be pressed *before* the card is registered. Also, the automatic feed switch must be turned OFF before the preceding card is completely verified. Pressing the alternate-program key, after the preceding card is released, causes transfer to the alternate program and card feeding.

When the first part of a card is verified under normal-program control and the remainder is verified under alternate-program control, this key can be pressed at anytime the alternate program is to be effective.

When the alternate-program key is pressed, programming from the alternate program is effective for the remainder of that card. When the following card is fed, the normal program again becomes effective.

Card Insertion

The card-insertion device simplifies the manual insertion of a master card in front of a group of cards to be verified or the insertion of a blank or prepunched trailer card at the end of a group of verified cards. Perhaps the operator wants to insert a card in front of a group. When switching the card insertion device to INSERT and pressing MC (the master-card key), the card being verified is released through the master station and then stops. The new card can then be inserted at the master station, which is barren.

To insert a card behind a group of cards that have been verified, the operator sets the switch to STACK and presses MC. The card being verified is released through the master station and stacked. The card can then be inserted behind cards in the stacker.

Continuous Skip

The continuous-skip device enables the operator to skip programmed fields by pressing the continuous-skip key and releasing it in the last field to be skipped.

Continuous Space

The continuous-space device enables the operator to space over successive columns as long as the key is pressed.

Decimal Tabulation

This device makes possible the semi-automatic verifying of zeros to the left of the first significant digit of a card field having seven positions or less. To use the device, the card-verifier operator presses, at the proper time, the numerical key corresponding to the number of significant digits in the field to be verified. Zeros are automatically verified to the left of the first significant digit, and the card is positioned at the column in which the operator is to begin verifying significant digits. Eight of the regular numerical keys are used for the decimal-tabulation operation. There are no additional keys on the keyboard.

The device is controlled by punches in the program card, which is prepared in the normal manner for all except decimal-tabulation fields. Each column of a decimal-tabulation field is punched with a column code and, in addition, every column of the field except the high-order column must contain the field definition (12) punch. The high-order column of the decimal-tabulation field is punched with a 6 code.

The decimal-tabulation program codes are:

First (units) position	7
Second (tens) position	8
Third (hundreds) position	7-8
Fourth (thousands) position	9
Fifth (ten thousands) position	7-9
Sixth (hundred thousands) position	8-9
Seventh (millions) position	7-8-9

A program card for a seven-position field is punched with all seven codes. A program card for a three-position field is punched with the codes for the units, tens, and hundreds positions. One- or two-position fields should not be programmed for decimal tabulation because no advantage would result from such programming.

A decimal-tabulation field is always a numerical field. More than one field can be controlled within a card, and these fields can be in consecutive columns.

High-Speed Skip

The high-speed skip device is for those applications that require skipping of 55 or more consecutive columns of the card. It is available for factory or field installation on the IBM 56. In addition, this device can also be installed on the IBM 56 machines that have variable-length card feed.

This program-controlled high-speed skip operates in conjunction with standard skipping. High-speed skipping is accomplished at the rate of approximately three time the standard skip speed. It results in a saving of eight milliseconds per column skipped at high speed. If 66 columns are skipped, 62 columns are skipped at high-speed with a saving of a half-second per card. The sensing mechanism is positioned in such a way that five columns at the end of the field must be reserved for drop-out. The lack of the 9-punch in the last five columns of the program card disengages (drops out) the high-speed skip and slows down the skip for the remainder of the card. This is necessary because the high skipping speed must be slowed down to obtain proper registration of the card.

When this device is installed on machines with the variable-length card-feed device, card output is also increased. The missing portions of these cards, for example, columns 51-76, or 60-76, are skipped at high-speed. The last four columns are skipped at a slower speed.

Index

CUT ALONG LINE

COMMENT SHEET

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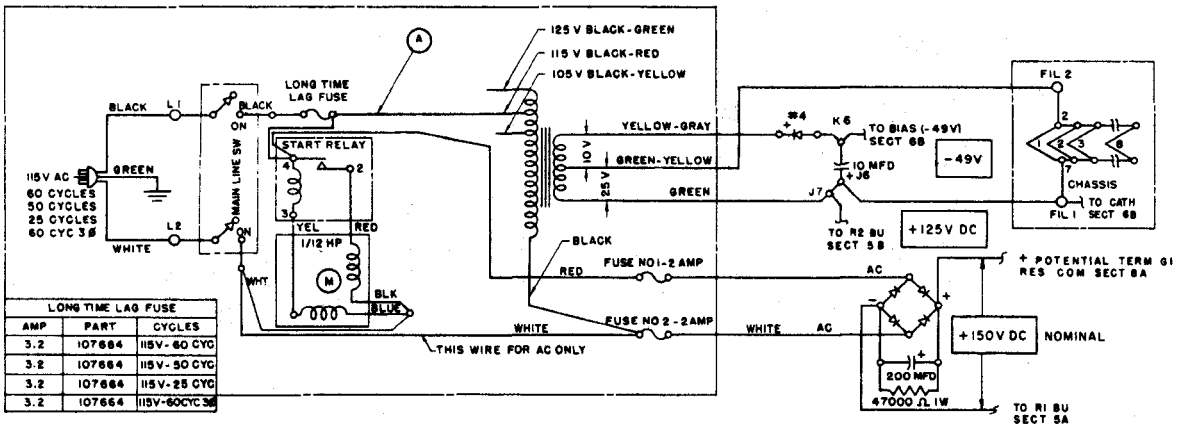
Wiring Diagram

056 INSTRUCTIONAL DIAGRAM

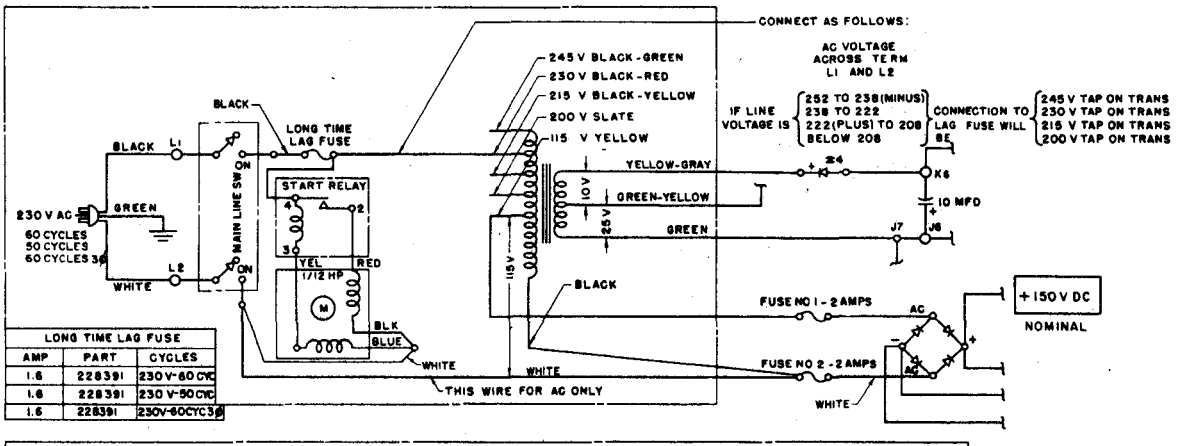
Includes Diagram No. 308601-N
(E.C. 202928) sections 1-16 and supplement
Diagram No. 311496-A (E.C. 202790E)
Sections 17 & 18

INTERNATIONAL BUSINESS MACHINES CORPORATION

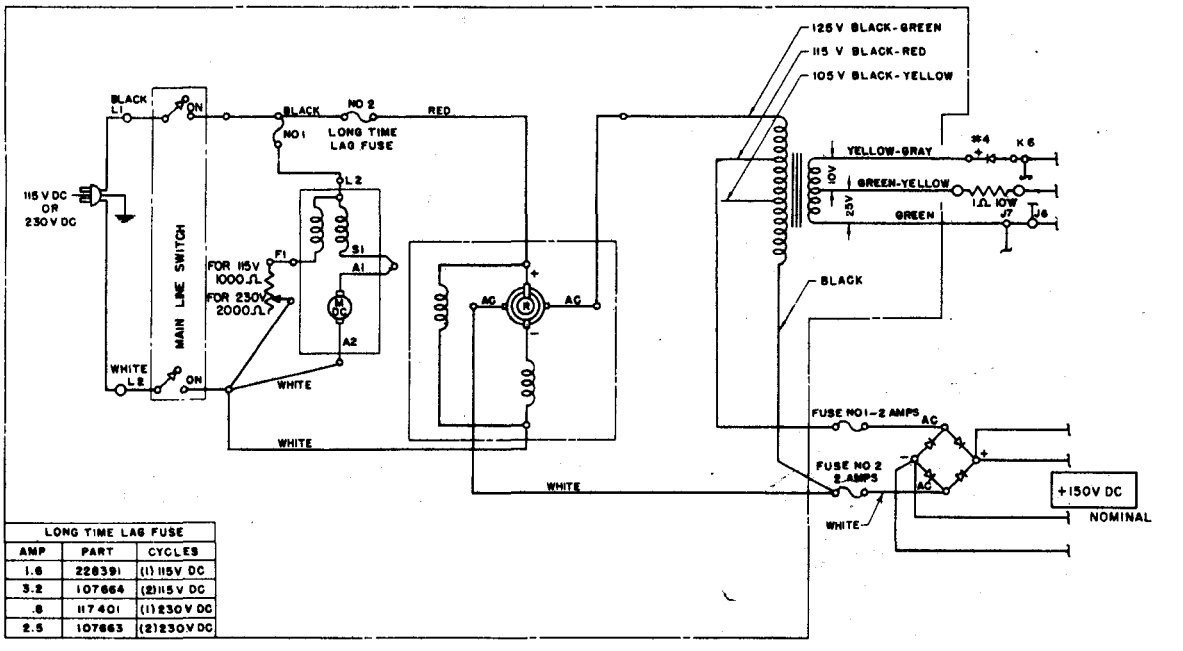
IF LINE VOLTAGE IS { 100 TO 110 / 110 TO 120 / OVER 120 } CONNECTION TO LAG FUSE WILL BE { 105 VOLT TAP ON TRANS (A) / LAG FUSE AS SHOWN / 125 V TAP ON TRANS (A) }



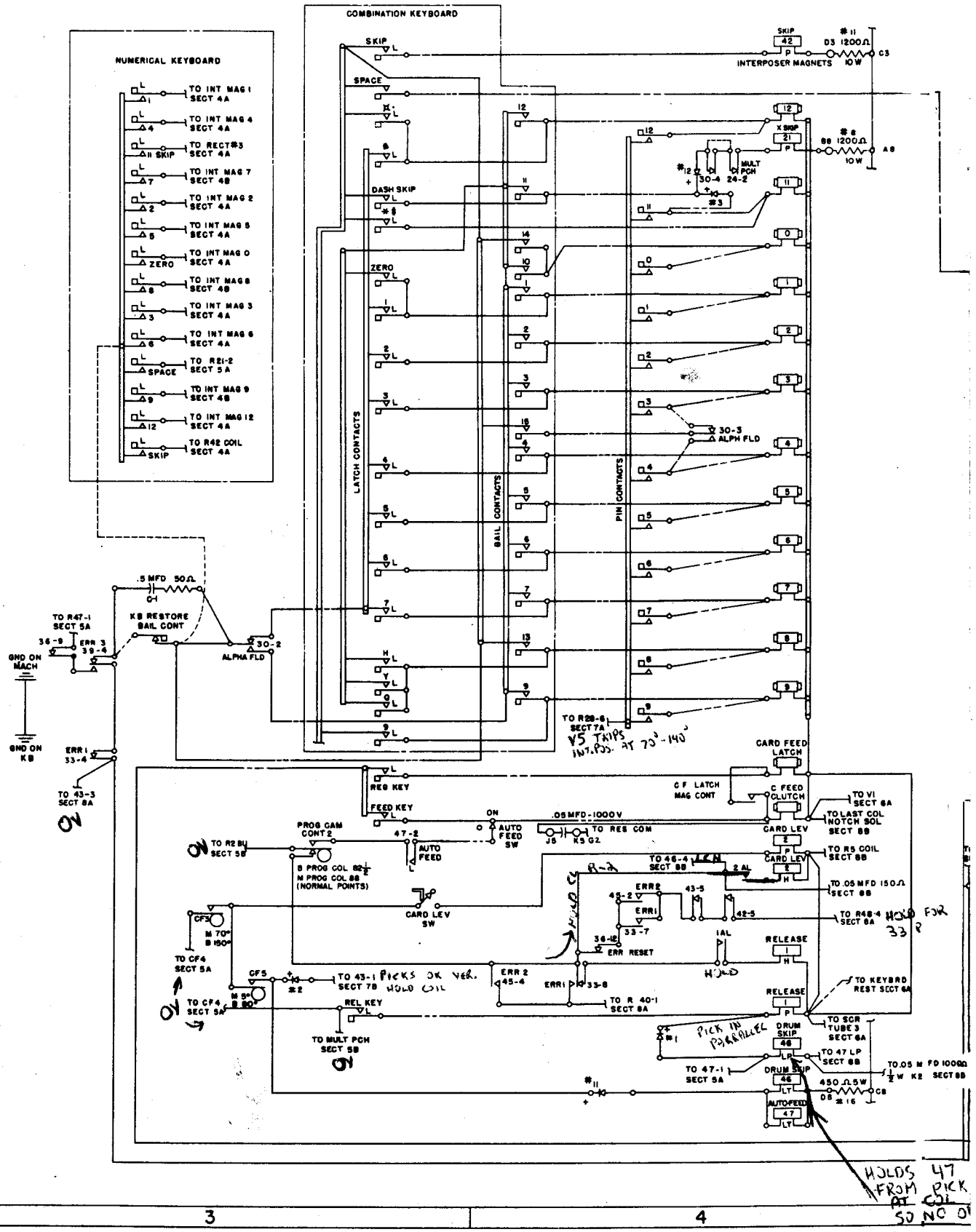
LONG TIME LAG FUSE		
AMP	PART	CYCLES
3.2	107664	115V-60 CYC
3.2	107664	115V-50 CYC
3.2	107664	115V-25 CYC
3.2	107664	115V-60CYC 3Ø

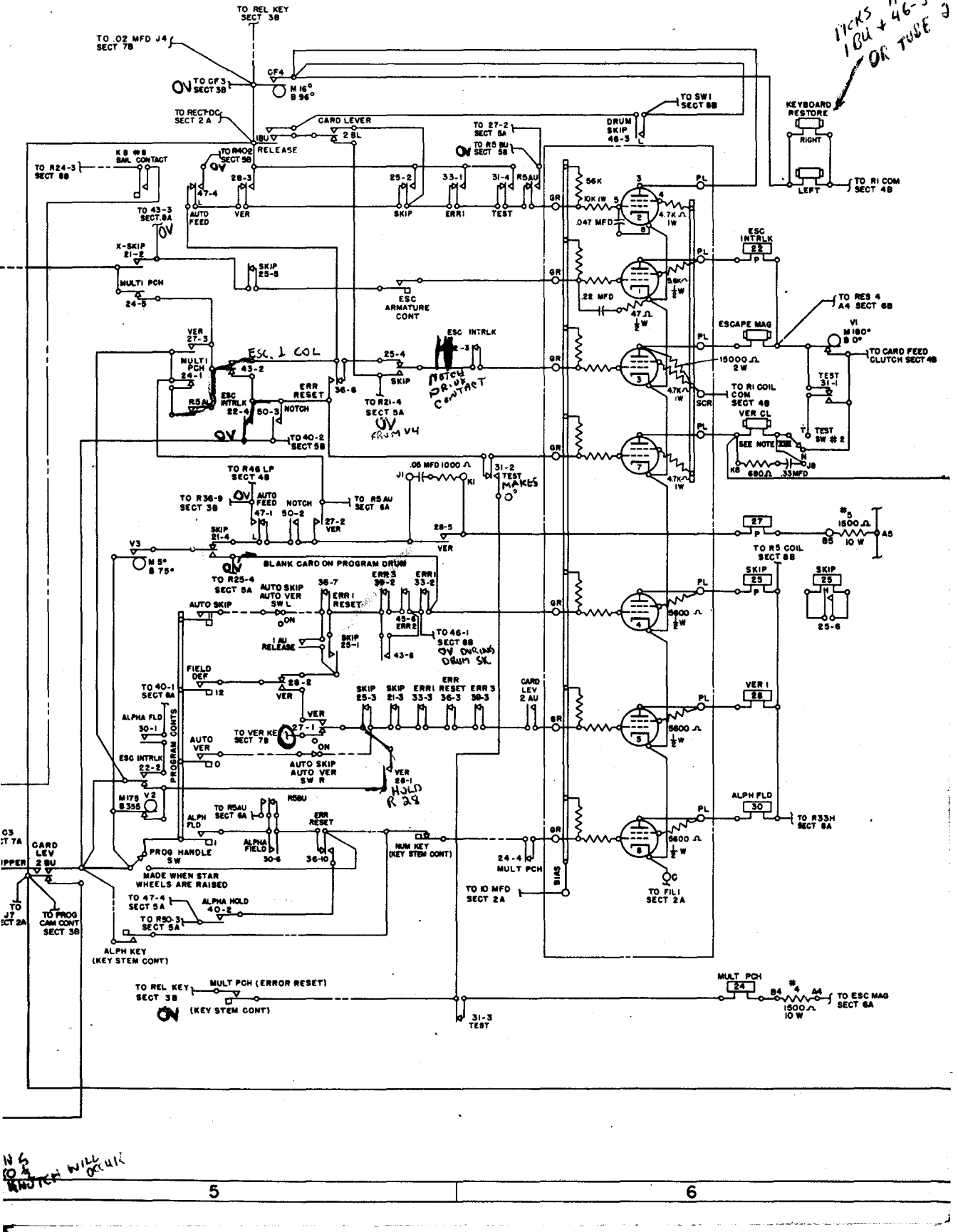


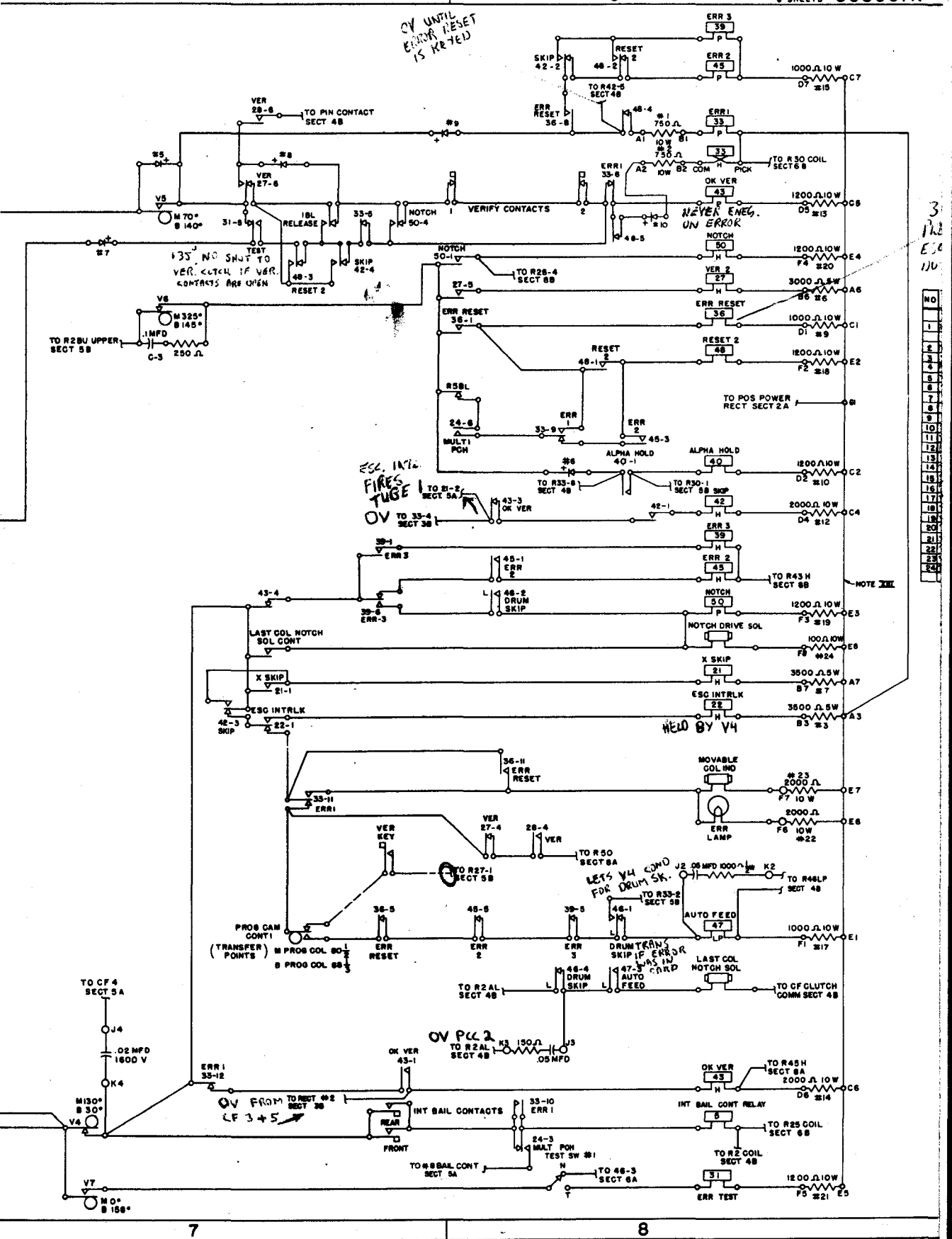
LONG TIME LAG FUSE		
AMP	PART	CYCLES
1.6	228391	230V-60 CYC
1.6	228391	230 V-50 CYC
1.6	228391	230V-60CYC 3Ø



LONG TIME LAG FUSE		
AMP	PART	CYCLES
1.6	228391	(1) 115V DC
3.2	107664	(2) 115 V DC
.8	117401	(1) 230 V DC
2.5	107663	(2) 230 V DC

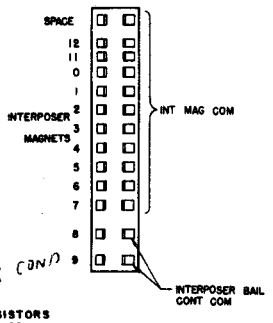

NUMERICAL KEYBOARD
TO INT MAG 1 SECT 4A
TO INT MAG 4 SECT 4A
TO RECT#3 SECT 4A
TO INT MAG 7 SECT 4B
TO INT MAG 2 SECT 4A
TO INT MAG 5 SECT 4A
TO INT MAG 0 SECT 4A
TO INT MAG 8 SECT 4B
TO INT MAG 3 SECT 4A
TO INT MAG 6 SECT 4A
TO R21-2 SECT 5A
TO INT MAG 9 SECT 4B
TO INT MAG 12 SECT 4A
TO R42 COIL SECT 4A
COMBINATION KEYBOARD
SKIP
SPACE
DASH SKIP
ZERO
LATCH CONTACTS
BAIL CONTACTS
PIN CONTACTS
INTERPOSER MAGNETS
D3 1200Ω 10W
D8 1200Ω 10W
30-4 MULT PCH 24-2
30-3 ALPH FLD
30-2 ALPHA FLD
.5 MFD 50Ω
KB RESTORE BAIL CONT
TO R47-1 SECT 5A
GND ON MACH
GND ON KB
TO 43-3 SECT 8A
TO R28-6 SECT 7A
CARD FEED LATCH
C F LATCH MAG CONT
C FEED CLUTCH
TO LAST COL NOTCH SOL SECT 8B
REG KEY
FEED KEY
.05 MFD-1000V
TO RES COM
PROG CAM CONT 2
47-2 AUTO FEED
AUTO FEED SW
CARD LEV SW
TO R2 BU SECT 5B
B PROG COL 82
M PROG COL 88 (NORMAL POINTS)
TO R5 COIL SECT 8B
TO .05 MFD 150Ω SECT 8B
TO R48-4 SECT 8A
TO 46-4 SECT 8B
ERR 1
ERR 2
ERR RESET
RELEASE
TO KEYBRD REST SECT 6A
REL KEY
TO MULT PCH SECT 5B
TO CF4 SECT 5A
TO 43-1 SECT 7B HOLD COIL
TO R 40-1 SECT 8A
DRUM SKIP
TO SCR TUBE 3 SECT 6A
TO 47 LP SECT 8B
TO 47-1 SECT 5A
450Ω .5W
AUTO FEED
TO .05 MFD 100Ω ½W K2 SECT 8B
PICK IN PARALLEL
HOLDS 47 FROM PICK AT 5D
NO 0


TO REL KEY SECT 3B
TO 02 MFD J4 SECT 7B
TO CF3 SECT 3B
CF4
M 16° B 96°
TO RECT DC SECT 2A
CARD LEVER 2 BL
1BU RELEASE
TO R40-2 SECT 5B
TO R24-3 SECT 8B
K 8 8B BAIL CONTACT
TO 43-3 SECT 8A
AUTO FEED
VER
SKIP
ERR1
TEST
TO 27-2 SECT 5A
TO R5 BU SECT 5B
R5AU
DRUM SKIP 46-3
TO SW1 SECT 8B
KEYBOARD RESTORE
RIGHT
LEFT
TO R1 COM SECT 4B
56K
10K 1W
.047 MFD
4.7K 1W
ESC INTRLK 22
TO RES 4 A4 SECT 6B
.22 MFD
47Ω 1/2W
ESCAPE MAG
VI M 180° B 0°
TO CARD FEED CLUTCH SECT 4B
15000Ω 2W
TO R1 COIL COM SECT 4B
SCR
TEST 31-1
VER CL
TO TEST SW # 2
SEE NOTE
K8 680Ω .33MFD
J8
X-SKIP 21-2
MULTI PCH 24-1
24-5
SKIP 25-5
ESC ARMATURE CONT
VER 27-3
ESC. 1 COL
43-2
ESC INTRLK 22-4
R5AU
50-3 NOTCH
ERR RESET
36-6
25-4
SKIP
TO R21-4 SECT 5A
OV FROM V4
NOTCH DRUM CONTACT
TO R46 LP SECT 4B
TO R36-9 SECT 3B
AUTO FEED 47-1
NOTCH 50-2
TO R5 AU SECT 6A
27-2 VER
.06 MFD 1000Ω
J1
K1
31-2 TEST MAKES
SKIP 21-4
28-5
VER
27
1500Ω 10 W
A5
TO R5 COIL SECT 8B
V3
M 5° B 75°
BLANK CARD ON PROGRAM DRUM
TO R25-4 SECT 5A
AUTO SKIP AUTO VER SW L
36-7
ERR1 RESET
ERR3 39-2
ERR1 33-2
AUTO SKIP
ON
1 AU RELEASE
SKIP 25-1
43-6 ERR2
TO 46-1 SECT 8B
OV DURING DRUM SK.
SKIP 25
25-6
FIELD DEF
12
28-2 VER
TO 40-1 SECT 8A
ALPHA FLD 30-1
PROGRAM CONTS
TO VER KEY SECT 7B
27-1 VER
AUTO VER
ESC INTRLK 22-2
AUTO SKIP AUTO VER SW R
VER 28-1
HOLD R29
SKIP 25-3
SKIP 21-3
ERR1 33-3
ERR RESET 36-3
ERR3 39-3
CARD LEV 2 AU
5600Ω 1/2W
VER 28
M 175 V2 B 358
R5BU
TO R5AU SECT 6A
ALPH FLD
ERR RESET
PROG HANDLE SW
ALPHA FIELD 30-6
36-10
NUM KEY (KEY STEM CONT)
ALPH FLD 30
TO R33H SECT 8A
CARD LEV 2 BU
MADE WHEN STAR WHEELS ARE RAISED
TO 47-4 SECT 5A
ALPHA HOLD 40-2
TO R50-3 SECT 5A
TO PROG CAM CONT SECT 3B
ALPH KEY (KEY STEM CONT)
24-4 MULT PCH
BIAS
TO 10 MFD SECT 2A
TO FIL1 SECT 2A
TO REL KEY SECT 3B
MULT PCH (ERROR RESET)
(KEY STEM CONT)
31-3 TEST
MULT PCH 24
1500Ω 10 W
TO ESC MAG SECT 6A
TICKS THRU 1BU + 46-3 OR TUBE 3
KNOTCH WILL OCCUR


OV UNTIL ERROR RESET IS KEYED
ERR 3 39 P
ERR 2 45 P
ERR 1 33 P
RESET 2
SKIP 42-2
46-2
ERR RESET 36-8
46-4
1000Ω 10 W C7
TO R42-6 SECT 4B
TO PIN CONTACT SECT 4B
VER 28-6
VER 27-6
#9
#5
#8
#7
V5
M 70° B 140°
31-8
IBL RELEASE
33-6
NOTCH 50-4
VERIFY CONTACTS
1
2
ERR 1 33-6
OK VER 43
NEVER ENEG. ON ERROR
46-5
#10
1200Ω 10W C5
TO R30 COIL SECT 6B
135° NO SHOT TO VER. CATCH IF VER. CONTACTS ARE OPEN
TEST
48-3
RESET 2
SKIP 42-4
NOTCH 50-1
NOTCH 50
1200Ω 10W E4
TO R28-4 SECT 8B
27-5
VER 2 27
3000Ω 5W A6
ERR RESET 36
1000Ω 10W C1
RESET 2 48
1200Ω 10W E2
V6
M 325° B 145°
.1 MFD C-3
250Ω
TO R2BU UPPER SECT 5B
R5BL
24-6
MULTI PCH
ERR 1 33-9
ERR 2 45-3
TO POS POWER RECT SECT 2A
ESC. INTL.
FIRES TUBE 1
TO 21-2 SECT 5A
43-3 OK VER
OV TO 33-4 SECT 3B
ALPHA HOLD 40-1
ALPHA HOLD 40
1200Ω 10W C2
TO R33-8 SECT 4B
TO R30-1 SECT 5B SKIP
42
2000Ω 10W C4
42-1
ERR 3 39
ERR 2 45
TO R43 H SECT 8B
NOTE XIII
45-1 ERR 2
46-2 DRUM SKIP
39-1 ERR 3
39-8 ERR-3
43-4
NOTCH 50
1200Ω 10W E3
NOTCH DRIVE SOL
100Ω 10W E8
LAST COL NOTCH SOL CONT
X SKIP 21
3500Ω 5W A7
ESC INTRLK 22
3500Ω 5W A3
HELD BY V4
X SKIP 21-1
ESC INTRLK 22-1
46-3 SKIP
36-11 ERR RESET
33-11 ERR 1
MOVABLE COL IND
#23 2000Ω F7 10 W E7
2000Ω F6 10W #22 E6
ERR LAMP
VER KEY
VER 27-4
28-4 VER
TO R50 SECT 8A
TO R27-1 SECT 5B
LETS V4 COND FOR DRUM SK.
J2 .05 MFD 1000Ω 1W K2
TO R46LP SECT 4B
TO R33-2 SECT 5B
PROG CAM CONT (TRANSFER POINTS)
36-5 ERR RESET
46-6 ERR 2
39-5 ERR 3
46-1 DRUM SKIP
AUTO FEED 47
1000Ω 10W F1 #17 E1
TRANS SKIP IF ERROR HAS IN CARD
LAST COL NOTCH SOL
46-4 DRUM SKIP
47-3 AUTO FEED
TO R2AL SECT 4B
TO CF CLUTCH COMM SECT 4B
TO CF 4 SECT 5A
J4
.02 MFD 1600 V
K4
M130° B 30°
V4
OV PCC 2
TO R2AL SECT 4B
K3 150Ω
.05 MFD J3
ERR 1 35-12
OK VER 43-1
OK VER 43
TO R45 H SECT 8A
2000Ω 10W C6
OV FROM TO SECT #2 SECT 3B
LF 3+5
INT BAIL CONTACTS
REAR
FRONT
33-10 ERR 1
INT BAIL CONT RELAY
TO R25 COIL SECT 6B
24-3 MULT PCH TEST SW #1
TO R2 COIL SECT 4B
TO 8 BAIL CONT SECT 5A
TO 46-3 SECT 6A
31 ERR TEST
1200Ω 10W F5 #21 E5
V7
M 0° B 150°

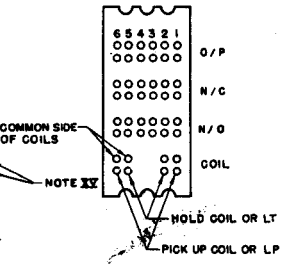
WIRE CONTACT RELAYS

PUNCH UNIT TERMINAL BLOCK FACING WRINKLED LUGS



RELAY NO	P COIL	H COIL	1	2	3	4	5	6	7	8	9	10	11	12	PART NO
21	4A	8B	7B	5A	5B	5A									196208
22	6A	8B	7B	5B	6A	5A									196208
24	6B		5A	4A	8B	6B	5A	8A							196196
25	6B	6B	5B	5A	5B	5A	5A	6B							196197
27	6A	8A	5B	5A	5A	8B	8A	7A							196198
28	6B		5B	5B	5A	8B	5A	7A							196196
30	6B		5B	3B	4A	4A		5B							196196
31	8B		6A	6A	6B	6A	7A								196196
33	8A	8A	5A	5B	5B	3B	7A	8A	4B	4B	6A	8B	7B	7B	196187
36	8A		8A		5B	AUXVER	7B	5A	5B	8A	3B	5B	8B	4B	196186
39	8A	8A	7A	5B	6B	3B	8B	7A							196198
40	8A		9A	5B											196206
42	4A	8A	8A	8A	7B	7A	4B								196198
43	8A	8B	7B	5A	8A	7B	4B	5B							196198
45	8A	8A	8A	4B	8A	4B	8B	5B							196198
46	4B	4B	8B	8A	6A	8B									186685
47	8B	4B	5A	3B	8B	5A									196686
48	8A		8A	8A	7A	8A	8A								196196
50	8A	8A	8A	5A	5A	7A									196207

WIRE CONTACT RELAY TERMINAL MOULDING WIRE SIDE



RESISTORS POWER SUPPLY MTG PANEL

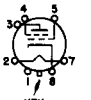
LOCATION BETWEEN	RESISTANCE	WATTS	PART NO	SECT
ERM A1-B1	750	10	340915	8A
ERM A2-B2	750	10	340914	8A
ERM A3-B3	3500	5	340909	8B
ERM A4-B4	1500	10	340916	6B
ERM A5-B5	1500	10	340916	6A
ERM A6-B6	3000	5	340918	8A
ERM A7-B7	3500	5	340909	8B
ERM A8-B8	1200	10	340908	4A
ERM C1-D1	1000	10	340920	8A
ERM C2-D2	1200	10	340919	8A
ERM C3-D3	1200	10	340919	4A
ERM C4-D4	2000	10	310915	8A
ERM C5-D5	1200	10	340908	8A
ERM C6-D6	2000	10	340924	8B
ERM C7-D7	1000	10	340921	8A
ERM C8-D8	450	5	340917	4B
ERM E1-F1	1000	10	340920	8B
ERM E2-F2	1200	10	340919	8A
ERM E3-F3	1200	10	340919	8B
ERM E4-F4	1200	10	340908	8A
ERM E6-F6	1200	10	340908	8B
ERM E6-F6	2000	10	340924	8B
ERM E7-F7	2000	10	340924	8B
ERM E8-F8	100	10	251609	8B
MAX TOLERANCE OF ALL RESISTORS ±10%				

CAPACITORS

LOCATION	SECT	CAP	RESSTANCE IN SERIES	WVDC	PART NO
DC SUPPLY	2A	200 MFD		200	167726
G-1	3B	.5 MFD	50 Ω	400	173706
C-3	7A	.1 MFD	250 Ω		193257
TERM J6,7-K6	2A	10 MFD		50	310919
TERM J 5-K5	4B	.05 MFD		1000	310918
TERM J 3-K3	8B	.05 MFD	150 Ω	400	340912
TERM J4-K4	7B	.02 MFD		1600	310920
TERM J1-K1	5A	.05 MFD	1000 Ω	400	341028
TERM J8-K8	6A	.33 MFD	680 Ω	600	344675
TERM J2-K2	8B	.05 MFD	1000 Ω	400	341028

DUO RELAYS

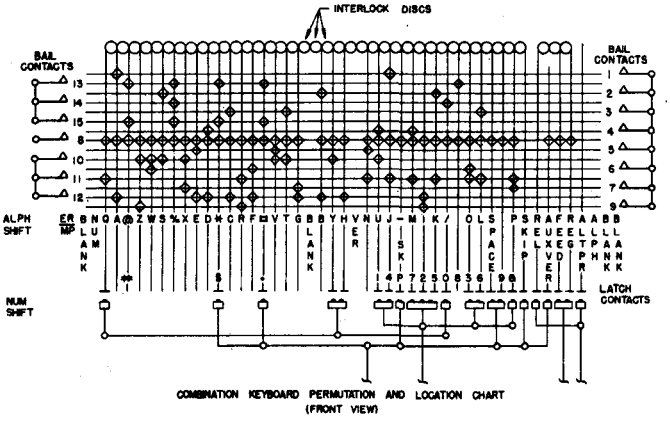
RELAY NO	P COIL	H COIL	AL PT	AU PT	BL PT	BU PT	PART NO
1	4B	4B	4B	5B	7A	5A	228210
2	4B	4B	4B	6A	5A	5B	228210
5	8B		5A	6A	8A	8B	282748



KEY
25L6 TUBE
BOTTOM VIEW OF SOCKET

RECTIFIERS

LOCATION	SECT	MILS RATING	PART NO
POWER RECT	2A	1000	340913
NO1 RECT STACK	4B	100	76162
NO2 RECT STACK	3B	100	76162
NO3 RECT STACK	4A	100	76162
NO 4 RECT STACK	2A	75	225618
NO 5 RECT STACK	7A	100	76162
NO 6 RECT STACK	8A	100	76162
NO 7 RECT STACK	7A	100	76162
NO 8 RECT STACK	7A	100	76162
NO 9 RECT STACK	8A	100	76162
NO 10 RECT STACK	8A	100	76162
NO 11 RECT STACK	4A	100	76162
NO 12 RECT STACK	4B	100	76162



NOTES

XIII ALL TUBES 25L6'S PART NO 192906

XIV ALL GRID LIMITING RESISTORS ARE 10,000 Ω (PART NO 184093) UNLESS OTHERWISE NOTED

XIII ALL BIAS RESISTORS ARE 56,000 Ω .5W (PART NO 301149)

XIII RESISTOR COMMON NOT WIRED POINT TO POINT

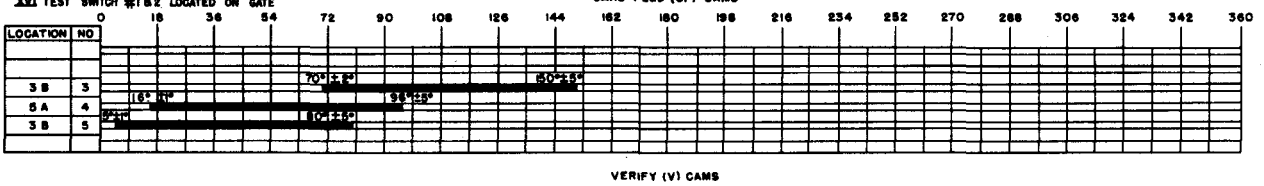
XIV TUBE NO 8, RELAYS 30 AND 40, AND ASSOCIATED RESISTORS USED ON MACHINES WITH COMB KEYBOARDS ONLY

XV RELAYS 46 AND 47 ARE LATCH RELAYS
——— INDICATES SOLID BAR (COMMON)
– – – – INDICATES WIRING WHEN COMB KEYBOARD IS USED
– – – – INDICATES WIRING WHEN NUMERIC KEYBOARD IS USED

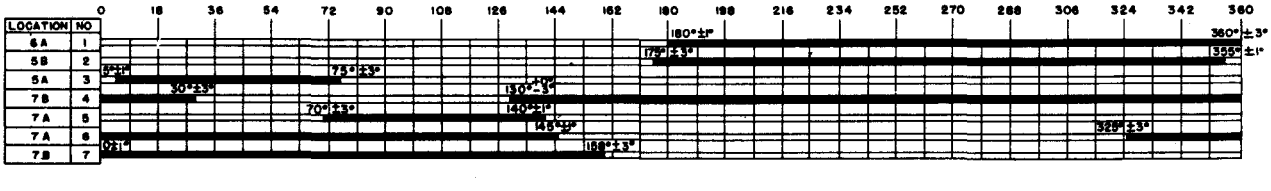
* ALPH MACHINES ONLY
SP CHARACTER KEYS MECHANICALLY INOPERATIVE ON STANDARD MACHINES

XVI TEST SWITCH #182 LOCATED ON GATE

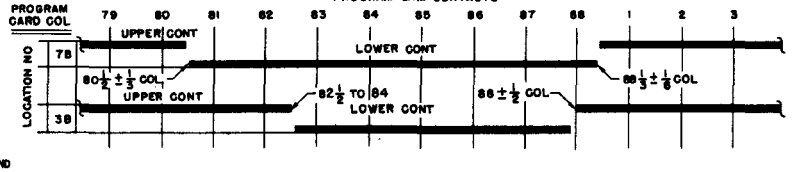
CARD FEED (CF) CAMS



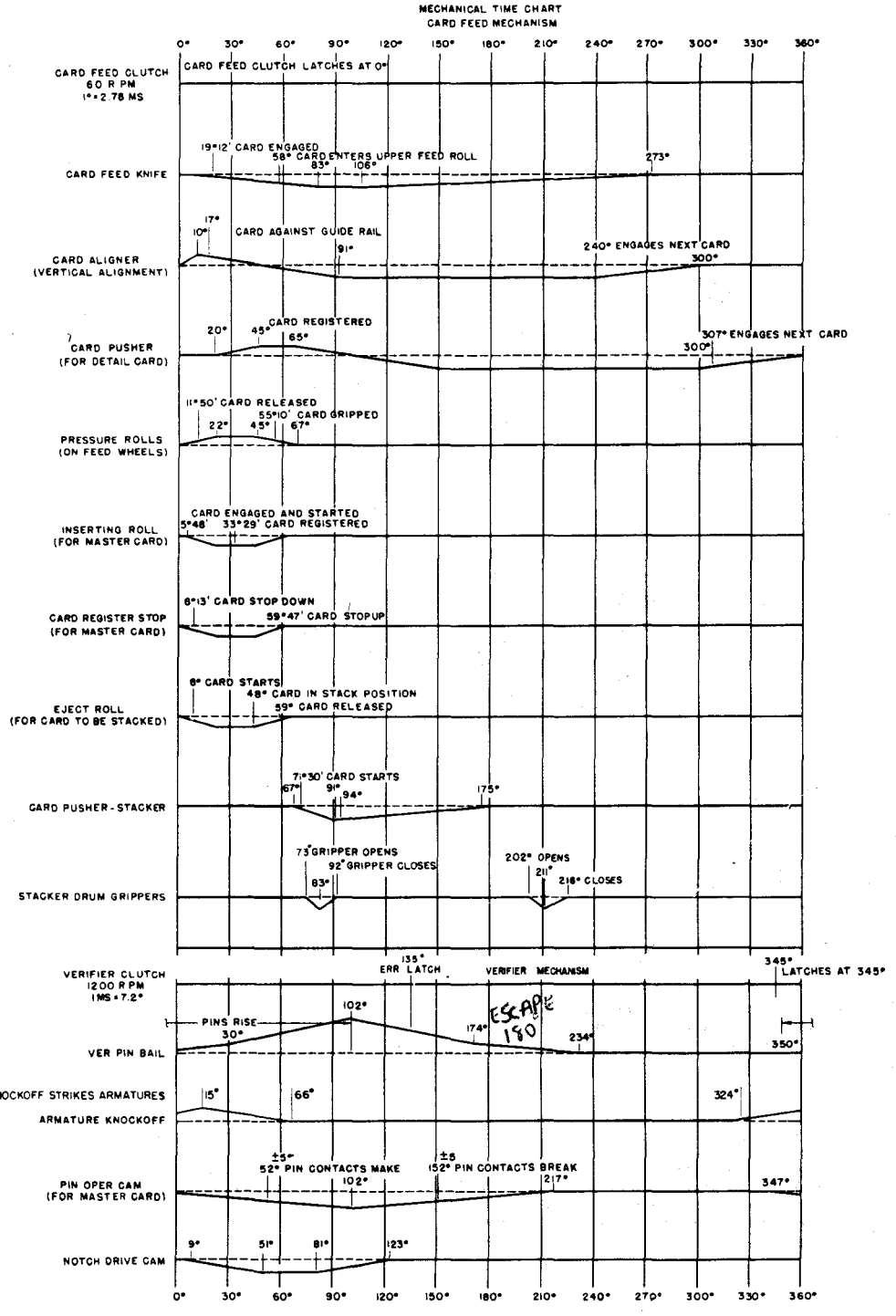
VERIFY (V) CAMS

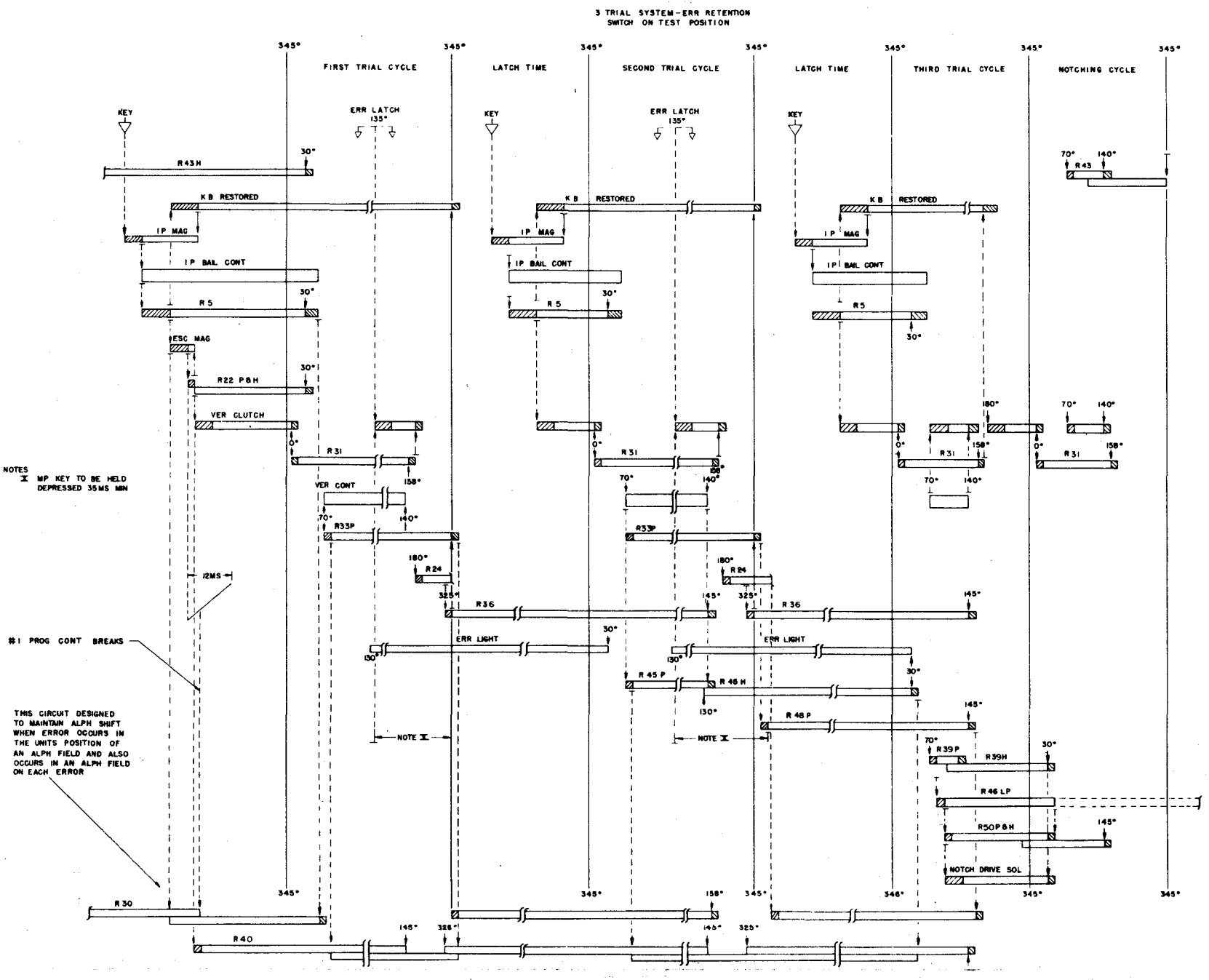


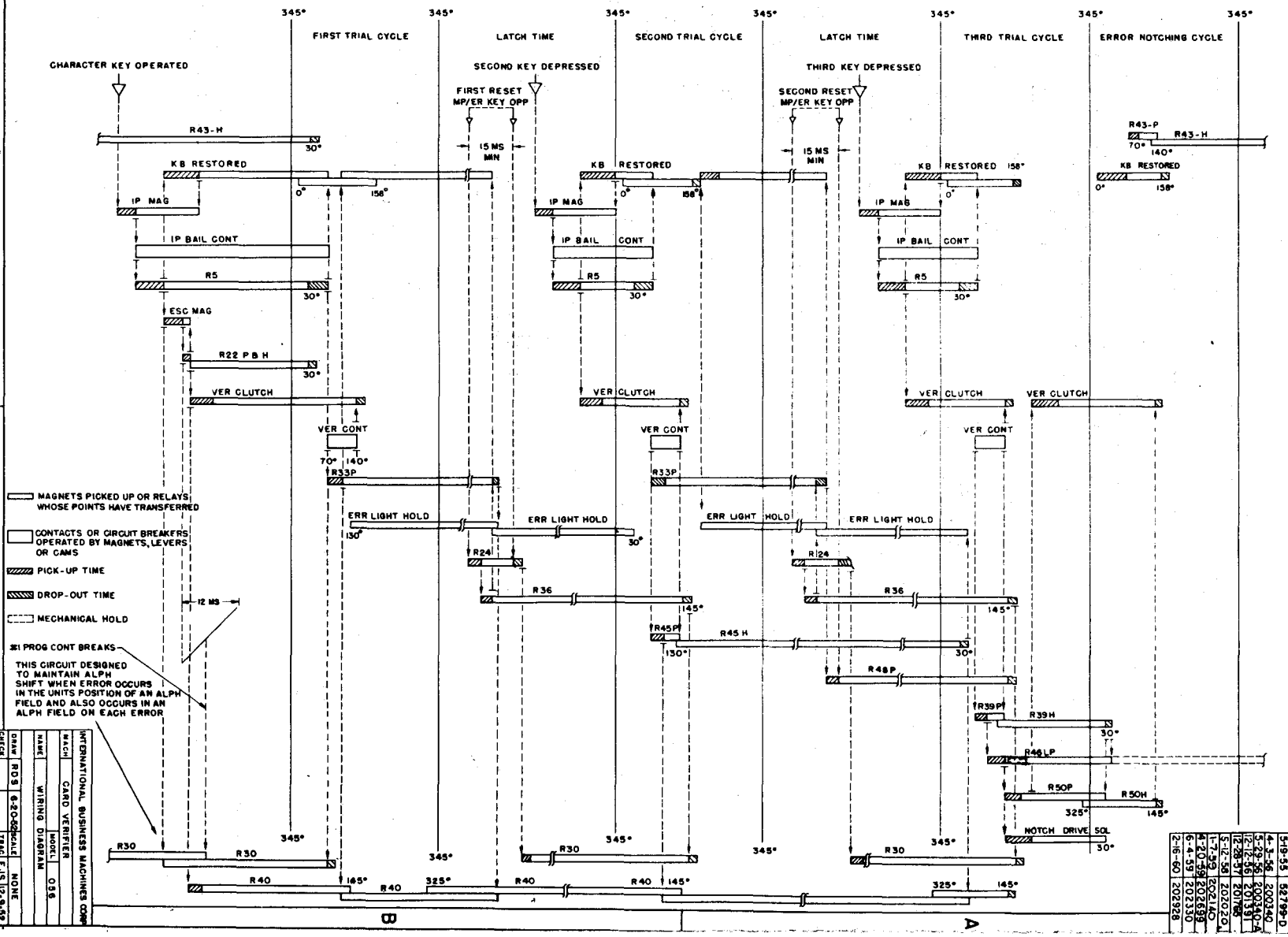
PROGRAM CAM CONTACTS



XVII-WHEN CYCLING MACHINE BY HAND CARE MUST BE TAKEN NOT TO STOP BETWEEN 70° AND 140° THE VER CLUTCH MAG COIL WOULD BE DAMAGED


MECHANICAL TIME CHART
CARD FEED MECHANISM
0° 30° 60° 90° 120° 150° 180° 210° 240° 270° 300° 330° 360°
CARD FEED CLUTCH 60 R PM 1°=2.78 MS
CARD FEED CLUTCH LATCHES AT 0°
CARD FEED KNIFE
19°12' CARD ENGAGED
58° CARD ENTERS UPPER FEED ROLL
83°
106°
273°
CARD ALIGNER (VERTICAL ALIGNMENT)
17°
10°
CARD AGAINST GUIDE RAIL
91°
240° ENGAGES NEXT CARD
300°
CARD PUSHER (FOR DETAIL CARD)
20°
45°
CARD REGISTERED
65°
307° ENGAGES NEXT CARD
300°
PRESSURE ROLLS (ON FEED WHEELS)
11°50' CARD RELEASED
55°10' CARD GRIPPED
22°
45°
67°
INSERTING ROLL (FOR MASTER CARD)
CARD ENGAGED AND STARTED
5°48'
33°29' CARD REGISTERED
CARD REGISTER STOP (FOR MASTER CARD)
6°13' CARD STOP DOWN
59°47' CARD STOP UP
EJECT ROLL (FOR CARD TO BE STACKED)
6° CARD STARTS
48° CARD IN STACK POSITION
59° CARD RELEASED
CARD PUSHER-STACKER
7°30' CARD STARTS
67°
91°
94°
175°
STACKER DRUM GRIPPERS
73° GRIPPER OPENS
92° GRIPPER CLOSES
83°
202° OPENS
211°
218° CLOSES
VERIFIER CLUTCH 1200 R PM 1MS=7.2°
135°
ERR LATCH
VERIFIER MECHANISM
348°
LATCHES AT 345°
PINS RISE
30°
102°
174°
ESCAPE
180
234°
350°
VER PIN BAIL
KNOCKOFF STRIKES ARMATURES
15°
66°
324°
ARMATURE KNOCKOFF
±5°
52° PIN CONTACTS MAKE
102°
±5
152° PIN CONTACTS BREAK
217°
347°
PIN OPER CAM (FOR MASTER CARD)
9°
51°
81°
123°
NOTCH DRIVE CAM
0° 30° 60° 90° 120° 150° 180° 210° 240° 270° 300° 330° 360°


3 TRIAL SYSTEM-ERR RETENTION
SWITCH ON TEST POSITION
FIRST TRIAL CYCLE
LATCH TIME
SECOND TRIAL CYCLE
LATCH TIME
THIRD TRIAL CYCLE
NOTCHING CYCLE
KEY
ERR LATCH
135°
345°
R43H
30°
K B RESTORED
I P MAG
I P BAIL CONT
R 5
ESC MAG
R22 P&H
VER CLUTCH
R 31
158°
VER CONT
70°
140°
R33P
180°
R24
325°
145°
R36
ERR LIGHT
130°
R45 P
R46 H
R48 P
R39P
R39H
R46 LP
R50P&H
NOTCH DRIVE SOL
R43
0°
12MS
NOTE X
#1 PROG CONT BREAKS
THIS CIRCUIT DESIGNED TO MAINTAIN ALPH SHIFT WHEN ERROR OCCURS IN THE UNITS POSITION OF AN ALPH FIELD AND ALSO OCCURS IN AN ALPH FIELD ON EACH ERROR
R30
R40
NOTES
X MP KEY TO BE HELD DEPRESSED 35 MS MIN



INTERNATIONAL BUSINESS MACHINES CORP.
MACH CARD VERIFIER
MODEL 056
NAME WIRING DIAGRAM
DRAW RDS 6-20-58 SCALE NONE
TRAC EJS 12-8-58
CHECK
APPRO

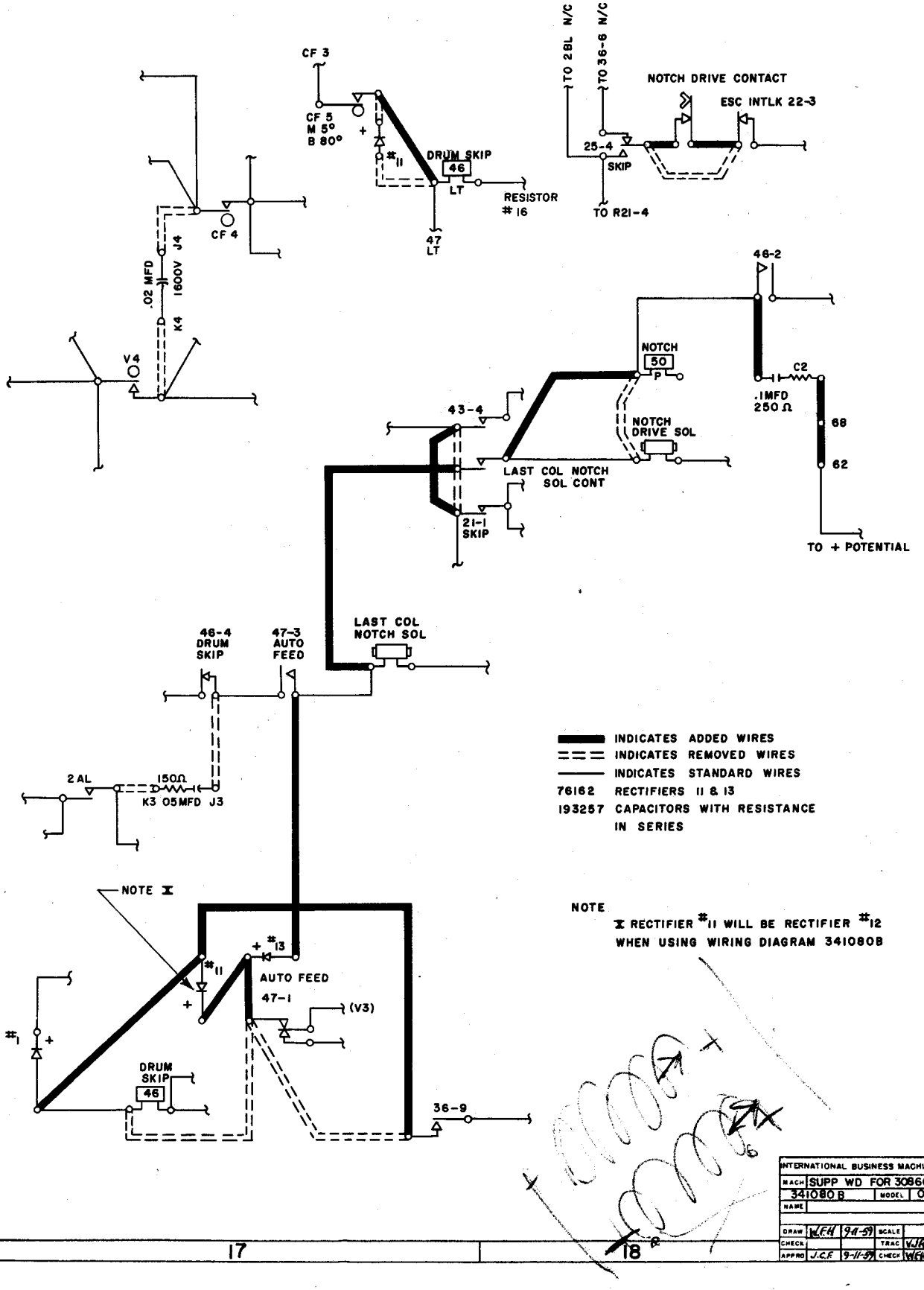
DATE	CHANGE NO	QTY
SEE INDEX CARD		
8-7-53	52603	
8-21-53	52811	
1-11-54	54146	
5-19-55	52799-D	
4-3-56	200340	
12-28-56	200340-A	
12-28-57	201198	
5-12-58	202020	
1-7-59	202140	
4-20-59	202699	
6-4-59	202330	
2-16-60	202928	

STANDARDS CODE NONE
RELEASED FOR ASSEM
SHEET 8 OF 8 SHEETS

30860I-N

15 16 15 16 B A

311496A
DATE 9-16-59 CHANGE NO 202790E

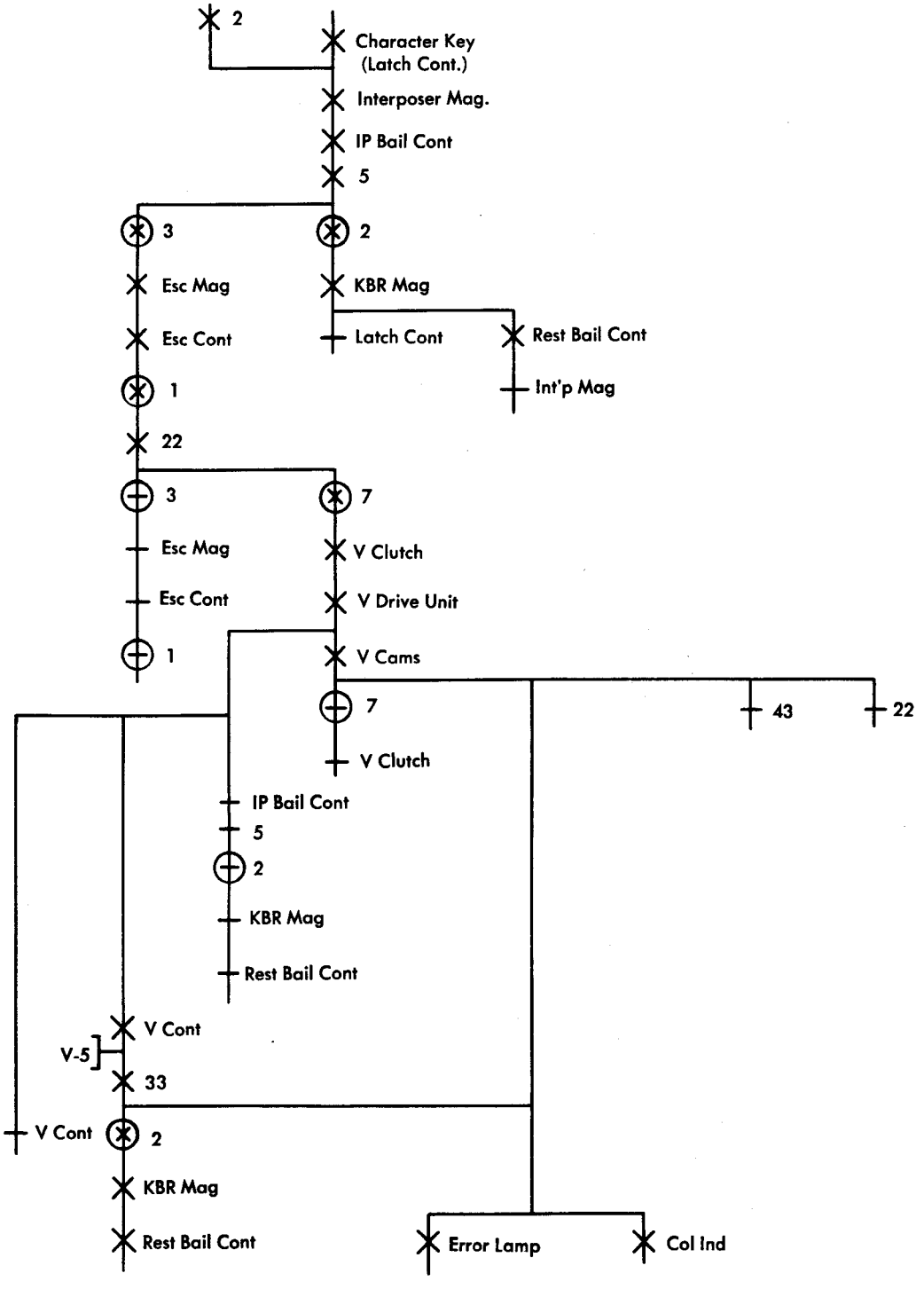


INDICATES ADDED WIRES
INDICATES REMOVED WIRES
INDICATES STANDARD WIRES
76162 RECTIFIERS 11 & 13
193257 CAPACITORS WITH RESISTANCE IN SERIES

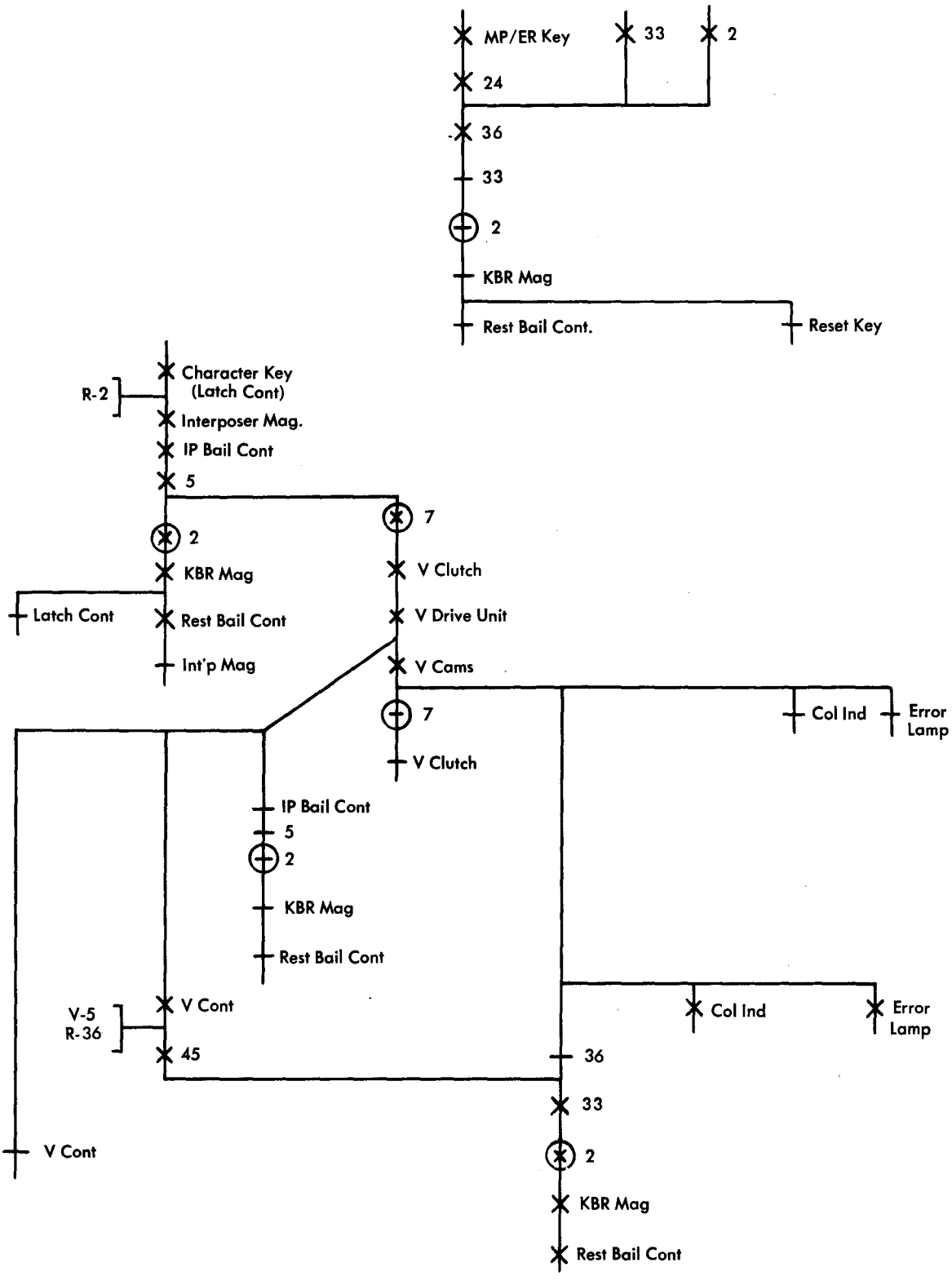
NOTE
I RECTIFIER #11 WILL BE RECTIFIER #12 WHEN USING WIRING DIAGRAM 3410808

INTERNATIONAL BUSINESS MACHINES CORP					
MACH	SUPP WD FOR 3086 0IN & 3410808		MODEL	056	
NAME					
DRAW	W.F.H	9-1-59	SCALE		
CHECK			TRAC	W.J.R	9-11-59
APPRO	J.C.F	9-11-59	CHECK	W.G.K	9-11-59

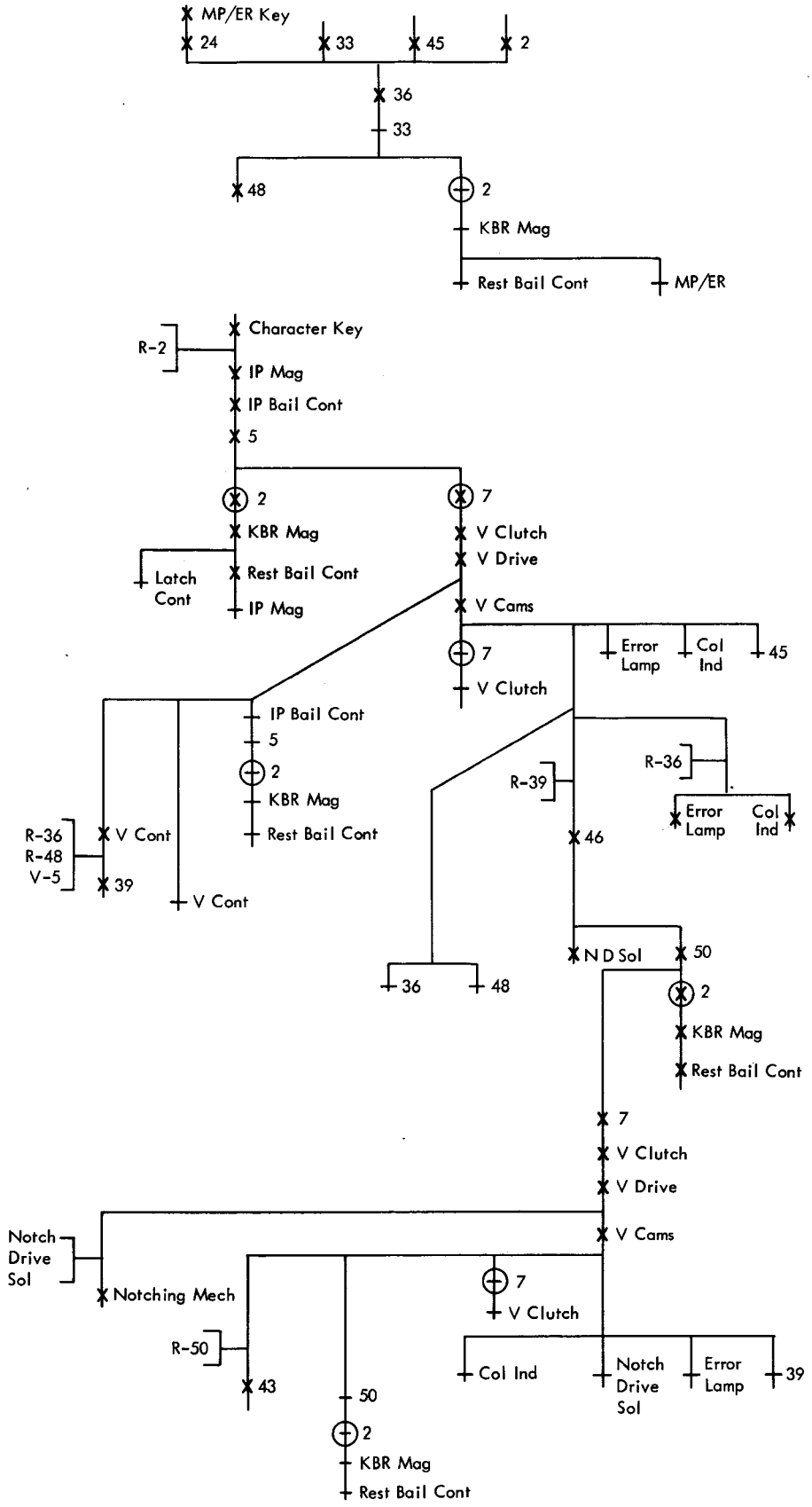
FIRST ERROR CYCLE



RESET & 2ND ERROR CYCLE



RESET, THIRD ERROR CYCLE & NOTCH



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